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Comparative investigations of new Bulgarian plum cultivars

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Abstract: The new cultivars 'Plovdivska renkloda', 'Sineva' and 'Ulpiya' surpass the source parent cultivars in a number of important characteristics – fruit ripening period, fruit weight, relative stone share, fruit skin colouration. Along with bearing large and uniform fruits, the major advantages of the three new cultivars are the very good taste qualities of their fruits. In that sense, the fruits of 'Plovdivska renkloda' and 'Sineva' are especially suitable for fresh consumption. A great advantage of 'Plovdivska renkloda' is its self-fertility, a characteristic that is not inherent to the other Reine Cludes. Good pollinators of the new cultivars are 'Stanley', 'Čačanska Lepotica' and 'Reine Claude d'Altan'. The three cultivars show good compatibility with the seedling rootstock Prunus cerasifera and they demonstrate good resistance to winter and late spring frosts. Grown under irrigation conditions, the new cultivars would demonstrate higher values of the biometric characteristics of their fruits and they would bear higher yields. Thanks to their good characteristics, the new cultivars were included in the updated breeding programme for establishing F2 hybrid progeny.

Keywords: plum cultivars, biometric and economic values

Introduction

Plum crop, grown ever since the remote past, has always determined the specificity of fruit-growing in Bulgaria. Under the conditions of the new restructuring of fruit-growing after the social and economic changes in the country in 1989, plum continued to be among the priority structure-forming fruit crops.

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In the 80s of the last century 'Stanley' cultivar occupied 80-90% of the plum orchards in Bulgaria. It displaced 'Kyustendilska sinya' cultivar, which had been the major cultivar until the 70s, but proved to be strongly susceptible to Plum pox virus (Iliev 1990).

Growing a single plum cultivar in Bulgaria, going on for decades, necessitated the updating of the old and the development of new breeding programmes. A comparatively new, still implemented programme in Bulgaria, which is the first one for 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 2002). The first successful final results of the breeding programme were the new plum cultivars 'Plovdivska renkloda' (Zhivondov 2010), 'Sineva' and 'Ulpiya' (Zhivondov and Bozhkova 2010).

In the general part of the plum breeding programmes developed in Bulgaria and in other countries, along with all the specific breeding aims predetermined by the conditions and needs of the country, there was a common major aim – the establishment of new plum cultivars tolerant or resistant to PPV. Another typical common objective of the breeding programmes was the application of conventional breeding methods that could successfully collaborate with molecular technologies (Zhivondov and Djouvinov 2002, Jacob 2007, Blazek and Vavra 2007, Ogasanovic *et al*., 2007, Botu and Botu 2007, Hartmann 2007).

The aim of the present investigations was to elaborate comparative evaluation of the major pomological and economic characteristics of the three new Bulgarian plum cultivars.

Material and Methods

The new cultivars 'Plovdivska renkloda', 'Sineva' and 'Ulpiya' were included in the investigations. The observations were carried out in a collection plantation in the period 2006-2010, when the trees were 11-15 years old. The orchard was grown on humus-carbonate soil, maintained as black fallow, under non-irrigation conditions, at a planting distance of 6 x 4 m, applying conventional plant protection practices. The observed phenological characteristics included flowering and fruit ripening. The pomological characteristics: colour of the fruit skin and flesh and fruit and stone shape, were determined using the IBPGR Descriptor list for plum. Annually, a biometric analysis of the fruits was performed and the yields were reported in kg per tree.

Observations and investigations were carried out on the cultivar susceptibility to Plum Pox virus and to other diseases.

Virological surveys included visual inspections for evaluation of the infection degree and enzyme-linked immunosorbent assay (ELISA). The

observed trees were tested serologically for the presence of Plum pox virus (PPV) and other economically important viruses on stone fruits, namely Prunus necrotic ring spot virus (PNRSV), Prune dwarf virus (PDV), Apple chlorotic leaf spot virus (ACLSV) and Apple mosaic virus (ApMV). ELISA (Clark and Adams, 1977) was applied using commercial diagnostic antiserums against PPV, PDV, ACLSV, manufactured by Bioreba AG, as well as against PNRSV and ApMV, supplied by Loewe Biochemica GmbH.

Data of the three studied cultivars were compared to those of the parent cultivars 'Stanley' and 'President'. For further precision, the data of 'Plovdivska renkloda' cv. were compared to those of 'Green gage', as both cultivars belong to the botanical subspecies Prunus domestica L. subsp. italica.

Data were statistically processed by Duncan's test (Steele and Torrie 1980).

Results and Discussion

Phenological observations showed that flowering periods of 'Sineva' and 'Plovdivska renkloda' were delayed compared to the mother parent 'Stanley' by 2 and by 5 days, respectively (Table 1). Flowering of 'Ulpiya' started and continued at the same time as that of 'Stanley' but it was 2 days delayed compared to flowering of the mother parent 'President' and that difference often showed to be important for avoiding the spring frosts. Flowering of 'Plovdivska renkloda' was the latest to start, delayed by 5 days compared to 'Green gage'. The difference was considerable and it guaranteed regular fruiting.

Table 1. Phenological and pomological characteristics

Cultivar	Time of flowering	Time of ripening	Fruit shape	Fruit skin colour	Fruit flesh colour
Sineva	7 Apr.	13-19 Aug.	ovate	violet-blue	yellow
Ulpiya	5 Apr.	10-16 Aug.	ovate	violet-blue	yellow-green
Plovdivska renkloda	10 Apr.	15-21 Aug.	rounded	purplish-violet	yellow
Stanley	5 Apr.	24 Aug. – 01 Sept.	ovate	dark blue	yellow
President	3 Apr.	14-21 Sept.	ovate	violet-blue	yellow
Green gage	5 Apr.	10-17 Aug.	rounded	yellow-green	yellow-green

Fruits of the new cultivars ripened in the second decade of August, the first being those of 'Ulpiya', followed by 'Sineva' and 'Plovdivska renkloda' in 3 and 5 days, respectively. The three new cultivars ripened 10-15 days before

'Stanley', 'Plovdivska renkloda' ripening 5 days later than 'Green gage'. Fruits of 'Ulpiya' ripened more than a month before those of 'President' cv. (Fig. 1).

The fruit shape and the skin colour are important components of the sensory profile of the fruits. They are the first characteristics attracting the attention of the consumers. According to the IBPGR Descriptor list for plum, the fruits of 'Sineva' and 'Ulpiya' cvs. are ovate in shape like those of 'Stanley' and 'President'. More precisely, the fruits of 'Ulpiya' are ovate-rounded in shape, while those of 'Plovdivska renkloda' are rounded as those of 'Green gage'. Fruit skin of 'Sineva' and 'Ulpiya' is violet-blue in colour, but the fruit skin colour of 'Sineva' is more deep, bright and attractive. The fruits of 'Plovdivska renkloda' are coloured in purplish-violet and they are quite different and more attractive than those of 'Green gage'. Fruit flesh of 'Ulpiya' is yellow-green and of the other two new cultivars it is golden yellow like that of 'Stanley'.

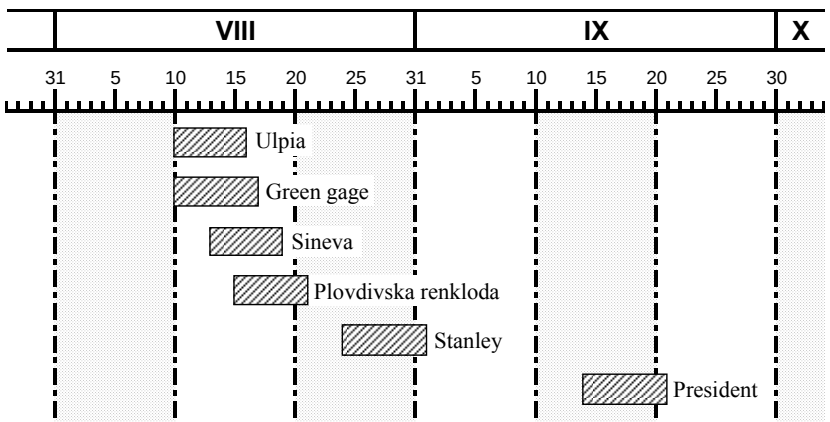

Fig. 1. Phenogram of fruit ripening

The results of the biometric analysis of the fruits showed that the height is the largest dimension in the cultivars 'Sineva', 'Ulpiya', 'Stanley' and 'President'. In both cultivars of the Reine Claude group, the largest dimension is fruit width, the differences being statistically significant (Table 2). The largest weight was reported for the fruits of 'Sineva" cv. – 53,13 g, the difference to the values of all the studied cultivars being statistically significant. The smallest were the fruits of 'Green gage', the difference to the other cultivars also being statistically significant. The fruits of the three new cultivars are bigger in weight compared to the standard cultivars. The only exception was established in 'Ulpiya' cv., the weight of its fruits being almost the same as of 'President'. The stone of 'Sineva' cv. is the largest, followed by that of 'Ulpiya' and the smallest is the stone of 'Green gage', the last one being the only statistically proven difference to all the other values. The stones of 'Plovdivska renkloda', 'Stanley'

and 'President' have the same characteristics. There are many exceptions to the rule that the larger fruits have larger stones. In that sense, the stone to fruit weight ratio is quite indicative. The biometric analysis in the present investigation showed that 'Sineva' cultivar, which has the largest fruits and the largest stones, has the lowest relative stone to fruit ratio – 3,77%. All the other cultivars showed closer values to each other and the differences between them were statistically insignificant. The longest fruit pedicel was reported in 'Plovdivska renkloda' cultivar – 18,10 mm and the shortest one in 'Sineva' – 15,73 mm.

Table 2. Average biometric and economic values (2006-2010)

Cultivar	Fruit size (mm)			Fruit weight (g)	Stones		Pedicel length (mm)	Yields	
	Height	Width	Thickness		Weight (g)	Relative share (%)		kg/tree	t/ha
Plovdivska renkloda	42.46c	42.62a	39.92b	43.73b	1.75a	4.01b	18.10a	64.2b	26.71
Sineva	49.66a	42.34ab	44.02a	53.13a	2.00a	3.77b	15.73a	63.2bc	26.29
Ulpiya	44.84bc	40.37b	39.96b	42.40b	1.97a	4.65a	16.99a	62.8c	26.12
Stanley	50.47a	38.09c	37.40c	39.24b	1.75a	4.48ab	17.63a	66.0a	27.46
President	45.35b	38.15c	39.35bc	42.70b	1.75a	4.09b	17.45a	62.0c	25.79
Green gage	32.85d	35.10d	34.63d	25.46c	1.00b	3.91b	15.81a	63.0bc	26.21
LSD 5%	2.44	1.97	2.02	4.97	0.26	0.47	2.93	1.27	

The economic parameters for the 5-year experimental period, the tree age ranging from 11 to 15 years, showed that the highest average yields in kg per tree were obtained from 'Stanley' cultivar – 66 kg/tree. The highest yield from the new cultivars was established for 'Plovdivska renkloda' – 64,20 kg/tree. The three new cultivars surpassed 'President' cv. in fertility and the yields obtained from 'Plovdivska renkloda' were higher compared to the yields of 'Green gage'. The yields calculated in t/ha, at 417 trees per ha, followed the same tendency as the yields reported in kg/tree.

The data of the virological surveys are presented in Table 3. The trees were grown under high natural infection pressure in the region of Plovdiv. Symptoms at different degrees of severity were recorded on the leaves but symptoms on the fruits were not observed. PPV and PNRSV were detected in single or in mixed infection in the tested trees. ApMV was identified in only one sample. Logically, the trees with mixed infection by PPV and PNRSV developed more severe symptoms on the leaves.

Table 3. Infection degree and ELISA results

Cultivar/tree	Infection degree		ELISA results				
	Symptoms on leaves	Symptoms on fruits	PPV	PDV	PNRSV	ACLSV	ApMV
Plovdivska renkloda – 1	severe	no symptoms	negative	negative	positive	negative	negative
Plovdivska renkloda – 2	medium	no symptoms	poisitive	negative	negative	negative	negative
Plovdivska renkloda – 4	severe	no symptoms	positive	negative	positive	negative	negative
Plovdivska renkloda – 5	medium	no symptoms	positive	negative	negative	negative	negative
Plovdivska renkloda – 6	medium	no symptoms	negative	negative	positive	negative	negative
Sineva – 1	medium	no symptoms	positive	negative	negative	negative	negative
Sineva – 2	severe	no symptoms	positive	negative	positive	negative	negative
Sineva – 3	severe	no symptoms	positive	negative	positive	negative	negative
Sineva – 4	severe	no symptoms	positive	negative	negative	negative	negative
Sineva – 5	severe	no symptoms	positive	negative	positive	negative	negative
Sineva – 6	severe	no symptoms	negative	negative	positive	negative	negative
Ulpiya – 1	medium	no symptoms	positive	negative	negative	negative	negative
Ulpiya – 2	severe	no symptoms	negative	negative	positive	negative	negative
Ulpiya – 3	medium	no symptoms	negative	negative	positive	negative	negative
Ulpiya – 4	medium	no symptoms	negative	negative	negative	negative	positive

medium symptoms – spots cover up to ½ of the leaf;
severe symptoms – spots cover up to ¾ of the leaf

The study on the response of the cultivars to PPV had started 8 years earlier, at their elite stage, under somewhat different agroecological conditions – in the region of Asenovgrad, also under high infection pressure. Under those conditions, 'Plovdivska renkloda' (elite 6-5) showed field resistance to PPV, whereas 'Sineva' (elite 6-51) and 'Ulpiya' (elite 5-174) showed tolerance (Milusheva *et al*., 2009). Under the conditions of the region of Plovdiv, a slight increase of susceptibility of 'Plovdivska renkloda' to PPV was observed, expressed in a higher infection degree on the leaves and therefore the cultivar could be evaluated as tolerant. Maybe the reasons for that should be sought in the mixed infection and in the virus strains. 'Plovdivska renkloda' and 'Sineva' were obtained as a result of open pollination of 'Stanley', while 'Ulpiya' was obtained from open pollination of 'President'. In comparison with the mother cultivars, all the three investigated cultivars revealed a higher level of resistance to PPV.

The tolerant and the partially resistant cultivars had quantitative resistance and they were more or less systematically infected and thus they could be the source of the infection. But for the current Sharka situation in our country, growing of tolerant cultivars would be suitable, under the condition that the new orchards are established using virus free planting material and applying good agricultural practices.

The three new cultivars grown under the agroecological conditions of the fruit-growing region of Plovdiv, demonstrated a high degree of resistance to the causative agent of red leaf spot (*Polystigma rubrum*), brown rot on flowers (*Monilinia laxa*) and rust on plum (Tranzschelia pruni spinosae).

Conclusion

The new cultivars 'Plovdivska renkloda', 'Sineva' and 'Ulpiya' surpass the source parent cultivars in a number of important characteristics – fruit ripening period, fruit weight, relative stone share, fruit skin colouration. Along with bearing large and uniform fruits, the major advantages of the three new cultivars are the very good taste qualities of their fruits. In that sense, the fruits of 'Plovdivska renkloda' and 'Sineva' are especially suitable for fresh consumption. A great advantage of 'Plovdivska renkloda' is its self-fertility, a characteristic that is not inherent to the other Reine Cludes. Good pollinators of the new cultivars are 'Stanley', 'Čačanska Lepotica' and 'Reine Claude d'Altan'. The three cultivars show good compatibility with the seedling rootstock Prunus cerasifera and they demonstrate good resistance to winter and late spring frosts. Grown under irrigation conditions, the new cultivars would demonstrate higher values of the biometric characteristics of their fruits and they would bear higher yields. Thanks to their good characteristics, the new cultivars were included in the updated breeding programme for establishing F2 hybrid progeny.

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UPOREDNA ISPITIVANJA NOVIH BUGARSKIH SORTI ŠLJIVE

-originalni naučni rad-

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Rezime

Nove sorte šljive 'Plovdivska renkloda', 'Sineva' i 'Ulpiya' nadmašuju izvorne roditeljske sorte u pogledu brojnih značajnih osobina – perioda sazrevanja ploda, mase ploda, relativnog udela koštice, obojenosti pokožice. Pored krupnog ujednačenog ploda, glavne prednosti ove tri sorte jesu i veoma dobre organoleptičke osobine ploda. U tom smislu, plodovi sorti 'Plovdivska renkloda' i 'Sineva' naročito su pogodni za svežu upotrebu. Značajna povoljna osobina sorte 'Plovdivska renkloda' jeste njena sposobnost samooplodnje, osobina koju nemaju ostale sorte 'Reine Clude'. U dobre oprašivače novih sorti spadaju sorte 'Stenli', 'Čačanska lepotica' i 'Reine Claude d'Altan'. Ove tri sorte pokazuju dobru kompatibilnost sa sejancem dženarike (*Prunus* cerasifera) kao podlogom i ispoljavaju dobru otpornost na zimske i kasne prolećne mrazeve. U uslovima navodnjavanja, ispitivane nove sorte šljive pokazuju više vrednosti biometrijskih osobina ploda i imaju više prinose. Zahvaljujući svojim dobrim osobinama, uvrštene su u obnovljeni program oplemenjivanja za stvaranje hibridnog potomstva F_2 generacije.

Ključne reči: plum cultivars, Plovdivska renkloda, Sineva, Ulpiya.