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EVALUATION OF SOME SWEET CHERRY CULTIVARS GRAFTED ON 'GISELA 6' ROOTSTOCK

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Abstract

The results regarding the evaluation of the trunk cross-sectional area of the scion, the rootstock and the grafting point and the calculation of the morphological index of thickening of the grafting zone in 5 sweet cherry cultivars ('Early Lory', 'Early Bigi', 'Grace Star', 'Regina' and 'Kordia'), grafted on 'Gisela 6' rootstock, are presented in this paper. The research was carried out in a commercial orchard located in Orodel commune, Dolj County, South-West part of Romania. The orchard was established in 2013, with a planting distance of 4 x 1.8 m. Based on the results obtained, the morphological index of thickening of the grafting area fluctuated significantly depending on the cultivar, reaching the highest value in 'Regina' cv. (0.012), the lowest being recorded in 'Kordia' and 'Early Lory' cv. (0.008). The largest differences between the rootstock and the grafting point were recorded in 'Grace Star' cv. (approx. 147 cm^2), and the largest differences between the grafting point and the scion were recorded in 'Early Lory' and 'Kordia' cv. (approx. 32 cm^2).

Key words*: compatibility, symbionts, trunk cross-sectional area.*

INTRODUCTION

Sweet cherry (*Prunus avium* L.), belongs to the genus *Prunus*, family *Rosaceae* (Aglar & Yildiz, 2014) and is cultivated mainly in countries with a temperate climate. Its fleshy drupes are among the most valued fruits and are mainly consumed fresh, but also processed in various forms (jam, marmalade, juice, compote, candied fruit) (Wani et al., 2014). Rootstocks have been used for more than 2000 years as a method of vegetative propagation of fruit tree species (Sitarek, 2008). Sweet cherry production has greatly advanced as a result of new selections of low-vigor rootstocks, the use of modern methods of protection of orchards against environmental factors, harvesting, handling and storage of fruits (Musacchi et al., 2015). Jakab-Ilyefalvi and Chiorean (2022) mention the worldwide use in sweet cherry culture of optimal management systems and cultivar × rootstock combinations to control the morphological characters of the plant and implicitly the production yield. The most commonly used rootstocks for cherry are 'Mazzard', 'Mahaleb', 'Weiroot 13', 'Colt', 'Gisela 5', 'Gisela 6', 'Gisela 12' (Long & Kaiser, 2010), 'Krymsk 5' and 'Krymsk 6'. Rootstock influences growth, production, but also fruit size and quality (Martins et al., 2021; Aglar et al., 2016; Aglar & Yildiz, 2014; Whiting et al., 2005). The use of semi-dwarf rootstocks is preferred in orchards where a higher production per unit area is desired (Aglar & Yildiz, 2014). Choosing an appropriate density according to the type of rootstock used and maintenance works are important cultural management strategies that improve the quality of an orchard (Neilsen et al., 2010). Trunk cross-sectional area (TCSA) is also influenced by water regime (used irrigation systems), soil treatments and tillage (Neilsen et al., 2010). The 'Gisela' dwarf rootstock series, developed at Liebig University in Giessen, Germany, induces early production and the current trend towards higher densities in stone and pome orchards calls for the adoption of more efficient management systems (Musacchi et al., 2015). 'Gisela 6' rootstock, exhibits a medium high vigor, induces precocity, it is suitable for the vast majority of soil types, but requires adequate drainage (Long & Kaiser, 2010). Hrotkó (2008) mentions the insufficient existing data on

cultivar × rootstock interactions in sweet cherry, although dwarf rootstocks are among the most widely used. López-Ortega et al. (2016) confirm, following the study carried out in Jumilla (Murcia, Spain), the influence of rootstocks ('Adara', 'Gisela 5', 'Gisela 6', 'Mariana 2624', 'Ma × Ma 14', 'Mayor', 'Pikú 1', 'Pikú 3', 'Pikú 4', 'Saint Lucie GF 64') on the yield of 'Newstar' cultivar and implicitly on the size, acidity, color and firmness of the sweet cherry fruits. Sansavini and Lugli (2014) mention 'Gisela 6' rootstock as being adapted to hot climate conditions, but it requires suitable cultivars, planting distances, appropriate management systems, and to be successful, in addition to an appropriate cultivar × rootstock combination, the yield of the crop depends on the vigor, photosynthetic efficiency and nutritional balance of the plants. The same authors exemplify 'Regina' cultivar grafted on 'Gisela 6', as having larger, sweeter and firmer fruits compared to the same cultivar grafted on 'W158'. The present work proposed the analysis of the degree of compatibility of five sweet cherry cultivars grafted on 'Gisela 6' rootstock in a commercial orchard in the South-West part of Romania.

MATERIALS AND METHODS

Materials

The experience was located in Orodel commune, Cornu village (44°13'N 23°16'E), Dolj County, South-West part of Romania. The study was carried out in 2022, on the cultivars 'Early Lory', 'Early Bigi', 'Grace Star', 'Regina' and 'Kordia' (trees in the 9th year since planting) grafted on the semi-dwarf rootstock 'Gisela 6'. Planting distances are 4 m between rows and 1.8 m between plants per row, with a density of 1389 trees/ha. The shape of the canopy is slender spindle with a support system and anti-hail protection. The irrigation method used in the plantation is drip irrigation. Regarding the pedological data according to the studies carried out, the plantation is located on typical preluvosol.

Research area

From a climatic point of view, the area is characterized by an average annual temperature of 10.9°C, with a minimum monthly average of -0.9°C in January, and the highest in July with 23.1°C. The rainfall regime is characterized by average annual precipitation of approx. 530 mm, the largest amount corresponding to the month of May with approx. 73 mm and the smallest amount corresponding to the month of February with approx. 2.5 mm. Within the plantation, the prevailing winds are from the North-West and North-East.

Research method

To highlight the differences in vigor between the two partners (scion × rootstock), the method described by Zamfirescu (2022) was used. The trunk diameter was measured 5 cm above and below the grafting point, as well as at the level of the grafting point. The difference in thickening between the two symbionts was determined based on the calculation of the trunk cross-section area of scion (SA), rootstock (SP) and grafting point (SÎ), by applying the formula:

- TCSA = $(D/2)^2$ x 3.14, in which: TCSA = trunk cross sectional area (cm^2); D = trunk diameter (cm).

After performing the three measurements, the morphological thickening index of the grafting zone MTI (morphological thickening index) was calculated as the result of the ratio between the trunk cross-sectional area of the scion, rootstock and the grafting point: MTI = SA/SP/SÎ.

The obtained data were statistically processed in the IBM SPSS Statistics 26 program and represent the mean, standard deviation, limits of variation and coefficient of variability. One-way ANOVA followed by Duncan's Multiple Range Test at $p < 0.05$ were used.

RESULTS AND DISCUSSIONS

The statistical data of the trunk cross-sectional area at the grafting point, below and above are presented in Table 1. From the analysis of the data, it appears that the cultivars 'Early Lory' and 'Early Bigi' recorded the highest values in terms of the measurement below the grafting point (SP), respectively 108.55 cm^2 and 107.85 cm^2. The lowest value (75.77 cm^2) was identified in 'Regina' cultivar for the same characteristic, i.e., 1.42 times lower than in 'Early Lory' cultivar. Regarding the data

obtained when determining the grafting point (SÎ), 'Grace Star' cultivar recorded the highest value (235.37 cm^2) and the lowest was also identified at 'Regina' cultivar (147.14 cm^2). For this feature as well, a 1.59 times difference between extreme mean values emerges. Regarding the results obtained at the measurement above the grafting point (SA), there were significant differences, 'Grace Star' cv. (215.14 cm^2) registering the highest value and 'Regina' cv. (132.64 cm^2) the lowest value, i.e., of 1.62 times less. Usenik et al. (2017) reported the greatest differences in trunk cross-sectional area above and below the grafting point in sweet cherry grafted on 'Gisela 6' (compared to 'Gisela 5', 'P-HLC', 'Piku 1' and 'Weiroot 158') in the study conducted in Slovenia. The greatest difference between the rootstock and the grafting point (Figure 1) was 147.07 cm^2 corresponding to 'Grace Star' cv. and the lowest value corresponding to 'Regina' cv. with 71.37 cm^2. Regarding the differences between the grafting point and scion (Figure 1), 'Early Lory' and 'Kordia' cv. with close values (31.76 cm^2 and 31.63 cm^2) and 'Regina' cv. with the lowest value of 14.23 cm^2. The coefficient of variation had values between 16.51 and 24.69%, which represents an average and high variability between the analyzed individuals.

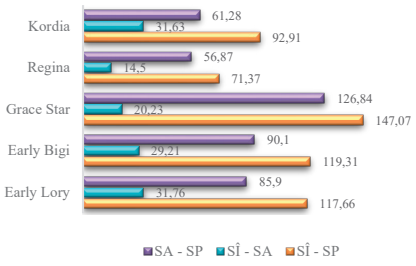

Figure 1. The differences between the trunk cross-sectional area of the grafting point (SÎ), rootstock (SP) and scion (SA) (cm^2)

The difference in thickening between rootstocks and scion had an average value of 84.19 cm^2, the biggest differences being in the case of the combination with 'Grace Star' cv. (126.84 cm^2), and the smallest differences at 'Regina' cv. (56.87 cm^2) (Figure 1). In all scion × rootstock combinations it was found that the trunk cross-sectional area above the grafting point (SA) was less than on the grafting point (SÎ) and greater than below (SP). The further the value of trunk cross-sectional area in the symbiont grafting point is compared to the values of the trunk cross-sectional area 5 cm above and below the contact zone of the symbionts, the lower the degree of compatibility of the combination (Asănică & Tudor, 2011; Mladin et al., 2006). According to Narandžić and Ljubojević (2023), trunk cross-sectional area measurements are frequently used to assess tree vigor and growth characteristics. Biško et al. (2017) mention 'Gisela 6' rootstock as incompatible with 'Regina' and 'Kordia' cultivars (compared to the same cultivars grafted on 'Gisela 5', 'Piku 1' and 'PHL-C' following the study carried out in the North-Western Croatia on very acidic soil, using the drip irrigation system.

The assessment of the grafting compatibility of the 5 sweet cherry cultivars in relation to the rootstock was carried out by calculating the morphological thickening index of the grafting area (Table 2), resulting from the ratio between trunk cross-sectional area of the rootstock (SP), scion (SA) and the grafting point (SÎ), and it was concluded that the morphological thickening index of the grafting zone in all 5 sweet cherry cultivars associated with 'Gisela 6' rootstock had low values, and the differences between the trunk cross-sectional area of the scion and the trunk section trunk cross-sectional area of the rootstock were very large (Figures 1 and 2), which indicates a reduced level of compatibility between the two symbionts.

According to the values of the morphological thickening index (Zamfirescu, 2022), grafting compatibility can be of three types: very good compatibility (type A) when the values of this index are greater than 0.330 and tend to 1.000; good compatibility (type B) when the morphological index values are between 0.300 and 0.330; poor compatibility (type C) when the values of the morphological index are lower than 0.300. As can be seen in Table 2, the highest morphological thickening index was calculated for 'Regina' cultivar (0.012), about 13% higher compared to 'Grace Star', but 31-33% higher compared to the group of cultivars 'Kordia', 'Early Bigi' and 'Early Lory'. Although

there is poor compatibility (Figure 2) between partners (rootstocks/scion), canopy shape, maintenance work, climatic factors, applied irrigation system, soil quality also influence the vigor and productivity of the studied sweet cherry cultivars.

Table 1. Statistical descriptors (mean, standard deviation, extreme values and variation coefficient) of TCSA - trunk cross-sectional area (cm^2)

Measuring point	Cultivar	Mean ± SD*	Min.-Max.	CV (%)
Below grafting point (SP)	'Early Lory'	108.55±25.10^a	49.71-150.50	23.12
	'Early Bigi'	107.85±22.34^a	60.15-143.66	20.71
	'Grace Star'	88.30±16.90^b	63.25-112.45	19.14
	'Regina'	75.77±13.32^b	59.28-100.24	17.58
	'Kordia'	102.21±16.33^a	84.01-150.50	15.98
At grafting point (SÎ)	'Early Lory'	226.21±39.82^a	147.06-295.96	17.60
	'Early Bigi'	227.16±44.60^a	133.70-310.69	19.63
	'Grace Star'	235.37±36.64^a	183.25-295.96	15.57
	'Regina'	147.14±36.33^c	100.24-215.07	24.69
	'Kordia'	195.12±35.09^b	153.98-300.83	17.98
Above grafting point (SA)	'Early Lory'	194.45±43.11^a	111.85-286.33	22.17
	'Early Bigi'	197.95±38.46^a	114.85-262.97	19.43
	'Grace Star'	215.14±37.31^a	161.06-273.13	17.34
	'Regina'	132.64±31.57^c	91.94-181.73	23.80
	'Kordia'	163.49±26.99^b	127.26-223.42	16.51

*SD- Standard Deviation; CV%-coefficient of variation. For each measurement point, different letters placed next to the values indicate significant differences between them

Table 2. Descriptive statistics of the morphological thickening index (MTI) of the graft area

Descriptive statistics	'Early Lory'	'Early Bigi'	'Grace Star'	'Regina'	'Kordia'
Mean ± SD*	0.008±0.002^c	0.009±0.002^c	0.011±0.002^b	0.012±0.002^a	0.008±0.002^c
Min.-Max.	0.005-0.015	0.006-0.014	0.008-0.014	0.009-0.017	0.005-0.011
CV (%)	25.00	22.22	18.18	16.67	25.00

*SD- Standard Deviation; CV%-coefficient of variation. For each measurement point, different letters placed next to the values indicate significant differences between them

'Regina' 'Early Lory' 'Grace Star' 'Early Bigi' 'Kordia'

Figure 2 Grafting point of the five sweet cherry cultivars grafted on 'Gisela 6' rootstock

CONCLUSIONS

The combinations of 'Early Lory', 'Early Bigi', 'Grace Star', 'Regina' and 'Kordia', grafted on 'Gisela 6' rootstock, showed a highly disharmonious relationship between the rootstock, the scion and the grafting point. According to the values of the morphological index of thickening of the grafting zone, the compatibility is weak, in the order 'Early Lory' - 'Kordia' - 'Early Bigi' - 'Grace Star' - 'Regina'.

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