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POMOLOGICAL PROPERTIES OF „GALA“ APPLE CLONES IN THE REGION OF SARAJEVO

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Abstract

The paper presents results of two – year study of some pomological properties of four clones of apple cultivar ‘Gala’ (‘Mondial Gala® Mitchgla’, ‘Gala Schniga® SchniCo(s)’, ‘Gala Must®’,‘Galaxy’). The research was carried out in the apple orchard for cultivar testing of Federal Bureau of Agriculture of Bosnia and Herzegovina and included the phenological characteristics, physical characteristics of the fruit and yield.
The obtained results have confirmed that agro – environmental conditions of Sarajevo are favorable for growing the above – mentioned clones. All four of ‘Gala’ apple clones has shown good physical properties of the fruit and they can be recommended for commercial growing in the region of Sarajevo. These cultivars may greatly contribute to the advancement of Bosnia and Herzegovina apple assortment.
Key words: apple, clones, ‘Gala’, pomological properties.

Introduction

Apple (*Malus domestica* Borkh.) is one of the most important and most cultivated fruit species both in the world and in our country. The reason for this is the long period of maturation (from early summer cultivars to late winter cultivars) and wide use value (many cultivars are used as fresh fruit, while a number of cultivars are used for processing).
Total production, trade and consumption of apples, is in third place in the world, behind citrus and bananas. During the period 1998 – 2007, the average apple production was 59.855409 t in the world (*Nikolić and Fotirić*, 2009). The most important producer countries are China (37%), United States (7%), Italy (4%), Turkey (4%), Iran (4%), Russia (3%), and Poland (3%). The production of apples is at the second place with a share of 24.94% of the total fruit production in Bosnia and Herzegovina. According to the data of Federal Bureau of Statistics, there has been an increase in the number of planted and productive trees recently, affecting an enlargement of production of apples. The environmental conditions of Sarajevo are ideal for the development of fruit production, and especially the production of apples. Major problem in production of apple in our country and in the neighboring countries is inadequate and obsolete assortiment. In this assortment, mostly dominate the autochthonous and standard cultivars, with cultivar ‘Idared’, which takes the leading place in assortment of apples (*Milatović et al.,* 2009). This cultivar is characterized by a high yield, large fruit, and good storage capacity, but the big a problem is bad quality of the fruit. At the present time the main goal is to modernize the existing assortiment through the introduction of new cultivars.
Most of the cultivars of apples were developed in process of clonal selection. Cultivar that is very prone to mutation is ‘Gala’. According to *Hampson and Kemp*(2003), cultivar ‘Gala’ belongs to the group of 12 major cultivars of apples, but this cultivar is only sporadically present in our country.

Clones of apple ‘Gala’ differ in additional color, the abundance of blooming, ripening time, yield, fruit size, but quality of fruit does not vary (*Kappel et al*., 1992; *Greene and Autio*, 1993).
The aim of this work was the study of phenological characteristics, physical characteristics of the fruit, and yield of four clones of apple ‘Gala’ in the region of Sarajevo. According to this results, recommendation of the best clones for commercial growing in the conditions of Sarajevo could be made.

Materials and methods

The research was carried out during 2011 and 2012, on the location of Sarajevo, in the apple orchard for cultivar testing of Federal Bureau of Agriculture of Bosnia and Herzegovina located in Butmir – Ilidza. Test plantation was bulit in the spring of 2007, at the altitude of 600 meters above sea level. Training system is slender spindle with spacing of planting 3,3×1 m (3030 trees/ha). Four clones of apple ‘Gala’ were studied: ‘Mondial Gala® Mitchgla’, ‘Gala Schniga® SchniCo(s)’, ‘Gala Must®’, and ‘Galaxy’. Rootstock for all clones was M9.
The area in which the orchard is established is characterized submountainous climate (Hydrometeorological Institute of Bosnia and Herzegovina), with cold winters that last longer than in the continental zone. The average annual air temperature is below 10°C. Autumn is warmer than spring. The absolute maximum temperature does not exceed or very rare exceeds 30°C in summer. The minimum temperature does not fall below -30°C in the winter. The annual precipitation ranges from 750 to1.000 mm, and they are, mostly, unevenly distributed. Snow takes an average of 2 – 3 months. Agro – environmental conditions in which the experiment was set, have lead to the use of standard cultural practeces. The research was included the phenological characteristics, physical characteristics of the fruit and yield.
The phenological characteristics included the time of flowering (beginning, full, end and duration of flowering) and the date of harvest. Flowering was followed by recommendations of the International working group for pollination (*Wertheim*, 1996).The date of beginning of flowering was taken when 10% of flowers were open, full – when 80% of flowers were open, end – when 90% of petals were fallen. Duration of flowering was determined by the number of days from the beginning to the end of flowering. The date of harvest is taken as the time of maturing. Characteristics of fruit are determined on a sample of 30 fruits for each clone. Standard morphometric methods were used to determine the weight of fruit, lenght and width of fruit and index of the fruit shape.
Yield of examined ‘Gala’ apple clones was registered by measuring the the weight of all fruits on the tree. It is expressed in kg/ha and kg/tree for each clone.
The results are processed by the statistical method of the analyses of variance for two factorial experiment. The significance of differences between mean values is determined by Duncan’s multiple range test at P=0.05 (*Dunnett*, 1955).

Results and discussion

Phenological properties. The phenological properties included the time of flowering and the date of harvest. Yield of apple trees depends on beginning, full, end and duration of flowering. The flowering time is greatly influenced by weather, particularly by temperature and relative humidity before the beginning of flowering and during flowering.
Although the beginning of apple flowering is mainly caused by weather conditions, the sequence of flowering of cultivars grown in identical agro – environmental conditions, is caused by the genetical characteristics of the cultivars.

The results of flowering and the time of maturation of examined ‘Gala’ apple clones are presented in Table 1.

Table 1. Phenological properties of ‘Gala’ apple clones in conditions of Sarajevo (average, 2011-2012)

Cultivar	Flowering				Time of maturation
	Beginning	Full	End	Duration /days	
‘MondialGala®Mitchgla’	24.04.	29.04.	07.05.	13	02.09.
‘Gala Schniga®SchniCo(s)’	25.04.	29.04.	05.05.	10	01.09.
‘Gala Must®’	25.04.	05.05.	07.05.	12	02.09.
‘Galaxy’	27.04.	02.05.	08.05.	11	03.09.

In average, the earliest date of beginning of flowering was in the clone 'Mondial Gala®Mitchgla' (24.04.), while the latest date of beginning of flowering was in the clone 'Galaxy' (27.04.).The differences in flowering between the years of studies were also noticed. Namely, in 2011, an earlier flowering period was noticed, by 1 – 2 days in comparison with 2012.

Date of full of flowering of examined clones was five to ten days after the beginning of flowering and lasted from 29.04. to 05.05.

The earliest date of the end of flowering was the in clone ‘Gala Schniga®SchniCo(s)’ (05.05.), while the latest date of the end of flowering was the in the clone ‘Galaxy’ (08.05.). The average duration of flowering was 11.5 days (with variation of 10 – 13 days).

Comparing our results with the results of *LukiC et al.* (2011), time of flowering of clones 'GalaMust®' and 'Galaxy ' occurred much later in agro – environmental conditions of Sarajevo.The flowering has occurred relatively later in environmental conditions of Sarajevo because of climatic conditions and later start of growing season, but the process and duration of flowering was in accordance with the characteristics of the examined clones.

Time of maturation depends, primarily, on genetical characteristics and environmental conditions, that may influence earlier or later ripening. The time of maturation of the studied clones was from 01.09. (‘Gala Schniga®SchniCo(s)’) to 03.09. (‘Galaxy’). Comparing the years of studies, it can be concluded that the differences in the time of maturation for the same clones were not big.

The average time of maturation of clones 'GalaMust®' and 'Galaxy' was 26.08.) and 25.08. respectively in the region of Cacak (*Lukić et al*., 2011). Earlier time of maturation for the same clones has been registered in the region of Topola (*Milatović et al*, 2009), where the clone 'Galaxy' matured on the 20th of August and the clone 'GalaMust®' on the 21st of August. According to *Atay et al* (2010) and *Bozbuğa and Pırlak* (2012), clone 'Galaxy' had earlier time of flowering and maturing.

Cutivar 'Gala' and its clones according to the time of maturing, belong to the group of autumn apple cultivars.

According to *Akhtar et al*. (2002), clones of apple 'Gala' ripening in mid-August, or 135 days from the beginning of flowering.

The differences between our results and results of other authors can be explained by the different climate conditions.

Physical characteristics of the fruit.Physical characteristics of examined clones of 'Gala' were studied immediately after harvesting. The results of physical characteristics of the fruit of 'Gala' apple clones are presented in Table 2.

Table 2. Fruit properties of 'Gala' apple clones in conditions of Sarajevo (average, 2011-2012)

Cultivar	Fruit weight (g)	Fruit lenght (cm)	Fruit width(cm)	Shape factor (L/W)
'MondialGala®Mitchgla'	168.36 b	6.79	7.58	0.89
'Gala Schniga®SchniCo(s)'	164.10 bc	6.49	7.25	0.89
'Gala Must®'	163.32 c	6.83	7.74	0.88
'Galaxy'	175.38 a	6.60	7.29	0.90

Means followed by the same letter do not differ significantly according to Duncan's multiple range test at P=0.05

The weight of fruit is one of the most important pomological characteristics because it affect a number of other properties, primarily yield, which is the ultimate aim of any production. In our study, the weight of fruit ranged from 163.32 g in clone 'Gala Must®' to 175.38 g in clone 'Galaxy'. Clone 'Galaxy' had statistically significant highest fruit weight than other clones.

Clone 'GalaMust®' had statistically significant lowest fruit weight than other clones in 2011 year, but same clon had statistically significant highest fruit weight than other clones in 2012. year.

According to *Lukić et al*. (2011) clone 'GalaMust®' had highest fruit weight, and clon 'Galaxy' had lowest fruit weight in the region of Cacak.

Lower fruit weight of clones 'GalaMust®' and 'Galaxy' was found in study of *Milatović et al*. (2009) in comparison to the results of our study. Comparing our results to the results of *Milošević et al*. (2007), and *Atay et al*. (2010) we can see that fruit weight of clone 'Galaxy' is higher in our research. Depending on the year of study, clone 'GalaMust®' had lower or higher fruit weight (*Krzysztof et al.*, 2005). Higher fruit weight of clone 'Galaxy' was found in our study in comparasion to the results of *Bozbuğa and Pırlak* (2012). According to the literature, fruit weight of examined clones may be a limiting factor in the growth of these clones, but in our study clones had acceptable values of fruit weight. The average lenght of fruit ranged from 6.49 to 6.83 cm, while the width of fruit was 7.25 to 7.74 cm.

Highest lenght and width of fruit was found in clone 'GalaMust®', while the lowest lenght and width was found in clone 'GalaSchniga®SchniCo(s)'.On the basis of fruit dimensions, fruit shape factor was calculated. That value was the lowest in clone'Gala Must®' (0.88), and the highest in clone'Galaxy' (0,90).

The results of yiel of the fruit of 'Gala' apple clones are presented in Table 3.

Table 3. Yields of ‘Gala’ apple clones in conditions of Sarajevo (kg/ha and kg/tree)

Cultivar	Yield of ‘Gala’ apple clones					
	2011.		2012.		Average	
	kg/ha	kg/tree	kg/ha	kg/tree	kg/ha	kg/tree
‘MondialGala®Mitchgla’	30,088.80	9.93	16,755.90	5.53	23,422.35	7.73
‘Gala Schniga®SchniCo(s)’	34,945.89	11.53	21,229.99	7.00	28,087.94	9,265
‘Gala Must®’	26,048.91	8.59	18,786.00	6.20	22,417.455	7,395
‘Galaxy’	1,896.78	0.62	15,144.84	4.99	8,520,81	2,805

Comparing yield between the years, the results showed that the highest yield was in 2011 year and only in clone ‘Galaxy’ the highest yield was in 2012. The lowest yield per tree and per hectare had clone ‘Galaxy’ (2.805 kg/tree, or 8,520.81 kg/ha), and the highest yield per tree and per hectare had clone ‘Gala Schniga®SchniCo(s)’ (9.265 kg/tree, or 28,087.94 kg/ha).
Milatović et al. (2007) and *Lukić et al*. (2011), reported higher yield for clones ‘Galaxy’ and ‘Gala Must®’, while *MiloseviC et al.* (2007) reported value of yield for the clone 'Galaxy' of 23.076 kg/tree. Higher yield of the clone 'Galaxy' has also obtained in studies of *Atay et al.* (2010) and *Bozbuğa and Pırlak* (2012).
Lower yields of the tested clones were expected, because the testing was done at a relatively young orchard .

Conclusion

On the basis of two-year investigations of the phenological characteristics, physical characteristics of the fruit and yield of ‘Gala’ apple clones in the region of Sarajevo we have made the following conclusions:
Flowering of studied cultivars started in the third decade of April, and it lasted 13.6 days (on average).
Average time of maturation was from 01.09. to 03.09.
The weight of fruit ranged from 163.32 g to 175.38 g.
Clone ‘Galaxy’ had significantly highest fruit weight than other clones.
Highest lenght and width of fruit was in clone 'GalaMust®', while the lowest lenght and width was in clone 'GalaSchniga®SchniCo(s)'.
Fruit shape factor ranged from 0.88 to 0.90.
The lowest yield had clone ‘Galaxy’ (2.80 kg/tree, or 8.520,81 kg/ha), and the highest yield had clone ‘Gala Schniga®SchniCo(s)’ (9.26 kg/tree, 28,087.94 kg/ha).
Taking all into account,, all of four clones of apple ‘Gala’ (‘Mondial Gala® Mitchgla’, ‘Gala Schniga® SchniCo(s)’, ‘Gala Must®’,‘Galaxy’) can be recommended for the advancement of Bosnia and Herzegovina apple assortiment.

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