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PRECOCITY, YIELD AND POSTHARVEST PHYSICAL AND CHEMICAL PROPERTIES OF PLUMS RESISTANT TO SHARKA GROWN IN SERBIAN CONDITIONS

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Abstract. The study focused on characterizing the three German plum cultivars ('Jojo', 'Hanita' and 'Katinka') hypersensitive (oversensitiveness) and/or tolerant to Sharka to acknowledge the tree vigour, precocity, yield performances and main physico-chemical quality attributes of the fruits grown in a Serbian agro-climatic conditions. The cultivars were grafted on 'Wangenheim Prune' seedlings rootstock and established at a 4 × 1.5 m. The following determinations were assessed: trunk cross sectional area, yield per tree and unit area, yield efficiency, fruit and stone mass, fruit linear dimensions, flesh rate, geometric mean diameter, sphericity, aspect ratio, surface area, soluble solids and sugars content, titratable acidity, and ratio between them, respectively. The cultivar *per se* (genotype) behaved as the most influencing factor conditioning plum tree vigour, yield characteristics, physical attributes, soluble solids content, titratable acidity and sugar profiles. The assessment of plum chemical compositions implies the great potential of German cultivars for fresh market, fruit processing and drying. In fact, the 'Katinka' seems particularly suitable for fresh consumption, whereas 'Jojo' and 'Hanita' can be recommended for fresh consumption, processing and drying. Finally, all three cultivars grafted on 'Wangenheim Prune' seedlings can be recommended for growers in similar conditions.

Key words: fruit size, *P. domestica* L., soluble solids and sugars content, yield efficiency

INTRODUCTION

Plum trees can grow over the five continents of the world and production level exceeds 11 million tons. Among fruit trees grown in Serbian orchards, plums rank first.

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Also, Serbia ranked 2nd in Europe and 3rd worldwide after China and Romania in terms of the volume of plum production in the year 2010 [FAOSTAT 2012]. For these reasons, in Serbia plums have high economical, social and supply importance. Generally, plum has an important place in human nutrition. As known, the fruit of plum is not only consumed fresh but also used to produce dried plum, frozen plum, dehydrated plum, jam, jelly, marmalade, pulp, juice, compote, nectar, extrusion products, candied fruit, and traditional Serbian plum alcoholic beverages "Šljivovica" or "Rakija" [Milosevic et al. 2010a]. Plum is also an important export fruit, fresh, frozen or dried [Milošević and Petrović 2000].

Major commercial plum cultivars grown in Serbia include 'Čačanska Lepotica', 'Čačanska Najbolja', 'Čačanska Rodna', 'Čačanska Rana' and 'Stanley' [Milošević and Milošević 2011a, b], and there is space in the market for large fruited late ripening cultivars. Additionally, 'Požegača' is a predominant cultivar in some regions of western Serbia. 'Požegača' and 'Čačanska Rodna' are popular among the growers and consumers; however, these plums are highly susceptible to Sharka or *Plum pox virus* (PPV) [Milosevic et al. 2010b]. It has caused irrecoverable economic damage for >75 years. No solution to this problem has been found, and the growers are looking for new cultivars to replace 'Čačanska Rodna', especially 'Požegača', in Serbian plum orchards. Because of its high economical importance, the creation and introducing of new cultivars of plum remains a priority [Milošević and Petrović 2000]. In addition, among stone fruit crops, the plum breeding is one of the most dynamic and new cultivars originated from *P. domestica* L. are released every year [Blažek et al. 2004]. Major objectives in the development of new plum *P. domestica* cultivars include good cropping, large, high-quality fruits with blue skin, trees as dwarf as possible [Kosina 2004], and in particular tolerance or resistance to the agents of economically major diseases, primarily PPV [Jakob 2007, Milošević and Milošević 2011a]. In this context, as a result of the plum breeding program in Germany (Hohenheim), among others, obtained using the two cultivar 'Katinka' ('Ruth Gerstetter' × 'Ortenauer') and 'Hanita' ('President' × 'Auerbacher') in the hinges and tolerant cultivars 'Jojo' ('Ortenauer' × 'Stanley') is quite resistant to specified virus [Hartmann and Neumüller 2006].

In past few years, these three cultivars are introduced to Serbia. However, their properties were not evaluated. For these purposes, the objective of the present study was to detect and compared tree growth, yield performances and the main physical properties and chemical profile of plum cultivars tolerant and/or resistant to PPV grown under Cacak (Western Serbia) environmental conditions.

MATERIAL AND METHODS

Plant material and field trial. The European plum cultivars used were 'Jojo', 'Hanita' and 'Katinka'. The cultivars were grafted on 'Wangenheim Prune' seedlings rootstock grown in the experimental orchards "Preljinsko Brdo" at Fruit Research Institute Cacak in Preljina (43°54' N; 20°24' E, 350 m above sea level) near Cacak city (Western Serbia). The orchard was established in spring of 2005. The "Zahn Spindle" training system at a spacing 4.0 × 1.5 m was used. Orchard management was consistent with

standard cultural practice (summer pruning, fertilization, pest and disease control, drip irrigation). Weather conditions of Cacak are characterized by the average annual temperature of 11.3°C and total annual rainfall of 690.2 mm.

The experiment was set up as a randomized block design in four replicates with 5 trees each (total 20 trees per cultivar). The fruit samples were hand harvested at commercial (fully) maturity stage in 2008, 2009 and 2010. For physical properties evaluation, fruits of each cultivar from five trees (ten fruit per tree) in four replicates were collected, packed in cartons and transferred to the laboratory facilities where they were subjected to analysis. Three replicates of ten fruits of each cultivar were randomly collected for chemical analysis. Immediately after harvest, fruits were transported in an air-conditioned car to the laboratory and analyzed the same day.

Measurement of the tree vigour and yield. Trunk circumference was measured during the end of vegetative cycle 10 cm above the graft union, and the trunk cross sectional area (TCSA) was calculated (cm^2). The measurements were made by a ruler and a digital caliper Starrett, 727 Series (Athol, NE, USA). Yield per tree (YT) and per hectare (YH), cumulative yield (CY) and yield efficiency (YE) (ratio of final yield in kg per final TCSA in cm^2) of each cultivar were computed from the harvest data. An ACS System Electronic Scale (Zhejiang, China) was used to measure fruit yield. The data are given in kg $tree^{-1}$, t ha^{-1} and kg cm^{-2}, respectively.

Measurement of the physical properties. Fruit mass (FM) and stone mass (SM) were determined using a Tehnica ET-1111 technical scale (Iskra, Horjul, Slovenia) with 0.01 g sensitivity. Data are given in g. For determining flesh rate (FRa), fruits were cut in half horizontally with a stainless-steel knife and the stones were removed and weighed. The FRa (%) was calculated by subtracting the stone mass from the whole plum FM.

For each plum fruit, three linear dimensions, length (L), width (W) and thickness (T) were measured by using a digital caliper gauge with a sensitivity of 0.01 cm. The measurement of L was made on the polar axis of fruit, i.e. between the apex and stem. The geometric mean diameter (D_g), sphericity (ϕ) and surface area (S) was calculated by using the following relationships [Mohsenin 1986]:

$$D_g = LWT^{\frac{1}{3}}, \tag{1}$$

where:

D_g – geometric mean diameter (mm),
L – length of plum fruit (mm),
W – width of plum fruit (mm),
T – thickness of plum fruit (mm),

$$\phi = \frac{D_g}{L}, \tag{2}$$

where: ϕ – sphericity (%),

$$S = \pi D_g^2 \tag{3}$$

where: S – surface area (mm^2).

The aspect ratio (R_a) was calculated [Maduako and Faborode 1990] as:

$$R_a = \frac{W}{L} \times 100 \quad (4)$$

where: R_a – aspect ratio (%).

Measurement of the chemical properties. Soluble solids contents (SSC) were assessed by Milwaukee MR 200 hand refractometer (ATC, Rocky Mount, NC, USA) at 20°C (°Brix). Titratable acidity (TA), as malic acid (%), was determined using an automatic titration device 877 Titrano plus (Herisau, Switzerland) with 0.1 N NaOH up to pH 8.1. Once the SSC and TA contents were assessed, the SSC/TA ratio or ripening index (RI) of evaluated cultivars was determined. The juice pH was determined by a Cyber Scan 510 pH meter (Nijkerk, The Netherlands).

The total sugars (TS) and reduced sugars (RS) content were determined on triplicate samples by the Luff-Schoorl method previously described by Schneider [1979]. The sucrose content (SU) was calculated according to the relationship: SU = (TS – RS) × 0.95. The results were expressed in % of fresh weight. TS/TA ratio (index of sweetness – IS) was calculated as the relationship between TS and TA. All results expressed as the mean + SE for each chemical properties for three consecutive years.

Data analysis. The recorded data were statistically analyzed by ANOVA using the software of MSTAT-C [Michigan State University, East Lansing, MI, USA]. Means were compared with the LSD test at $P \leq 0.05$.

RESULTS AND DISCUSSION

Tree vigour and yield performances. Tree vigour, as measured by TCSA, significantly affected by cultivars, starting from third year after planting (fig. 1). The greatest final TCSA was exhibited by ‘Katinka’, and the lowest by ‘Jojo’.

This data show that trees of ‘Jojo’ grow more slowly than other two cultivars, and being less vigorous cultivar with a good capacity to control vigour. However, Blažek and Pištěkova [2009] reported that trees of ‘Katinka’ and ‘Jojo’ grafted onto St. Julien A rootstock had significantly smaller TCSA values than those of ‘Hanita’ at four years after planting. The good adaptation of ‘Katinka’ on ‘Wangenheim Prune’ rootstock to the growing conditions, probably favoured higher values for these characteristics in our study, as previously reported by Blažek et al. [2004].

In the second and third year after planting, 2006 and 2007, yields were low (~0.5 kg tree^{-1}), and there were no statistically significant cultivar differences (data not shown). However, in the next cropping years (2008–2010), differences in precocity among cultivars became evident, ‘Hanita’ and ‘Jojo’ being the most efficient cultivars. Namely, the highest YT and YH were observed in the both of above cultivars, and the lowest in ‘Katinka’ (tab. 1). By year sixth after planting, the CY was greater in ‘Hanita’, followed by ‘Jojo’ and ‘Katinka’. The best YE recorded in ‘Jojo’, probably due to its weak growth and cumulative production. The lowest YE registered in ‘Katinka’, probably due to its low yield and high TCSA. In a earlier study obtained by Blažek and

Pištěkova [2009], 'Katinka' and 'Jojo' had better YE than 'Hanita'. The differences between our results and those of cited authors could be explained by differences in the agro-climatic conditions and cultural practices. Additionally, Grzyb and Sitarek [2007] registered that 'Hanita' when grafted on seedlings of 'Wangenheim Prune' had the best YE in relation to other generative and vegetative rootstocks. The relatively high vigour, shown by 'Hanita' and 'Katinka', may be recommendable when planting on poor soils or under replanting conditions.

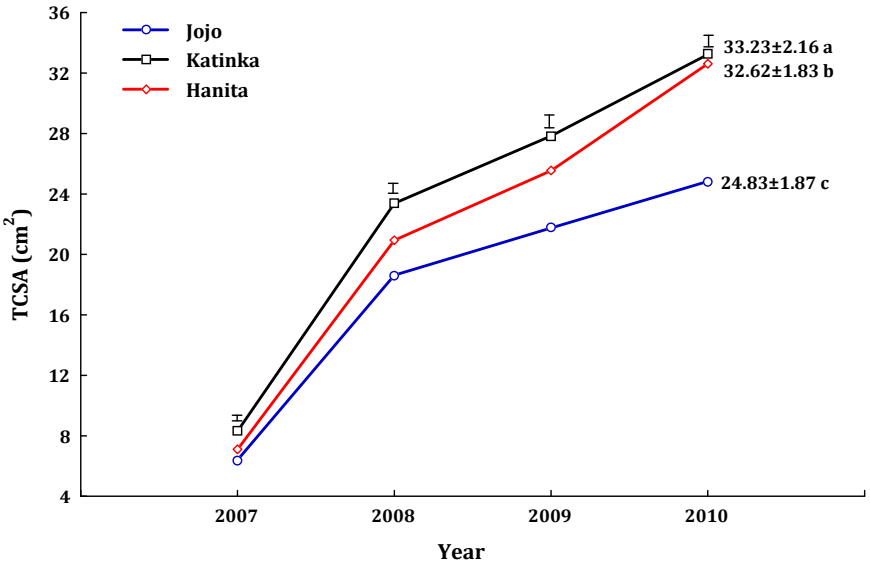

Fig. 1. Cultivar influence on trunk cross-sectional area (TCSA) from the third (2007) to the sixth (2010) year after planting. Vertical lines indicate LSD at $P \leq 0.05$

Rys. 1. Wpływ odmiany na przekrój pnia (TCSA) od trzeciego (2007) do szóstego (2010) roku po sadzeniu. Linie pionowe oznaczają LSD przy $P \leq 0,05$

Fruit physical properties. The data in table 2 show values obtained for FM, SM, FSr and three fruit linear dimensions (L, W, T). The results show a large variability in the evaluated plum cultivars, and significant differences were observed among them. The highest FM was observed in 'Hanita', and the lowest in 'Katinka'.

In fact, plums fruit showed a great variability of FM [Walkowiak-Tomczak et al. 2007, Sosna 2010, 2012, Milošević and Milošević, 2012]. So, Hartmann and Neumüller [2006] and Blažek and Pištěkova [2009] reported that FM of 'Hanita', 'Katinka' and 'Jojo' ranged from 30–40 g, 25–30 g and 40–50 g, and/or 25–40.5 g, 17.4–24.4 g and 36.1–48.5 g, respectively. A high disagreement in comparison to above data could be stated in 'Jojo'. Probably, the high yield showed by this cultivar affected its FM when compared with the other low yielding cultivars [Halapija-Kazija et al. 2009]. This cultivar is very interesting for practical and commercial growing because of its resistance to PPV [Hartmann and Neumüller 2006] despite that its inner FM was rather under mean

level. Additionally, adverse relationship between yield and mean FM were determined in some plum accessions and cultivars recently [Milošević and Milošević 2012, Sosna 2012].

Table 1. Impact of cultivar on yield per tree and unit area, cumulative yield and yield efficiency of 'Jojo', 'Katinka' and 'Hanita' plums, in the fifth (2010) year after planting
Tabela 1. Wpływ odmiany na plon na drzewo oraz jednostkę obszaru, plon całkowity oraz plonowanie odmian śliwy 'Jojo', 'Katinka' i 'Hanita" w piątym (2010) roku po sadzeniu

Cultivar Odmiana	YT (kg tree^{-1}) Plon roczny (kg drzewo^{-1}) 2010	YH (t ha^{-1}) Plon w przeliczeniu na 1 ha 2010	CY (kg tree^{-1}) Plon łączny z lat 2008–2010	YE (kg cm^{-2}) Współczynnik plenności 2010
Jojo	16.60 ± 0.48 b	27.67 ± 0.90 b	39.90 ± 1.54 b	0.67 ± 0.06 a
Katinka	13.10 ± 0.72 c	21.84 ± 1.35 c	31.48 ± 1.24 c	0.39 ± 0.05 c
Hanita	16.90 ± 0.41 a	28.17 ± 0.76 a	41.10 ± 0.81 a	0.52 ± 0.04 b

For abbreviations see section "Material and methods" – Skróty, zob. rozdział „Materiał i metody"
The different letters in columns indicates significant differences among means by LSD test at $P \leq 0.05$
Inna litera wskazuje na istotne różnice między średnimi przy $\alpha \leq 0.05$ według testu NIR

The highest values of SM, fruit L and T were found in 'Jojo' and 'Hanita', and the lowest in 'Katinka' (tab. 2). Differences between 'Jojo' and 'Hanita' for these traits were not significant. The highest fruit W was found in 'Hanita'.

Table 2. Fruit and stone mass, flesh/stone ratio and three linear fruit dimensions
Tabela 2. Masa owoców i pestek, stosunek miąższu do pestki oraz trzy liniowe wymiary owoców

Cultivar Odmiana	FM Masa owocu (g)	SM Masa pestki (g)	FRa Udział miąższu (%)	L (mm)	W (mm)	T (mm)
Jojo	30.55 ± 0.68 b	1.85 ± 0.05 a	93.81 ± 0.16 b	45.23 ± 0.29 a	32.54 ± 0.28 b	33.86 ± 0.26 a
Hanita	34.33 ± 0.54 a	1.79 ± 0.03 a	94.65 ± 0.10 b	44.14 ± 0.34 a	35.35 ± 0.25 a	34.83 ± 0.20 a
Katinka	24.82 ± 0.62 c	1.05 ± 0.02 b	95.60 ± 0.11 a	38.74 ± 0.37 b	31.53 ± 0.39 b	31.01 ± 0.32 b

*see table 1 – patrz tabela 1

Our results are similar to those published by Blažek and Pištěkova [2009] with same cultivars for SM. Fruit size is a major factor determining yield, fruit quality and consumer acceptability [Crisosto et al. 2004, Walkowiak-Tomczak et al. 2007]. Also, axial dimensions are important in determining aperture size of machines, particularly in separation of materials, and these dimensions may be useful in estimating size of machine

components, especially for mechanical harvesting [Jannatizadeh et al. 2008]. The best FRa was observed in 'Katinka'. In fact, consumers preferred plums with high FRa [Milošević and Milošević 2011b].

Data for D_g, ϕ, R_a and S of three plum cultivars are given in tab. 3. Significantly higher values of D_g had 'Jojo' and 'Hanita', and lower was observed in 'Katinka'.

Table 3. Geometric mean diameter, sphericity, aspect ratio and surface area
Tabela 3. Średnica średniej geometrycznej, sferyczność, format obrazu i powierzchnia

Cultivar Odmiana	D_g Średnia geometryczna pomiarów (mm)	ϕ Kulistość	R_a Współczynnik kształtu (%)	S Powierzchnia owocu (mm^2)
Jojo	36.66 ± 0.47 a	0.82 ± 0.01 a	72.26 ± 0.84 b	4258.86 ± 89.50 b
Hanita	37.84 ± 0.32 a	0.86 ± 0.01 a	80.31 ± 0.34 a	4513.28 ± 78.17 a
Katinka	33.65 ± 0.25 b	0.87 ± 0.01 a	81.42 ± 0.61 a	3560.15 ± 47.65 c

*see table 1 – patrz tabela 1

The results for the above values are due to the differences in values of linear dimensions. The knowledge related to D_g would be valuable in designing the grading process [Mohsenin 1986, Çalışır et al. 2005]. The global fruit shape is determined in terms of its ϕ and R_a. Values of ϕ were similar in all three plums, whereas values of R_a significantly affected by cultivars. When ϕ values is different from 1, the shape is oval, flattened or with protruding sutures. For example, Stefanova et al. [2008] reported that fruits of 'Hanita' have elliptical shape with well-marked abdominal suture. The highest R_a was found in 'Hanita' and 'Katinka', and the lowest in 'Jojo'. The R_a relates the W to the L of the fruit which is indicative of its tendency toward being spherical in shape [Maduako and Faborode 1990]. The S of the 'Hanita' fruit was significantly greater than those of the other two cultivars. These properties could be beneficial in proper prediction of plum drying rates and hence drying times in the dryer [Çalışır et al. 2005].

Fruit chemical properties. All chemical traits were significantly affected by cultivars, except SU (tab. 4 and 5). The highest SSC, TA, RS and TS were recorded in 'Hanita'; the highest values of juice pH, SSC/TA and TS/TA ratio were found in 'Katinka'. The SU were quite similar for each cultivar (tab. 5). Generally, 'Jojo' had intermediate values of chemicals evaluated. Walkowiak-Tomczak et al. [2007] and Sosna [2010, 2012] found that plum genotypes have a significant influence on SSC, which confirmed results in our study. However, another greater discrepancy between the results was in the SSC of all plum fruits. Generally, our results are inferior to the results obtained by Blažek and Pištěkova [2009] and Halapija-Kazija et al. [2009] for the same plum cultivars grown in a Czech Republic and Croatian conditions, respectively.

Table 4. Soluble solids content, titratable acidity, juice pH and soluble solids/titratable acidity ratio of three plum cultivars
Tabela 4. Zawartość rozpuszczalnych ciał stałych, kwasowość miareczkowa, pH soku oraz stosunek między rozpuszczalnymi ciałami stałymi i kwasowości miareczkowanej u trzech odmian śliwy

Cultivar Odmiana	SSC Exstract (°Brix)	TA Kwasowość miareczkowa (%)	Juice pH pH soku	SSC/TA Wskaźnik dojrzewania
Jojo	13.75 ± 0.49 b	0.79 ± 0.04 b	3.84 ± 0.09 b	19.57 ± 1.42 b
Hanita	15.26 ± 0.38 a	1.28 ± 0.05 a	3.54 ± 0.07 c	12.04 ± 0.47 c
Katinka	12.63 ± 0.63 c	0.71 ± 0.08 b	3.97 ± 0.10 a	21.18 ± 2.99 a

*see table 1 – patrz tabela 1

This could be connected with ecological conditions, cultural practices, maturity stage at harvest date and rootstocks used, as previously obtained by Crisosto et al. [2004]. Above authors also reported that plums with ≥12% SSC and ≤0.60% TA were preferred by consumers. In addition, the SSC/TA ratio or RI has an important role in consumer acceptance of apricots, peaches, nectarines and plums [Ruiz and Egea 2008].

Table 5. Sugars content and index of sweetness of three plum cultivars
Tabela 5. Zawartość cukrów oraz indeks słodkości trzech odmian śliwy

Cultivar Odmiana	RS Cukry redukujące (%)	SC Sacharoza (%)	TS Cukry ogółem (%)	TS/TA Wskaźnik słodkości
Jojo	7.13 ± 0.35 b	4.53 ± 0.09 a	11.68 ± 0.38 b	16.98 ± 1.16 b
Hanita	7.92 ± 0.25 a	4.56 ± 0.17 a	12.95 ± 0.24 a	10.09 ± 0.47 c
Katinka	6.55 ± 0.44 c	4.55 ± 0.16 a	11.34 ± 0.54 c	18.75 ± 2.52 a

*see table 1 – patrz tabela 1

The juice pH significantly differed among the cultivars (tab. 4), and this interval range agreed with those reported from other cultivars grown in similar conditions [Milošević and Milošević 2011b]. The German plum cultivars evaluated on this study significantly differed in RS, TS and IS (tab. 5). While the cultivar 'Hanita' showed the highest RS and TS, 'Katinka' exhibited a highest TS/TA ratio (IS), whereas differences among cultivars for SU were not significant. About data from literature, glucose and SU were the predominant plum sugars, whereas fructose occurred at lowest content [Kumar et al. 2001]. However, Klewicki and Uczciwek [2008] noticed that some plums had the highest content of SU, followed by glucose and fructose. To some researchers, the di-

vergence noticed on sugar contents might be due to diverse agro-climatic conditions [Nergiz and Yldz 1997]. To others in contrast, the cultivar factor *per se* (genotype) mostly influences plum sugars profiles [Crisosto et al. 2004]. The TS/TA ratio (IS) determines the quality attributes of plum juice and consumer acceptance. So, Forni et al. [1992] reported that the TS/TA ratio, for good quality plums, should be between 12 and 24, which partially confirmed our results.

From this point, it could be said that fruits of 'Katinka' primarily recommended for fresh consumption, whereas 'Jojo' and 'Hanita' can be recommended for fresh consumption, processing and drying, as previously reported by Hartmann and Neumüller [2006]. In addition, above authors reported that 'Hanita', 'Katinka' and 'Jojo' had excellent, very good and good fruit quality, respectively.

CONCLUSIONS

1. The highest tree vigour was observed in 'Katinka', and the lowest in 'Jojo'. 'Hanita' had the best yield per tree and unit area and cumulative yield, while 'Jojo' had the highest yield efficiency.

2. 'Hanita' had the best values of fruit mass, fruit width and thickness, geometric mean diameter and surface area, whereas sphericity was similar in all cultivars. Also, respectable some physical properties were observed in 'Jojo'. The best flesh rate was recorded in 'Katinka'.

3. The highest soluble solids content, titratable acidity and sugars content was found in fruits of 'Hanita', whereas the highest values of pH juice, ratio between soluble solids content and acidity and between total sugars content and acidity were observed in 'Katinka'.

4. All three cultivars are very interesting to growers because of its resistance and/or tolerance to Sharka, good precocity and yield characteristics. Also, fruits of the cultivars were quite attractive and with good size and good chemical composition, and can be recommended for fresh consumption, processing and drying. Therefore it has a great chance for extended use in commercial and amateur plum growing in Serbia and other countries that suffers a lot from the disease.

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PRZEDWCZESNY ROZWÓJ, PLON ORAZ FIZYCZNE I CHEMICZNE WŁAŚCIWOŚCI ŚLIW ODPORNYCH NA WIRUS OSPOWATOŚCI, HODOWANYCH W WARUNKACH SERBSKICH

Streszczenie. Badania dotyczyły charakterystyki niemieckich odmian śliwy (‘Jojo’, ‘Hanita’ i ‘Katinka), które są nadmiernie wrażliwe (nadwrażliwość) i/lub tolerancyjne wobec wirusa ospowatości w celu ustalenia żywotności, przedwczesnego rozwoju, plonu oraz głównych cech fizyko-chemicznych owoców hodowanych w serbskich warunkach agroklimatycznych. Odmiany były zaszczepione na podkładkach śliwy ‘Wangenheim Prune’, rośliny uprawiano w rozstawie 4 × 1,5 m. Ocenie poddano: przekrój pnia, plon w przeliczeniu na jedno drzewo i na jednostkę obszaru, masę owocu i pestki, liniowe wymiary owoców, wskaźnik miąższu, średnicę średniej geometrycznej, sferyczność, format obrazu, powierzchnię, zawartość cukrów i rozpuszczalnych ciał stałych, kwasowość miareczkową oraz, odpowiednio, proporcje między nimi. Odmiana *per se* (genotyp) była czynnikiem wywierającym największy wpływ na żywotność śliwy, cechy plonu, cechy fizyczne, zawartość rozpuszczalnych ciał stałych, kwasowość miareczkową oraz krzywe cukrowe. Ocena składu chemicznego śliwy wskazuje na wielki potencjał niemieckich odmian dla rynku świeżych owoców, przetwórstwa owoców oraz ich suszenia. ’Katinka’ wydaje się szczególnie odpowiednia do konsumpcji w stanie świeżym, natomiast ‘Jojo” oraz ‘Hanita’ można zarekomendować do konsumpcji świeżej, do przetwórstwa oraz suszenia. Wszystkie trzy odmiany zaszczepione na ‘Wangenheim Prune’ można zarekomendować hodowcom w podobnych warunkach.

Słowa kluczowe: rozmiar owocu, *P. domestica* L., zawartość rozpuszczalnych ciał stałych i cukrów, plonowanie

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