AgroSym

BOOK OF PROCEEDINGS

IX International Scientific Agriculture Symposium
"Agrosym 2018"
Jahorina, October 04-07, 2018

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Impressum

IX International Scientific Agriculture Symposium „AGROSYM 2018“

Book of Proceedings Published by

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CIP - Каталогизација у публикацији
Народна и универзитетска библиотека
Републике Српске, Бања Лука

631(082)

INTERNATIONAL Scientific Agricultural Symposium "Agrosym 2018" (9 ; Jahorina)
Book of Proceedings [Elektronski izvor] / IX International Scientific Agriculture Symposium "Agrosym 2018", Jahorina, October 04 - 07, 2018 ; [editor in chief Dušan Kovačević]. - East Sarajevo =Istočno Sarajevo : Faculty of Agriculture =Poljoprivredni fakultet, 2018

Način pristupa (URL):
http://agrosym.ues.rs.ba/index.php/en/archive. - Bibliografija uz radove. - Registar.

ISBN 978-99976-718-8-2

COBISS.RS-ID 7815448

PROPERTIES OF APRICOT (*Prunus armeniaca* L.) GENOTYPES SELECTED IN THE ČAČAK REGION (CENTRAL SERBIA)

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Abstract

The Čačak region (central Serbia) is famous for apricot growing, accounting for about 10% of total apricot production in Serbia, with 3–4,000 t of fruit produced in high-yield years. Research was conducted from 2008 to 2012 to evaluate a large number of apricot genotypes in the region. Five genotypes exhibiting the best performance were singled out and marked with the letters GG and the numbers 1–5. This paper presents two-year results on the properties of these genotypes and their comparison with cv. 'Roxana' used as the control. Phenological characteristics (flowering and ripening), leaf traits and fruit attributes were assessed. The results showed that, compared to the control, all apricot genotypes began to flower 2 to 3 days earlier and were similar in both the progress and abundance of flowering. The onset and termination of ripening in all genotypes were 5 to 6 days earlier than in the control cultivar. As far as leaf properties are concerned, the genotypes GG_1 and GG_2 had larger leaf dimensions compared to the control. The petioles in all genotypes were shorter and had fewer glands than those of 'Roxana'. Regarding fruit dimensions and fruit weight, the fruit size of GG_5, followed by GG_4, was similar to that of 'Roxana', whereas the other genotypes had smaller fruit dimensions and lower weight. Soluble solids content was highest in GG_1. There was no significant difference in this trait between 'Roxana' and the tested genotypes. Overall, the largest number of positive properties was found in GG_5 and GG_4, which could be used as experimental material in further research, as well as for orchard establishment.

Keywords: *Apricot, genotype, phenological properties, fruit traits*

Introduction

Apricot (*Prunus armeniaca* L.) originates from western China, where apricot kernels have been found dating back to 5,000 or 6,000 B.C. The natural gene centres of origin of apricots are the Tian Shan mountains, the Sungari and Amur River valleys, parts of Manchuria and the region around Beijing (Milošević, 1997). Apricots are widely grown today in the Mediterranean countries, as well as in Iran, Pakistan and Uzbekistan. Turkey is the largest apricot producer, with the total annual production of 695,364 t (FAOSTAT, 2014). In terms of apricot acreage, Serbia ranks eighth in Europe. Central Serbia, particularly the Čačak region, is rich in biodiversity as a source of apricot germplasm; hence the abundance of different genotypes, varieties and forms. There is a large number of individual apricot trees, in gardens, fields or neglected areas of land, which are grafted using unknown material, mostly on myrobalan plum (*Prunus cerasifera* Ehrh) or 'Belošljiva' (*Prunus domestica* L.). Some of these trees have positive biological and pomological traits, and are gladly chosen for plantations around Čačak, where they are grown under different local names and equally distributed along with the most dominant cultivars, such as 'Hungarian Best', 'Roxana' and the Novi Sad cultivars 'NS 4' and 'NS Rodna' (Milošević *et al*., 2009, Milošević *et al*., 2011). The objective of this study was to assess the selected apricot genotypes in the Čačak region, focusing on their phenological and pomological traits. The selected genotypes can be used for

future breeding work, and can also be grown in new apricot orchards under similar environmental conditions.

Material and Methods

The research was conducted in an apricot orchard in the village of Gornja Gorevnica located 9 km northwest of Čačak (20°57'48" N; 20°19'31" E; 396 m a.s.l.). Apricot trees were grafted high above ground level (60-80 cm) on the 'Belošljiva' vegetative rootstock, and were planted at a spacing of 5 × 4 m (500 trees ha^{-1}). The vase training system with 3-4 scaffold branches was employed. The cultural operations common in intensive apricot orchards were used, without irrigation (due to lack of sufficient amounts of water and consequential irrigation irregularity).

The farm household where the research was conducted is traditionally engaged in apricot growing. In 2005, 2006 and 2007, scions were collected from the best oldest apricot trees from this and surrounding farms to perform grafting for orchard establishment. In autumn 2008, a new orchard was established for research purposes. During initial years after planting, trees were monitored for growth and development, coming into bearing, vitality and other properties. After 4 years (in 2012), 8 trees having positive traits and good initial cropping were singled out. In the following year (2013), 5 trees repeated their positive traits; therefore, these trees were marked as genotypes for future research and observation. The genotypes were marked with the numbers 1-5, preceded by the letters GG, abbreviated from Gornja Gorevnica, the village where they were singled out (GG 1, GG 2, GG 3, GG 4 and GG 5). The genotypes were singled out for their large fruit weight, great initial cropping and high vitality during initial years after planting. The trees were marked and analysed in the following year (2014), in the 6th growing season of the orchard. The genotypes were compared with cv. 'Roxana' (control).

The genotypes were characterised and evaluated in accordance with the Apricot Descriptor (Guerriero and Watkins, 1984).

The analysis focused on:

-Flowering (beginning, full, end and abundance);

-Fruit ripening (beginning, end);

-Leaf and petiole traits (length, width, number of glands on the petiole)

-Fruit traits (dimensions, weight, stone weight, soluble solids content (^{o}Brix).

Leaf and petiole lengths (mm) were measured by a ruler, and fruit dimensions were taken by an INOX 1/20mm calliper. Fruit and stone weights were measured using a KERN FCB precision balance (Kern & Sohn GmbH, Belingen, Germany) with a weighing range of 6,100 g and an accuracy of ±0.2 g. Soluble solids content (^{o}Brix) was assessed by a Milwaukee MR 200 hand refractometer (ATC, Rocky Mount, USA). The obtained data were subjected to statistical analysis by calculating the mean value, and its absolute variation was determined by the standard error of the mean (±SE). The statistical analysis and testing of the significance of differences were performed by the analysis of variance and LSD test at a significance level of $P \leq 0.05$ using the Statistica statistical software, Version 5.0 (SPSS for Windows, Chicago, Illinois,USA).

Results and Discussion

The results on the beginning of flowering, full flowering and end of flowering, as well as on the abundance of flowering, are presented in Tab. 1.

Tab. 1. Flowering of apricot trees

Genotype (cultivar)	Flowering			
	Beginning	Full	End	Abundance
GG 1	14 March	17 March	22 March	4
GG 2	15 March	18 March	22 March	4
GG 3	15 March	18 March	23 March	3
GG 4	14 March	17 March	22 March	4
GG 5	14 March	17 March	22 March	4
Roxana	17 March	20 March	27 March	4

The beginning of flowering in the studied genotypes ranged over a short period from 14 to 15 March, the earliest (on 14 March) in GG1, GG4 and GG5, a day later in GG2 and GG3, and the latest in the control cv. 'Roxana' (17 March). Full flowering was first reached in GG1, GG4 and GG5 on 17 March, followed by GG2 and GG3 on 18 March, whereas the latest full flowering date was observed in 'Roxana' on 27 March. The end of flowering date showed the same pattern: flowering ended first in GG1, GG2, GG4 and GG5 on 22 March, followed by GG3 on 23 March and 'Roxana' on 27 March. The analysis of the results revealed that the shortest flowering was in GG2 (7 days) and the longest in 'Roxana' (10 days). The abundance of flowering was lowest in GG3 (rating: 3), as opposed to the higher identical abundance of flowering in the other genotypes (rating: 4). As shown, differences in the beginning and end of flowering dates among genotypes were not significant, and were characteristic of 'Roxana' and the genotypes analysed (Milošević, 1997). This subject has also been dealt with by Milatović *et al*. (2015). In their research, the average flowering time was at the end of March and beginning of April. Flowering time differed across years, as also found by Vachun (2003). Mehlenbacher *et al.* (1991) observed that the beginning and course of growth stages are affected by a multitude of factors. Ripening time in the tested genotypes and the control cultivar is presented in Tab. 2.

Tab. 2. Fruit ripening of apricot trees

Genotype (cultivar)	Fruit ripening	
	Beginning	End
GG 1	9 July	18 July
GG 2	9 July	18 July
GG 3	10 July	20 July
GG 4	9 July	19 July
GG 5	9 July	19 July
Roxana	15 July	24 July

The beginning of ripening was earliest in GG1, GG2, GG4 and GG5 (on 9 July), followed by GG3 (10 July), and latest in 'Roxana' (15 July). End of ripening occurred first in GG1 and GG2, then in GG4 and GG5, followed by GG3 and 'Roxana', which ended its ripening on 24 July. The longest fruit ripening period was in GG3, GG4 and GG5, i.e. 10 days, and somewhat shorter (a day shorter) in 'Roxana' and GG1 and GG2. As shown by the results, there were no considerable differences in fruit ripening time between the genotypes and 'Roxana'. In apricot, more than in other fruit crops, the choice of rootstock has a decisive effect on cropping and fruit quality and ripening (Mišić, 1984). The beginning and course of fruit ripening are determined by genotype and growing conditions. Depending on cultivar, the fruit development and ripening period (from flowering to fruiting) lasts for 71–121 days (Pejkić and Ninkovski, 1986), as also confirmed by the present research. The fruits

of 'Hungarian Best', from which the genotypes tested in this study originate, ripen in the second ten-day period in July, and those of 'Roxana' about 7 days later (Milatović, 2013). These results are supported by the findings of the present study.
Leaf characteristics are given in Tab. 3.

Tab. 3. Leaf and petiole characteristics

	Leaf dimensions			Petiole	
	Length (mm)	Width (mm)	C[1] (mm)	Length (mm)	Glands
GG 1	89.65±5.40 a	71.76±6.04 a	35.18±1.90	49.68±3.12 cd	2.55±0.09 b
GG 2	91.18±6.20 a	73.16±5.02 a	35.83±2.11	52.76±2.70 b	2.26±0.11 c
GG 3	85.23±6.11 b	71.26±5.20 a	33.96±1.95	53.50±2.71 b	2.00±0.08 d
GG 4	79.30±5.11 c	67.36±3.80 ab	30.70±2.15	51.15±4.33 bc	1.55±0.10 e
GG 5	86.41±6.03 b	68.06±4.05 ab	33.83±1.75	54.73±2.70 ab	2.15±0.09 c
Roxana	86.93±4.11 b	64.77±2.23 b	36.35±3.09	58.83±3.90 a	4.25±0.17 a

The different lowercase letters in columns show significant differences between means at $P \leq 0.05$ according to LSD test
[1] distance of the widest part of the blade from the leaf blade base

Leaf length in the examined cultivars ranged from the smallest in GG4 (79.30±5.11 mm) to the greatest in GG2 (91.18±6.20 mm) and GG1 (89.65±5,40 mm). As compared with the control, leaf length was significantly greater in GG1 and GG2, and significantly smaller in GG4. The largest differences in leaf width were observed between 'Roxana' leaf as the narrowest (64.77±2.23 mm) and GG2 leaf as the widest (73.16±5.02 mm). In comparison to 'Roxana', GG4 and GG5 showed no significant difference in leaf width. As regards the distance of the widest part of the blade from the leaf blade base, there were no significant differences between the genotypes and cv. 'Roxana'. Petiole length varied from 49.68±3,12 mm (in GG1) to 58.83±3,90 mm (in 'Roxana'). A significant difference was also observed between the other genotypes and 'Roxana', which had the longest petiole, with the exception of GG5, which also had a long petiole. The number of glands was lowest in GG4 (1.55±0.10), and the highest in 'Roxana' (4.25±0.17). All tested genotypes had a significantly lower number of glands on the petiole in comparison to 'Roxana'. The morphological characteristics of the fruit of the studied genotypes (fruit height, thickness and width) are given in Tab. 4.

Tab. 4. Fruit dimensions

	Fruit dimensions		
	Height (mm)	Width (mm)	Thickness (mm)
GG 1	45.20±2.66 c	45.26±2.11	44.38±2.70 c
GG 2	47.93±3.71 bc	46.52±3.90	46.21±2.19 c
GG 3	48.59±4.02 b	47.39±3.80	45.10±2.60 c
GG 4	49.86±3.80 b	50.65±3.80	51.37±2.77 a
GG 5	53.52±2.55 a	51.80±2.66	49.51±3.90 b
Roxana	50.75±3.22 ab	48.22±3.23	47.14±3.90 bc

The different lowercase letters in columns show significant differences between means at $P \leq 0.05$ according to LSD test

Fruit height ranged from 45.20±2.66 mm in GG1 to 53.52±2.55 mm in GG5. In comparison to 'Roxana', significantly lower values were measured only in GG1. Variations were also observed in fruit width, i.e. between 45.26±2.11 mm in GG1 to 51.80±2.66 mm in GG5. In this case, when compared with 'Roxana', fruit was wider in two genotypes and narrower in three, with no significant differences. Fruit thickness values were lowest in GG1 – 44.38±2.70 mm, followed by GG3 – 45.10±2.60 mm and GG2 – 46.21±2.19 mm. 'Roxana' followed with

47.14±3.90 mm, and values greater than the control were measured in two genotypes - GG5 49.51±3.90 mm and GG4 51.37±2.77 mm. Similar results on fruit dimensions were reported in a study by Milatović *et al.* (2014): fruit height 42.5–50.5 mm, fruit width 41.1–50 mm and fruit thickness 37.3–46 mm. Results on fruit weight, stone weight and chemical characteristics of the fruit are presented in Tab. 5.

Tab. 5. Fruit and stone properties

Genotype (cultivar)	SSC (°Brix)	Fruit weight (g)	Stone weight (g)	Flesh/stone ratio (%)
GG 1	15.06±1.10 a	68.08±5.17 b	3.81±0.17 c	94.40
GG 2	11.18±0.89 c	66.35±4.90 b	4.37±0.22 a	93.41
GG 3	12.85±0.90 b	61.49±4.45 c	3.80±0.25 c	93.82
GG 4	13.13±0.59 b	75.12±6.15 a	4.22±0.35 a	94.38
GG 5	13.27±1.07 b	72.46±5.60 ab	4.00±0.31 b	94.47
Roxana	13.31±1.07 b	76.05±6.03 a	3.96±0.27 b	94.79

The different lowercase letters in columns show significant differences between means at $P \leq 0.05$ according to LSD test

Soluble solids content in this study was 11.18±0.89 °Brix in GG2 and 15.06±1.10 °Brix in GG1, whereas the other genotypes had values within this range and were not significantly different from 'Roxana', as opposed to GG1 and GG2. Soluble solids (mostly containing sugars) and acids indicate fruit sweetness (Milatović, 2013). These fruit attributes have been the subject matter of a number of studies (Ayanoglu and Kaska, 1995; Licznar-Małańczuk and Sosna, 2005). Milošević *et al*. (2009) reported the lowest soluble solids content in G-9 (15.7), and the highest in G-5 (18.88). The genotypes tested in the present research had somewhat lower soluble solids contents in comparison to the findings of the above author. Fruit weight was lowest in GG3 (61.49±4.45 g), followed by GG2 (66.35±4.90 g) and GG1 (68.08±5.17 g), and highest in GG4, GG5 and the control cv. 'Roxana'. Fruit weights of all genotypes were greater than the average (60 g). Milošević *et al*. (2009) obtained somewhat different values for fruit weight, ranging between 41.34 g in G-5 to 81.5 g in G-1, possibly resulting from either different climatic and other conditions during the research or different genotypes analysed in this study. Similar results on greater fruit size in selected genotypes than in 'Hungarian Best' were obtained by Licznar-Małańczuk and Sosna (2005). Stone weight in the tested genotypes as an important trait for cultivar identification and classification varied from 3.80±0.25 g in GG3 to 4.37±0.22 g in GG2. When compared with 'Roxana', stone weight was lower in two genotypes and higher in three. The flesh to stone ratio ranged from 93.41 % in GG2 to 94.79 % in 'Roxana'. The present results on stone weight and flesh/stone ratio are similar to those of Milošević *et al*. (2009).

Conclusions

In comparison to the control cultivar, all apricot genotypes began to flower 2 to 3 days earlier and exhibited a similar course and abundance of flowering. The beginning and end of ripening was 5 to 6 days earlier than in the control ('Roxana'). As regards leaf characteristics, leaf dimensions were greater in GG1 and GG2 than in the control. All genotypes had shorter petioles and fewer glands. When analysing fruit dimensions and fruit weight, fruit size was found to be similar in GG5 to that of 'Roxana', followed by GG$, whereas the other genotypes had smaller dimensions. Soluble solids content was highest in GG1. This trait exhibited no significant differences between the genotypes and 'Roxana'. Flesh to stone ratio in the tested genotypes was not significantly different from 'Roxana'. Overall, the largest number of positive traits was exhibited GG5 and GG4, which can serve not only as experimental material in further research, but also for orchard establishment.

Acknowledgement

This study is part of Project Ref. No. TR 31064 ("Creation and Maintenance of the Genetic Potential of Continental Fruit Crops") financially supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia. We acknowledge the financial support and all other types of support and assistance provided by the Ministry in implementing project activities.

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