Scientific Papers. Series B, Horticulture. Vol. LXVI, No. 1, 2022
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

FRUIT QUALITY OF TWO PLUM CULTIVARS GRAFTED ON 'DOCERA 6' (*PRUNUS DOMESTICA* L. X *PRUNUS CERASIFERA* EHRH.) ROOTSTOCK

Marieta NESHEVA[1], Vanya AKOVA[1], Nesho NESHEV[2]

[1]Agricultural Academy, Fruit Growing Institute, 12 Ostromila Str, Plovdiv, Bulgaria
[2]Agricultural University, 12 Mendeleev Blvd, Plovdiv, Bulgaria

Corresponding author email: marieta.nesheva@abv.bg

Abstract

The most commonly used rootstock for plum cultivars in Bulgaria is the seedling P.cerasifera Ehrh. In studies concerning the resistance of some rootstocks to the Plum Pox Virus, good results were obtained for the clonal rootstock 'Docera 6 '. Considering that plum fruit quality depends mainly on the scion genotype, but could be influenced by the rootstock as well, the objective of the current study was to evaluate the fruit quality of the plum cultivars 'Jojo' and 'Topgigant Plus', when grafted on 'Docera 6'. The same cultivars grafted on the seedling rootstock P. cerasifera were used for comparison. The trees were planted in 2016 at the Fruit Growing Institute of Plovdiv, Bulgaria. In 2020-2021 fruit biometrical data, fruit flesh firmness, TSS (°Brix), skin colour and fruit flesh colour were measured. For evaluating the consumer acceptance and nutritional value of the fruits, sensory and chemical analyses were performed. All of the studied parameters were significantly influenced by the cultivar. The largest fruits were measured for the combination Topgigant Plus/Docera 6 (71.53 g). The content of sugars and organic acids were the highest in 'Jojo' fruits.

Key words*: European plum, evaluation.*

INTRODUCTION

European plum (*Prunus domestica* L.) is grown in temperate climate zones, mainly in Central, Southern and South-Eastern Europe. The Balkans is forming centre of the species, and therefore plum is a fruit of great importance. The plum (*Prunus domestica* L.) is one of Bulgaria's main stone fruit species. It is widely grown in all country regions and is the third after walnut and sweet cherry in areas occupied (Agrostatistical handbook, 2020).

Along with the species' wide distribution, a major disease related to it is endemic in our country. The Sharka disease, caused by the Plum pox virus (PPV), is among the most harmful and a major limiting factor for plum production (Milusheva et al., 2015). As there is no effective chemical control against viral diseases, tolerance or resistance to PPV is one of the most wanted characteristics in the newly bred plum cultivars and rootstocks.

'Docera 6' is a rootstock obtained due to the breeding program of the University of Munich. Its primary purpose was to create rootstocks resistant to the PPV suitable for stone fruit species. The 'Docera' series plants are interspecific hybrids between *Prunus domestica* and *Prunus cerasifera* (Neumüller et al., 2012). The laboratory and field tests of 'Docera 6', conducted at the Fruit Growing Institute - Plovdiv, define it as a promising rootstock in its reaction to the virus (Milusheva et al., 2015). Therefore, the new 'Docera 6' rootstock is of interest to all plum producing countries where PPV is spread.

The resistance of the rootstock to specific diseases is significant, but it is not the main criterion for its introduction into orchards. The most important features are the agronomic and biological characteristics that the rootstock induces to the grafted cultivar and on which the producer's incomes depend. In addition, the rootstock has a significant impact on the development of the trees, when they start fruiting, the quality and quantity of their fruit production.

As roots absorb water containing dissolved minerals, it can be assumed that the rootstock will influence the ability to provide nutrients for the whole plant. Thus, nutrient sufficiency is also an essential factor affecting fruit production and quality. The relationships between different rootstocks and differences in leaf nutrient levels

have been documented in other fruit species (Tsipouridis and Thomidis, 2005, North and Cook, 2008). Described is the effect of eleven apple rootstocks on the fruit weight, quality, soluble solids (Tomala et al., 2008).
In Germany for 5-year-old trees, Hilsendegen (2018) reported that 'Docera 6' reduced the growth strength of 'Jojo' and 'Čačanska Lepotica' by 12-14% compared to the same cultivars grafted on 'Wavit' rootstock. In Poland, Sitarek and Machlańska (2019) also described the early development of 'Jojo' and 'Čačanska Lepotica' trees and compared them to trees grafted on 'Wavit' and 'Weiva'. However, the authors report a stronger vegetative growth of the trees grafted on 'Docera 6'. After obtaining the first fruits, the varieties grafted on the test rootstock had a lower average yield and smaller fruits.
Fruit production is the most important for growers, processors and consumers. Therefore, this research aimed to study the influence of 'Docera 6' on the fruit quality of the cultivars' Topgigant Plus' and 'Jojo' and to compare it with the fruit quality of the same cultivars grafted on the standard for Bulgaria rootstock.

MATERIALS AND METHODS

The current research was conducted in a trial orchard at the Fruit Growing Institute – Plovdiv, Bulgaria. The cultivars 'Jojo' and 'Topgigant Plus' grafted on 'Docera 6' were compared to the same cultivars grafted on the standard for our country rootstock, the seedling *Prunus cerasifera* Ehrh. The trees were planted in 2016. In 2020-2021 fruit biometric, colourimetric and sensory analyses were performed. An average sample of 25 fruits was taken and fruit biometry was measured using Mitutoyo 500-196-30 Digimatic Absolute Caliper 150 mm. Average fruit weight was measured with a digital scale. Plum fruits were subjected to colour evaluation in the CIEL*a*b* system. Using handheld colourimeter PCE-CSM 2, colour parameters of the equatorial part of 10 fruits with and without natural wax bloom were measured. The 0 L* values represent the black colour, 100- represents a perfect reflecting diffuser (bright). A positive a* value indicates red and a negative a* value - green colour, a positive b* value indicates yellow and a negative b* value blue colour. The Hue angle expresses the colour nuance and values are defined as follows: red-purple: 0°, yellow: 90°, bluish-green: 180°, and blue: 270° (McGuire, 1992; Voss, 1992). The Chroma defines the saturation of the colour. Fruit firmness was measured using a PCE-PTR-200N digital penetrometer. The total soluble solids content was measured using digital refractometer Kern ORF 85BM. In 2021 fruit chemical analyses were performed. Chemical analyses of the fruit flesh included determining the sugar content-total, inverted and sucrose, by the method of Schoorl-Regenbogen, the acid content - titrimetrically and the active acidity (pH) - potentiometrically, by pH meter.
For sensory evaluation of the fresh fruits a methodology developed at the Fruit Growing Institute Plovdiv was used. A total number of 8 characteristics were scored by a group of trained consumers using the following scale: 1-3 - bad; 3-5-satisfactory; 5-7 good; 7-8 - very good, above 8 - excellent. Each characteristic was multiplied by a coefficient, established by the scientists of section "Breeding, genetic resources and biotechnology" at the Fruit Growing Institute Plovdiv, depending on its importance: 0.175 for appearance, 0.050 for aroma attractiveness and 0.225 for aroma intensity, 0.200 for sweetness, 0.125 for sour taste, -0.125 for bitterness, 0.200 for taste balance, and 0.150 for fruit flesh texture and juiciness (Neshev et al., 2021).
Data were statistically processed by Duncan's multiple range test of the IBM SPSS statistics 26 software. The independent samples t-test was applied in this study for determining the significance of the difference in the chemical analyses.

RESULTS AND DISCUSSIONS

The quality of food products is the most important feature for anyone involved in their production and processing. Fruit size is one of the leading fruit characteristics affecting market value and consumer preferences (Martins et al., 2021). Although the fruit quality depends mainly on the cultivar, it can also be influenced by the rootstock (Scalzo et al., 2005). The dimensional fruit sizes of the scion/rootstock combinations are presented in Table 1.

Table 1. Fruit biometric analyses

Scion/rootstock combination	Fruit height (mm)	Fruit width (mm)	Fruit thickness (mm)	Fruit weight (g)	Peduncle length (mm)	Stone weight (g)	Sone relative share (%)
Topgigant plus/ Docera 6	58,09 a	44,22 a	46,41 a	71,36 a	9,75 a	2,73 a	3,83 b
Topgigant plus/ *P. cerasifera*	56,04 a	43,93 a	45,05 a	66,40 a	8,33 b	2,48 b	3,73 b
Jojo/Docera 6	48,28 b	36,60 b	35,07 b	38,74 b	8,71 ab	1,99 c	5,17 a
Jojo/*P. cerasifera*	49,71 b	34,83 c	35,98 b	40,89 b	8,42 b	1,98 c	4,84 a

Different letters in the same column indicate statistically significant differences ($p < 0.05$) according to Duncan's test.

Significant differences are observed only between the different plum cultivars. The largest fruit weight was measured for the scion/rootstock combination Topgigant Plus/Docera 6 (71.53 g).

The difference with the same cultivar grafted on *P. cerasifera* is 4.96 g, and it is statistically non-significant. The peduncle of the fruits obtained by the cultivars grafted on 'Docera 6' is longer compared to the ones obtained from the grafted on the standard rootstock.

The well-informed consumer demands delicious fruits with high nutritional value. Chemical analyzes are a part of the efficient production of quality fruits. The total soluble solids content, sugars and acids are essential for the taste quality and the value of the fruits for the human nutritional diet. All of them are influenced by the overall development of plants, which in turn depends on the scion/rootstock combination. Fruit flesh firmness is important quality relevant to fruit shelf life and consumer acceptance.

Fruit flesh firmness is a combination of skin and flesh strength, and in general, genotypes with the firmest fruits are preferred (Hend et al., 2009).

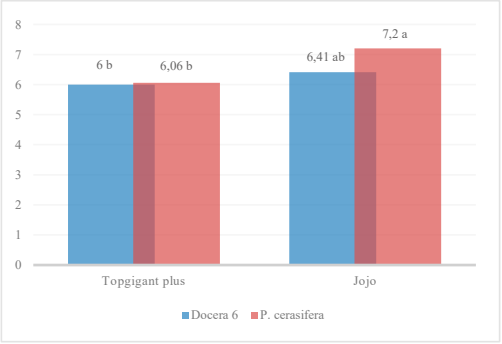

Figure 1. Fruit flesh firmness (kg/cm^2)

The TSS content is important for dried fruits production. Its high content is associated with a higher amount of sugars and increases the yield and quality of the dried product. Non-significant differences were observed for fruit flesh firmness and TSS content between the cultivars grafted on the different rootstocks.

'Jojo' had a higher fruit flesh firmness and TSS content compared to the other cultivar 'Topgigant Plus'.

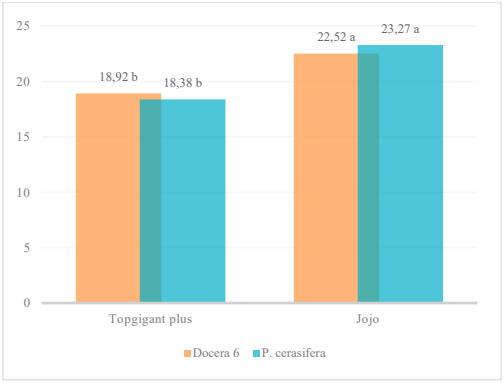

Figure 2. Total soluble solids content (°Brix)

The highest fruit firmness and TSS content were measured for 'Jojo' when grafted on the seedling *P. cerasifera* (Figures 1 and 2).

In some cases, the rootstocks could significantly affect the minerals content, sugars (sucrose and fructose) and organic acids in the fruit.

If there are such differences, it could affect the commercial value of the fruits and guide the choice of rootstock when planning and establishing an orchard (Caruso et al., 1996).

In a previous study, no substantial differences were observed in the main nutrients content (N, P, K) in the leaves of the trees grafted on *P. cerasifera* and 'Docera 6' (Akova et al., 2019).

After analyzing the fruit chemical content of the fruits, non-significant differences between the cultivars grafted on different rootstocks were observed, too (Table 2). Although the non-significant differences, 'Topgigant Plus'/ *P.*

cerasifera had higher sugars and acids content compared to the same cultivar grafted on 'Docera 6'. 'Jojo'/*P. cerasifera* had higher sucrose and acids content.

Table 2. Fruit chemical analyses

Scion	Rootstock	Sugars %			Acids %	pH
		Total	Inverted	Sucrose		
Jojo	*P.cerasifera*	14,82	10,44	4,16	1,21	3,53
	Docera 6	14,82	11,76	2,91	0,94	3,28
Difference significance		ns	ns	ns	ns	*
Topgigant Plus	*P. cerasifera*	12,96	9,04	3,72	1,40	2,81
	Docera 6	11,46	7,92	3,36	1,21	2,85
Difference significance		ns	ns	ns	ns	ns

*Asterisks indicate significant differences between the tested cultivars by independent samples t-test at P≤0.05, ns – non-significant difference.

The data of the chemical analyses and TSS content in the fruits are in correspondence with their sensory evaluation. When grafted on *P. cerasifera* the fruits of 'Jojo' had the highest TSS and sucrose and their sweet taste was highly appreciated by the consumers (Table 3). The fruits obtained of 'Jojo' grafted on the standard seedling rootstock had the highest grade for their attractive and intensive aroma, sweetness and balanced taste.

Skin colour is an essential indicator of fruit maturity and quality, and consequently, it is a decisive consumer preference and acceptance parameter (Crisosto et al., 2003; Romano et al., 2006). Chromatic parameters of both cultivars grafted on 'Docera 6' and *P. cerasifera* rootstocks are presented in Table 4. Both cultivars have very similar skin colours before and after removing the wax bloom. Significant differences between rootstocks were observed for the chromatic parameters b and Chroma index of the fruit flesh colour of 'Jojo'. The grafted on *P. cerasifera* 'Jojo' had brighter and richer yellow coloured fruit flesh.

Table 3. Fruit sensory analyses

Scion/rootstock	Appearance	Aroma		Taste				Fruit flesh texture and juiciness	Total grade	
		Attractive	Intensive	Sweet	Sour	Bitter	Balanced taste			
Top gigant plus /Docera 6	1,49	0,38	0,36	1,10	0,63	-0,03	1,18	1,45	6,55	Good
Top gigant plus/ *P. cerasifera*	1,53	0,38	0,36	1,20	0,59	-0,03	1,14	1,35	6,52	Good
Jojo/Docera 6	1,40	0,24	0,30	1,20	0,56	-0,03	1,09	1,55	6,33	Good
Jojo/ *P. cerasifera*	1,49	0,45	0,45	1,35	0,44	-0,03	1,23	1,65	7,03	Very good

Table 4. Fruit colour

	Chromatic parameter	Topgigant Plus/Docera 6	Topgigant Plus/ *P. cerasifera*	Jojo/Docera 6	Jojo/*P. cerasifera*
With wax bloom	L	33,34 a	33,02 a	34,82 a	34,58 a
	a	0,11 a	-0,41 a	0,12 a	-0,12 a
	b	-7,26 a	-7,15 a	-4,57 a	-6,67 a
	Chroma	7,41 a	7,37 a	6,11 a	6,77 a
	Hue	273,21 a	269,84 a	275,19 a	271,52 a
Wax bloom removed	L	17,81 b	18,02 b	21,67 a	19,50 ab
	a	4,93 a	3,60 a	3,83 a	4,50 a
	b	0,80 a	0,45 a	0,53 a	0,49 a
	Chroma	5,14 a	3,78 a	4,01 a	4,63 a
	Hue	147,89 a	109,24 a	114,87 a	79,69 a
Fruit flesh	L	42,52 a	43,12 a	44,61 a	46,69 a
	a	1,17 b	1,51 b	3,88 a	5,19 a
	b	23,88 c	21,90 c	29,99 b	35,57 a
	Chroma	23,96 c	22,17 c	30,37 b	35,99 a
	Hue	86,86 a	85,10 a	83,09 a	81,85 a

Different letters in the same row indicate statistically significant differences ($p < 0.05$) according to Duncan's test.

CONCLUSIONS

All studied characteristics of the fruits obtained from the two cultivars grafted on 'Docera 6' are similar to the features of the grafted on *Prunus cerasifera*. A tendency for better taste qualities of the 'Jojo' cv. when grafted on *P. cerasifera* was observed. The clonal rootstock 'Docera 6' did not significantly affect the fruits' appearance, size, and chemical characteristics. Their quality is similar to the grafted on the standard rootstock cultivars.

ACKNOWLEDGEMENTS

This research work was carried out with the support of The Bulgarian National Science Fund (BNSF), project КП-06-ПМ 46/2 “Study of the new ‘Docera 6’ clonal rootstock impact on the agronomic characteristics and fruit quality” from 27.11.2020.

REFERENCES

Agrostatistics Handbook (2020). Ministry of Agriculture, Food and Forestry, Sofia.

Akova, V., Nesheva, M., Staneva, I., Malchev, S., Nikolova, V., Bozhkova, V., & Neshev, N. (2019). Nutrient content in the leaves of young plum trees depending on the rootstock and nitrogen fertilization. *Scientific Papers-Series B, Horticulture,* 63(1), 103-108.

Caruso, T., Giovannini, D., & Liverani, A. (1996). Rootstock influences the fruit mineral, sugar and organic acid content of a very early ripening peach cultivar. *Journal of Horticultural Science*, 71(6), 931-937.

Crisosto, C.H., Crisosto, G.M.; Metheney, P., (2003). Consumer acceptance of ‘Brooks’ and ‘Bing’ cherries is mainly dependent on fruit SSC and visual skin color. *Postharvest Biol. Technol.* 28, 159–167.

Hend B., Ghada B.M., Sana M., Mohamed T., Mokhtar S.H., (2009). Amel Genetic relatedness among Tunisian plum cultivars by random amplified polymorphic DNA analysis and evaluation of phenotypic characters *Sci. Hortic., 121*, 440-446.

Hilsendegen, P. (2018). Comparison of hypersensitive plum rootstocks. *Acta Agraria Debreceniensis*, 183-184.

Martins, V., Silva, V., Pereira, S., Afonso, S., Oliveira, I., Santos, M., Ribeiro, C., Vilela, A., Becelar, E., Silva, A.P., & Gonçalves, B. (2021). Rootstock Affects the Fruit Quality of ‘Early Bigi’ Sweet Cherries. *Foods, 10*(10), 2317.

McGuire R. G., 1992. Reporting of objective color measurements. *HortScience*, 27(12): 1254-1255

Milusheva, S., & Bozhkova, V. (2015). Reaction of six Prunus rootstocks to Plum pox virus in Plovdiv, Bulgaria. *Acta Hortic*. 1063, 111-116

Neshev N., Nesheva M. Akova V., 2021. Agronomic and fruit quality characteristics of the Bulgarian plum cultivar ‘Pagane’. *Acta Hortic*. 1322: 33-40.

Neumüller, M., Mühlberger, L., Siegler, H., Hartmann, W., & Treutter, D. (2012). New rootstocks with resistance to Plum pox virus for Prunus domestica and other stone fruit species: the ‘Docera’ and ‘Dospina' rootstock series. *In X International Symposium on Plum and Prune Genetics, Breeding and Pomology* 985, 155-165.

North, M. S., & Cook, N. C. (2008). Effect of six rootstocks on 'Forelle'pear tree growth, production, fruit quality and leaf mineral content. *Acta Hortic.* 772, 97-103

Romano, G.S.; Cittadini, E.D.; Pugh, B.; Schouten, R. (2006). Sweet cherry quality in the horticultural production chain. *Stewart Postharvest* Rev., 6, 1–8.

Scalzo, J., Politi, A., Pellegrini, N., Mezzetti, B., Battino, M. (2005). Plant genotype affects total antioxidant capacity and phenolic contents in fruit. *Nutrition, 21*, 207–213.

Sitarek, M., & Machlańska, A. (2019). The effect of new rootstocks with hypersensitivity resistance to Plum pox virus ' Docera 6' and 'Dospina 235' on the growth and yield of young plum trees. *Acta Hortic*. 1260, 199-202

Tomala, K., Andziak, J., Jeziorek, K., & Dziuban, R. (2008). Influence of rootstock on the quality of ‘Jonagold’apples at harvest and after storage. *Journal of fruit and ornamental plant research,* 16, 31-38.

Tsipouridis, C., & Thomidis, T. (2005). Effect of 14 peach rootstocks on the yield, fruit quality, mortality, girth expansion and resistance to frost damages of May Crest peach variety and their susceptibility on Phytophthora citrophthora. *Scientia Horticulturae,* 103(4), 421-428.

Voss D. H., 1992. Relating colorimeter measurement of plant color to the Royal Horticultural Society Colour Chart. *HortScience,* 27(12): 1256-1260.