

SIRMA AND PAGANE - NEW BULGARIAN PLUM CULTIVARS

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Abstract

Plum is a traditional fruit crop grown in Bulgaria. Fruit Growing Institute has launched its plum breeding program in 1987 in order to improve the range of available plum cultivars for this region. In 2019 were registered two new plum cultivars - 'Sirma' and 'Pagane'. In this study are presented their main tree and fruit characteristics observed from 2014 to 2018. The standard cultivar 'Stanley' was used for comparison. The flower development of all three cultivars starts in the third decade of March. 'Sirma' had a moderately early flowering period which starts 2-3 days before 'Stanley'. 'Sirma' outperforms the standard cultivar in yield – 170.30 kg per tree (from 7 years old, not pruned trees) and average fruit weight of 44.70 g. Compared to 'Stanley', 'Pagane' had lower yield (78 kg/per tree) but much larger fruits with an average weight of 63.68 g. After sensory evaluation, both cultivars had higher marks than 'Stanley' and their taste qualities were rated as very good. 'Sirma' cv. had a smaller tree size. Between 'Stanley' and 'Pagane' was not observed significant difference for their tree dimensions. The new cultivars are tolerant to Sharka like 'Stanley'.

Key words: breeding, fruit, new cultivars, plum.

INTRODUCTION

Plum is a traditional fruit crop for Bulgaria. Due to its high productivity and good adaptability to the agro-climatic conditions it is widespread in the country (Vitanova et al., 2014). According to Agrostatistics (2018), 18.5% of the harvested areas are occupied by plums. This puts it on second place after the cherry with harvested area of 4876 ha and fourth in fruit production - 24 640 t. Sharka disease caused by Plum Pox Virus (PPV) is a major limiting factor for the plum production (Milusheva et al., 2013). The most secure way for limiting the disease spread is growing tolerant or resistant cultivars. In the past, in our country the most commonly grown plum cultivar was the highly susceptible 'Kyustendilska sinya sliva'.

This led to endemic disease spread through infected planting material in the 70's. Later this highly susceptible cultivar was replaced by the tolerant 'Stanley' (Bozhkova et al., 2004; Dragovski et al., 2009).

This cultivar combines tolerance to PPV with high fertility and attractive, suitable for canning fruits (Vitanova et al., 2014). *Prunus domestica* is a hexaploid and breeding new cultivars and clarifying the mechanisms of inheritance of resistance is extremely difficult (Neumüller et

al., 2007). That is why 'Stanley' is officially registered as a plum cultivar back in 1926, and in the 80's of the 20th century it became the main grown cultivar for our country, occupying about 80% of the cultivated area (Dzhuvinov et al., 2012). Afterwards in the past years the resistant to sharka disease 'Jojo' cultivar has been widely planted in production orchards. Unfortunately, this cultivar manifests itself to be sensitive to the late spring frosts occurring in the country.

For the new plum orchards in Bulgaria are needed cultivars resistant or tolerant to Plum Pox Virus which are providing high yield and good fruit quality early. In general these are the main objectives of the plum breeding programs developed in Bulgaria.

The first plum breeding program of the Fruit Growing Institute - Plovdiv, started in 1987. F1 hybrid progeny consisted of populations obtained by controlled hybridization and by open pollination of the tolerant cultivars 'Stanley', 'President', 'Green gage', 'Scoldush', etc. (Zhivondov, 1994; Zhivondov and Djouvinov, 2001). The first successful final results of the breeding program were the new plum cultivars 'Plovdivska renkloda' (Zhivondov, 2008), 'Sineva' and 'Ulpiya' (Zhivondov and Bozhkova, 2008), 'Ostromila' (Zhivondov and Milusheva, 2016).

As a result of the ongoing plum breeding program of the Fruit Growing Institute, the two new cultivars 'Sirma' and 'Pagane' were registered in 2019. The aim of the present study was to describe the major pomological and fruit quality characteristics of two new Bulgarian plum cultivars and to compare them with the standard 'Stanley' cv.

MATERIALS AND METHODS

The current study was conducted in the period 2014-2018 in a collection orchard at the Fruit Growing Institute of Plovdiv, Bulgaria planted in 2011. The orchard was grown on humus-carbonate soil, maintained as black fallow, under non-irrigation conditions, at a planting distance of 5 x 4 m, applying conventional plant protection practices. The flower development was traced according to the stone fruits BBCH (2001) scale. Yield per tree was measured in 2018. For determining the fruit quality biometric analyses and sensory evaluation were performed. An average sample of fruits was taken and biometric data was measured with Mitutoyo 500-196-30 Digimatic Absolute Caliper 150 mm. Total soluble solid content (Brix°) in juice using a handheld Sper Scientific 300019 Digital Refractometer was determined. For the sensory evaluation a total number of 8 characteristics determining the fruits appearance and taste qualities were scored using the following scale - 1-3 very bad to bad; 3-4-satisfactory; 5-6 better and 7-9 - excellent. Each characteristic was multiplied by a coefficient depending on its importance: 0.175 for appearance, 0.050 for flavour attractiveness and 0.225 for flavour intensity, 0.200 for sweetness, 0.125 for sour taste, 0.125 for bitterness, 0.200 for flavour balance, and 0.150 for fruit flesh texture and juiciness. The final result was obtained based on the average grade of the total evaluation grades by each consumer. According to the final grade, the fruits were classified as fruits with bad (1-3), medium (3-5), good (5-7), very good (7-8) and excellent (above 8) qualities. After drying the fruits the sensory evaluation was repeated. Trunk diameters, tree height, canopy width of both sides (east-west and north-south) were also measured and canopy volume was calculated using the formula $V=(3.14*d^2*h)/12$.

For statistical data processing Duncan's multiple range test (Steele and Torrie, 1980) of the IBM SPSS Statistics 19 statistical software was used.

RESULTS AND DISCUSSIONS

'Sirma' cv. was obtained from open pollination of 'Stanley' cv. The stones were stratified in moist sand and grown in a nursery and a breeding orchard where from the population Elite № 3-12 was selected. 'Pagane' was obtained after open pollination of the 'Altan's gage' cultivar. The collected stones were irradiated with 1000 Re. The stones were stratified in moist sand and plants were grown in a nursery and breeding orchard, where from the resulting population Elite № 1-53 was selected. The development of principal growth stages inflorescence emergence and flowering was traced in 2014-2016 period (Table 1). The earliest flowering cultivar is 'Sirma'. The flowering of this cultivar was moderately early - 2-3 days before 'Stanley'. This difference is negligible when compared to the standard cultivar. All stages of the flower development of 'Pagane' run a day after 'Sirma' and 0 to 3 days before 'Stanley'. The duration of full flowering phase typically varies over the years (Dumitru et al., 2009). Its longer duration is a prerequisite for better pollination (Tsonev, 1991). The average duration of the whole flowering phenophase of 'Sirma' and 'Pagane' was 10.3 and 10.0 days resp. which was a day longer compared to 'Stanley'. Manipulation of tree architecture is the cornerstone of horticultural management and has continued to evolve as the development of intensive planting systems (Tustin, 2014). The reduced compact tree habit allows creating intensive orchards. The tree growth of 'Pagane' is vigorous. Out of the studied cultivars, it had the smallest measured trunk diameter. 'Pagane' trees were the shortest and the difference between its canopy height and the one measured for 'Stanley' was statistically significant (Table 2). Due to its dense and widely spread canopy this cultivar had higher value of the calculated canopy volume than 'Sirma'. Compared to 'Stanley', 'Pagane' had smaller canopy volume but the difference was statistically non-significant.

Table 1. Development of principal growth stages inflorescence emergence and flowering

Cultivar	Year	BBCH code						Flowering period (days)
		55	57	61	65	67	69	
		Stage						
		Single flower buds visible	Single flowers with white petals	Beginning of flowering	Full flowering	Flowers fading	End of flowering	
Pagane	2014	20.03	21.03	24.03	26.03	29.03	2.04	10
	2015	05.04	9.04	11.04	13.04	17.04	20.04	10
	2016	26.03	26.03	28.03	29.03	6.04	7.04	10
	average	29.03	29.03	29.03	2.04	7.04	10.04	10
Sirma	2014	20.03	21.03	24.03	26.03	28.03	2.04	10
	2015	2.04	6.04	8.04	10.04	14.04	17.04	10
	2016	24.03	26.03	28.03	29.03	7.04	8.04	11
	average	28.03	28.03	30.03	1.04	6.04	9.04	10.3
Stanley	2014	20.03	24.03	26.03	28.03	31.03	3.04	9
	2015	7.04	9.04	10.04	11.04	14.04	17.04	8
	2016	28.03	30.03	1.04	2.04	9.04	10.04	10
	average	29.03	31.03	2.04	3.04	5.04	10.04	9

Table 2. Tree dimensions

Cultivar	Trunk diameter	Tree height	Canopy height	Canopy width 1	Canopy width 2	Canopy volume
Sirma	36.38 a	3.96 a	3.45 ab	2.56 b	2.39 a	5.52 b
Pagane	33.75 a	3.86 a	3.26 b	3.31 a	2.81 a	8.01 a
Stanley	37.33 a	4.35 a	4.00 a	2.77 b	2.87 a	8.32 a

The tree growth of ‘Sirma’ is also vigorous. This cultivar’s tree is tall but with compact, moderately dense and spherical crown. ‘Sirma’ had the smallest calculated canopy volume and the statistical difference with the other studied cultivars was significant. ‘Pagane’ has fruits with very attractive appearance and good quality. ‘Pagane’s fruits were categorized as large, with an average fruit weight of 63.68 g. (Table 3). The bigger fruits have bigger stones, but the stone relative share compared to the

whole fruit was very good. It’s fruits also have and obovate, asymmetrical shape and deeply sunken suture, they are violet-blue in color with strong wax bloom (Picture 1). The fruits ripen at the end of August - 20.08 on average. The fruiting is regular and abundant. In 2018 were obtained 78 kg fruits from 7-years-old trees grown without pruning (Figure 1).

‘Sirma’ also has larger fruits than the standard cultivar, with an average fruit weight 44.70 g. The stone is medium sized and the stone relative share was also better compared to the standard. ‘Sirma’s fruits are oval in shape, symmetrical with dark violet-blue color, with strong bloom (Picture 2). Out of the three studied cultivars ‘Sirma’ had the highest yield in 2018 (Figure 1). Its yield was 52.7 kg more than the amount of fruits picked from ‘Stanley’.

Table 3. Fruit biometry analyses

Cultivar	Ripening time	Fruit				Stone weight (g)	Relative share (%)
		Length (mm)	Width (mm)	Thickness (mm)	Weight (g)		
Pagane	22.08.2014	49.84	43.76	45.28	57.98	1.87	3.22
	20.08.2015	53.38	44.91	48.59	68.48	1.98	2.89
	18.08.2016	49.02	46.58	44.93	64.59	2.05	3.18
average	20.08.	50.75 a	45.08 a	46.27 a	63.68 a	1.97 a	3.10 b
Sirma	18.07.2014	45.49	40.16	39.88	43.52	1.42	3.26
	20.07.2015	49.56	42.41	44.15	55.91	1.50	2.68
	23.07.2016	43.14	35.68	37.29	34.67	1.38	3.98
average		46.06 a	39.42 b	40.44 b	44.70 b	1.43 b	3.31 b
Stanley	2.09.2014	48.93	35.7	36.17	35.88	1.74	4.84
	21.08.2015	50.34	33.96	37.7	36.46	2.02	5.54
	30.08.2016	48.23	39.62	37.73	41.04	1.64	3.99
average		49.17 a	36.43 b	37.20 b	37.79 b	1.80 a	4.79 a



Picture 1. Fruits of 'Pagane'cv.



Picture 2. Fruits of 'Sirma'cv.

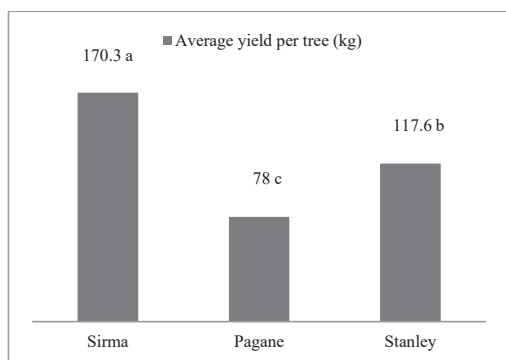


Figure 1. Average yield per tree obtained in 2018

The fruit quality is a combination of their physical and chemical characteristics - appearance, consistency, taste and aroma (Velisek and Cejpek, 2007). Consumers in our country prefer attractive fruits - medium to large, with a dark purple-blue skin color. Usually, a well-informed consumer prefers fruits with good taste, and when evaluated in sensory analyzes, the taste qualities are the most important ones (Bozhkova and Nesheva, 2016). After the fruits of the three studied cultivars were picked from the tree their appearance and taste qualities were evaluated by a group of trained consumers (Table 4). 'Pagane' has the most attractive and sweet fruits with balanced taste and very good texture of the fruit flesh. 'Sirma' has sweet fruits with moderate intensiveness of the aroma. They have the highest grade for sourness but anyway the taste is balanced and the final grade for this cultivars fruits is the highest. Both new cultivars do not have that intensive and attractive aroma as 'Stanley' but according their total score and final grades, their fruits are as good as the fruits of the standard and their taste qualities were evaluated as very good.

Total soluble solid content is important characteristic for the dried fruits production. Its high content is related to the high amount of sugars and increases the quality and yield of the dried product (Akin et al., 2008). Dry fruits producers prefer to use cultivars with high TSS content. 'Pagane' has a little bit higher TSS content in the fruits compared to 'Sirma' and the standard.

After sensory evaluation of the dried fruits both cultivars had equally good results. The trained consumers evaluated their dried fruits with very good qualities. 'Sirma's dried fruits had a little higher grade for their sweetness and consistency. 'Pagane' has better appearance and taste balance of its dried fruits (Table 5).

Table 4. Sensory evaluation of fresh fruits

Cultivar	TSS	Appearance	Aroma		Taste qualities				Fruit flesh texture and juiciness	Total score/ Final grade	
			Attractiveness	Intensiveness	Sweetness	Sourness	Bitter taste	Taste balance			
Pagane	20	1.44	0.43	0.45	1.6	0.38	-0.03	1.23	1.65	7.15	Very good
Sirma	18.6	1.28	0.5	0.53	1.53	0.71	-0.03	1.23	1.47	7.22	Very good
Stanley	18.2	1.36	0.6	0.64	1.35	0.47	-0.02	1.27	1.45	7.11	Very good

Table 5. Sensory evaluation of dried fruits

Cultivar	Appearance	Color	Skin tickness	Sweetness	Sourness	Bitter taste/ presence of mold	Taste balance	Consistency	Total score/ Final grade	
Pagane	1.56	0.9	-0.17	1.44	0.43	-0.04	1.56	1.48	7.16	Very good
Sirma	1.52	0.95	-0.15	1.64	0.38	-0.03	1.52	1.52	7.35	Very good

CONCLUSIONS

The two new plum cultivars, described in that study, are suitable for diversifying the variety list in the new orchards. The most valuable features of 'Sirma' are its early ripening and good fruit taste. 'Pagane' has markedly dessert qualities of the fruit.

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