

PRELIMINARY RESULTS OF TESTING OF NEWLY INTRODUCED APPLE CULTIVARS IN BULGARIA

Dimitar Sotirov¹, Stanislava Dimitrova¹, Meiying Liu²

¹Institute of Agriculture, Kyustendil, Bulgaria

²Fruit Tree Institute, Yantai Agricultural Academy, China

Corresponding author: dksotirov@yahoo.com

Abstract

The results of the testing of three new Polish apple varieties grown under the conditions of Kyustendil, Bulgaria during the first six years after planting (2012-2017) are presented. Earliest flowering time was recorded in 'Gold Milenium' (15 April) and the latest in 'Melfree' (20 April). Average ripening date was between 30 August ('Melfree') and 25 September ('Free Redstar'). The trees of 'Gold Milenium' had stronger growth. No significant differences were found in the productivity of the cultivars. Fruit weight range from 168.2 ('Melfree') to 198.0 g ('Gold Milenium'). With the most harmonious flavor were the fruit of 'Gold Milenium'. No symptoms of apple scab and powdery mildew were found. Preliminary data showed that all three cultivars are suitable for growing in the Kyustendil region.

Keywords: 'Gold Milenium', 'Free Redstar', 'Melfree', flowering, yield, chemical composition.

Introduction

Each cultivar is created under specific environmental conditions and in this area it perform the best its potential. The right choice of the most appropriate cultivars for the different places of growth is a major factor for the successful production of apples. Very often, however, cultivars introduced to habitats with conditions other than those in which they are selected do not develop their potential. Therefore introduction and testing of new cultivars that have shown valuable biological and economic characteristics is one of the main tasks of many research teams in the world (Blagov et al., 2009; Kiprijanovski et al., 2009; Sotirov and Dimitrova, 2014). Apple scab and powdery mildew are the main diseases on apple worldwide and currently are managed mainly by scheduled applications of fungicides. That's why the creation and selection of resistant cultivars is one of the most important objectives of the apple breeding programs that has been conducted for many years in different countries (Blažek, 2004; Sasnauskas et al., 2006; Bryk and Broniarek-Niemiec, 2008; Dinkova et al., 2009; Czynczyk et al., 2011; Żurawicz et al., 2013). The objective of this study was to evaluate three new Polish scab-resistant apple cultivars under agro-ecological conditions of Kyustendil region (Bulgaria). In the present paper are showed the first results for the development of the cultivars to the end of the 6th year after planting.

Material and methods

In the period 2014 – 2017 at the Institute of Agriculture in Kyustendil three new apple cultivars - 'Gold Milenium', 'Free Redstar' and 'Melfree', introduced from Research Institute of Horticulture in Skierniewice, Poland were studied. The cultivars were grafted on MM 106 rootstock and the trees were planted in the spring of 2012 at distances of 4.50 x 2.50 m. Each cultivar was represented with five trees and each individual tree was treated as a repetition. Trees were trained as free-growing crowns. The soil in the experimental orchard is Chromic Luvisols, slightly sandy-loamy with a neutral reaction. The space between the rows was maintained in clean cultivation and within the rows by manual digging around the trees and use of herbicides. The trees were fertilised annually with 9 g/tree nitrogen in the form of ammonium nitrate. The experimental plantation was grown under standard agro-technology. The yearly recorded parameters included: dates of flowering and

harvesting, trunk diameter (30 cm above the grafting zone) and from the data was calculated trunk cross-sectional area (TCSA, in cm²), length of one-year old shoots (cm), average and cumulative yields (kg/tree), yield efficiency (kg/cm² of TCSA), fruit weight (g), fruit sizes (mm), fruit flesh firmness (kg/cm²) - evaluated by a penetrometer. Soluble solids of the fruit (%) were determined by a hand refractometer (Pocket PAL-1, Atago, Japan), the total sugars by Luff-Schoorl method (%), and the titratable acids (%) - titrimetrically with 0.1 N NaOH. The susceptibility to apple scab (*Venturia inaequalis* (Cke) Wint) and powdery mildew (*Podosphaera leucotricha* (Ellis et Everh.) Salm.) were determined too. The results were statistically evaluated by analysis of variance (ANOVA). The significance of differences between the cultivars was evaluated by Duncan's multiple range test at p=0.05.

Results and discussion

For the first time blooming in the studied apple cultivars, grafted on the MM 106 rootstock, was observed in the 3rd year after planting. Flowering in different years depend on average daily temperatures and relative air humidity during the January-April period. 'Gold Milenium' began to bloom comparatively earlier than the other two cultivars. The phenophase beginning of flowering in this cultivar was 15 April, and 3 to 5 days later in 'Free Redstar' and 'Melfree', respectively (Table 1). With regard to flowering, 'Free Redstar' and 'Melfree' had some advantages. Their trees began of full flowering 3-4 days after those of 'Gold Milenium', which is valuable quality - this can reduce damages from possible late spring frosts.

Table 1. Average dates of flowering and ripening of fruit of three scab-resistant apple cultivars (2014-2017)

Phenological phases	'Gold Milenium'	'Free Redstar'	'Melfree'
Beginning of flowering	15.04	18.04	20.04
Beginning of full flowering	18.04	21.04	22.04
End of full flowering	25.04	28.04	29.04
End of flowering	28.04	30.04	01.05
Duration of flowering (days)	14	13	11
Fruit ripening: from - to	26.08 - 03.09	22.09 - 28.09	21.09 - 25.09
Average ripening date	30.08	25.09	23.09

The end of flowering was earliest in 'Gold Milenium' (28 April), while latest in 'Melfree' (01 May). According to these data the flowering period continued for 11-14 days. The averaged data for the studied period showed that the calendar flowering times of these cultivars coincide with those of most apple cultivars cultivated in the Kyustendil region found in other studies (Blagov, 2011; Dimitrova and Sotirov, 2014, 2016). The earliest maturation period had the fruits of 'Gold Milenium', which ripened between 26 August and 3 September, under the conditions of the region. The average ripening date of the other two cultivars was 23 and 25 September for 'Melfree' and 'Free Redstar', respectively (Table 1). The tree sizes of the studied cultivars are expressed as a trunk cross-sectional area (TCSA) and average annual shoot length. The results obtained showed that in the period 3th-5th year after planting the trees of 'Gold Milenium' had significantly stronger growth compared with the other two cultivars (Figure 1). Between 'Free Redstar' and 'Melfree' the differences were minimal and insignificant. Our results with respect to the growth of these three cultivars are in agreement with the results reported by Czynczyk et al., (2011). The cultivars started to bear fruit in the third year after planting, but the obtained fruit quantity was negligible (Table 2). Over the next two years, a higher yield per tree and cumulative yield for the period were registered from 'Gold Milenium', followed by 'Melfree' and 'Free Redstar', but the differences were insignificant. In 2017 no fruit were obtained because late spring frosts on 22 and 25 April injured 100% the blossoms.

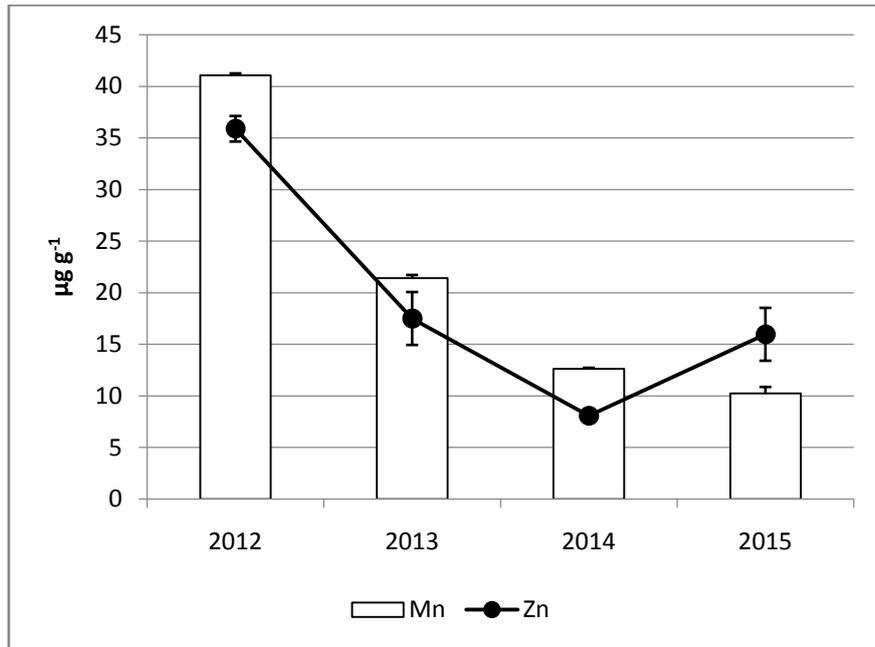


Figure1. Growth characteristics of apple cultivars (3th-5th vegetation).

Table 2. Productivity of apple cultivars for the period 3th-5th vegetation

Cultivar	Yield (kg/tree)				Yield efficiency (kg/cm ² of TCSA)
	2014	2015	2016	Cumulative	
'Gold Milenium'	1,2 a	5,6 a	7,5 a	14,3 a	0,37 a
'Free Redstar'	0,6 a	3,8 a	6,2 a	10,6 a	0,33 a
'Melfree'	0,9 a	4,5 a	6,7 a	12,1 a	0,44 a

The productivity of the trees, expressed by the cumulative yield efficiency (kg/cm² of TCSA) was the highest for 'Melfree', followed by 'Gold Milenium' and 'Free Redstar', without significant differences among them. It was found a significant positive correlation between the trunk-cross sectional area and the yield (Figure. 2).

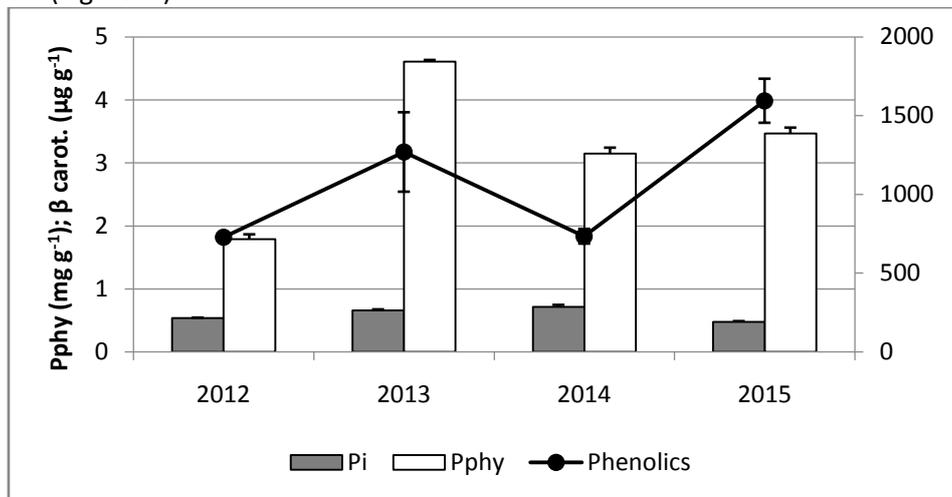


Figure 2. Relationship between the trunk-cross sectional area (cm²) and the cumulative yield per tree

'Gold Milenium' had the largest fruit (average fruit weight 198.0 g), followed by 'Free Redstar' (185.5 g) and 'Melfree' (168.2 g) (Table 3). The fruit of all three cultivars had a diameter more than 70 mm, and according to this indicator, they refer to class 'Extra' according to the National ordinance №.108/2006 for the quality of the fresh fruit. Fruit flesh firmness was the highest in 'Free Redstar' (10.5 kg/cm²) and the lowest in 'Melfree' (7.2 kg/cm²).

Table 3. Physical and chemical characteristics of apple cultivars (2014-2016)

Cultivar	'Gold Milenium'	'Free Redstar'	'Melfree'
Fruit weight (g)	198.0 a	185.5ab	168.2 b
Flesh firmness (kg/cm ²)	9.7 a	10.5 a	7.2 b
Fruit diameter (mm)	76.8 a	73.9 a	70.9 a
Fruit height (mm)	63.9 a	67.3 a	62.4 a
Soluble solids (%)	16.5 ab	13.0 b	19.8 a
Total sugar (%)	8.7 a	7.5 b	9.0 a
Titrateable acids (%)	0.34 b	0.49 a	0.63 a
Sugar/Acids index	25.6	15.3	14.3

Fruit analysis showed some significant differences in the chemical composition of the fruit. The content of soluble solids and total sugars were the highest 'Melfree', and the lowest in 'Free Redstar' (Table 3). The fruit of 'Gold Milenium' had the lowest titrateable acid content and their taste was the sweetest. Fruit of this cultivar had the highest sugar-acid index (25.6) and this gives them the most harmonious flavor. For establishing the reaction of the trees to scab (*Venturia inaequalis*) and powdery mildew (*Podosphaera leucotricha*) annually were carried out observations and readings during the vegetation. In 2014-2017 the conditions for developing of diseases were extremely favorable. In the period April to September, there were from 26 to 32 days were favorable for infections from *V. inaequalis*. In 2017, the lack of apple fruits due to injured from spring frosts gave us the opportunity to restrict fungicide treatments in the apple plantation. This year we only had one fungicide treatment. Our goal was to better assess the response of the apple trees from the available gene pool, including and the studied cultivars. In the visual observations until the end of the sixth vegetation, there were no symptoms of apple scab and powdery mildew diseases, regardless of the number of plant protection treatments. Our results confirmed the results of other authors for the resistance of these cultivars to apple scab (Bryk and Broniarek-Niemiec, 2008; Czynczyk et al., 2011; Żurawicz et al., 2013).

Conclusions

The first results of the testing of the cultivars 'Gold Milenium', 'Free Redstar' and 'Melfree' showed that they are suitable for the soil-climatic conditions of the Kyustendil region. The phenological phases of flowering were within the established time for the most spreaded apple cultivars in the region. The cultivars started to bear fruit in the 3rd year after planting. The trees of 'Gold Milenium' produced the highest average yield and the largest fruit with the most harmonious flavor. 'Melfree' was the most yield efficient cultivar. The tolerance of the cultivars to the main economic diseases - apple scab and powdery mildew was confirmed and they can enrich the list of cultivated apple cultivars in our country. They can be successfully included in the organic apple production schemes.

Acknowledgements

The publication of this article is supported by the Ministry of Education and Science (Fund "Scientific Research") – Project: "Evaluation and Innovation of Apple Disease-resistant Genetic Resources in Bulgaria and China" – Contract DNTS/China 01/15/28.12.2016.

References

1. Blagov, A., N. Christov, D. Sotirov, An. Stoyanova (2009). Comparison of some new apple and sweet cherry cultivars under the environmental conditions of Kyustendil, Bulgaria. *Acta Hort.*, 825: 89-96.
2. Blagov, A. (2011). Some results of agrobiological investigation of apple cultivars and Hybrids in Kyustendil region. *Plant Science*, (48): 14-19.
3. Blažek, J., (2004). Response to diseases in new apple cultivars from the Czech Republic. *J. Fruit Ornam. Plant Res. Special ed. Vol. (12): 241-250.*

4. Bryk, H., A., Broniarek-Niemiec. (2008). Three years of experience with the apple disease control in an organic orchard. *Zemdirbyste -Agriculture*, Vol. 95 (3): 395–400.
5. Czynczyk, A., P., Bielicki, A., Mika, A., Krawiec. (2011). A nine-year evaluation of several scab-resistant apple cultivars for organic fruit production. *J. Fruit Ornament. Plant Res.* Vol. 19 (2): 87-97.
6. Dimitrova S., D. Sotirov. (2016). Biological and economic qualities of some apple hybrids. *Acta Hort.* 1139: 37-42.
7. Dinkova., H., K., Dragoyski., B. Stefanova. (2009). Possibilities for organic production of apple fruits in the region of central Balkan mountains. *Plant Science*, (46): 6-9.
8. Kiprijanovski, M., Arsov, T., Gjamovski, V., Damovski, K., (2009). Study of certain introduced apple cultivars in the Prespa region. *Acta Hort.*, 825: 125-132.
9. Sasnauskas, A. Gelvonauskiene, D., Gelvonauskis, B., Viskelis, P., Duchovskis, P., Bobins, C., Siksnianieneand, J., Sabajeviene, G. (2006). Productivity and fruit quality of scab resistant apple cultivars and hybrids. *J. Fruit Ornament. Plant Res.* 14, (Suppl. 2): 247-255
10. Sotirov.D., S. Dimitrova. (2014). Comparative study of new apple cultivars under the conditions of Kyustendil region. *Journal of Mountain Agriculture on the Balkans*, Vol. 17 (5): 1318-1329.
11. Żurawicz, E., M., Lewandowski, K. P. Rutkowski, K., Pruski. (2013). Productivity of selected Polish scab resistant apple cultivars grown on different rootstocks. *Acta Hort.* 976: 141-146.