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Comparative Study on the Effect of GiSelA 5 Rootstock Propagation Methods on Sweet Cherry Growth and Physiology

Sławomir Świerczyński * and **Anita Schroeter-Zakrzewska**

Department of Ornamental Plants, Dendrology and Pomology, Poznan University of Life Sciences, J.H. Dąbrowskiego 159, 60-594 Poznan, Poland
* Correspondence: slawomir.swierczynski@up.poznan.pl; Tel.: +48-61848-7955

Abstract: The basis of orchard production is rootstocks that reduce the vigor of sweet cherry trees. However, not all rootstocks for this species can be easily propagated using traditional methods of stooling or cutting. Some of these must be propagated using the in vitro method. This is expensive and, consequently, increases the price of maiden sweet cherry trees. Our experiment assessed the growth of maiden trees of selected sweet cherry varieties ('Bellise', 'Earlise', 'Lapins', 'Vanda') depending on the method of propagation of a semi-dwarf GiSelA 5 rootstock. Additionally, the intensity of physiological processes taking place in the obtained maiden trees was also examined. The experiment compared one type of GiSelA 5 rootstock, obtained using a cheaper softwood cuttings method, with another rootstock propagated using an in vitro method. During the two years of study, there were no significant differences in the percentage of maiden trees obtained in the case of the propagation methods for both types of rootstocks, ranging from 77.43% to 87.74%. The vigor of maiden tree growth in the first year of this study was stronger than in the second year. In particular, the stem diameter of maiden trees varied from 7% to 39%, depending on the variety considered. With the exception of one variety, maiden trees produced from a rootstock propagated by stem cuttings were characterized by a larger stem diameter for the three varieties, ranging from 23% to 29%, and by a greater number of side shoots, ranging from 73% to 172%, compared to those from in vitro. Additionally, when using the stem cutting method of propagation, the rootstocks had a better developed root system, except for the 'Earlise' variety. However, most often, no significant differences were found between the methods of propagation regarding the fresh weight of the maiden trees and leaves and their leaf blade area. The activity of physiological processes of maiden sweet cherry trees varied, and no constant regularities were found. In the second year of the experiment, maiden trees were more often characterized by lower levels of net photosynthetic intensity and internal CO_2 concentration, which was associated with worse growth results. Based on the collected results, it is recommended to propagate the considered rootstock using stem cuttings, which yields maiden trees with similar and sometimes even better growth parameters than those propagated using the in vitro method.

Keywords: nursery; efficiency; vigor; side shoots; root system; leaf blade area; rate of photosynthesis and transpiration

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1. Introduction

In recent decades, the cultivation of sweet cherry trees in Europe has been characterized by great popularity and increased intensity of production, which has been achieved by planting a larger density of trees per unit area. The dominant species is the apple tree, but fruit growers, wanting to minimize the risk of production, also cultivate other tree species, among which sweet cherry has become the most profitable due to the price of its fruits. In Poland, the main rootstock used in orchards is 'Colt', whose share in the production of certified trees was over 80% in 2023. The recommended rootstocks for the production of maiden sweet cherry trees also include those that reduce the vigor of trees;

however, 'Colt' is not one of them. Recently, the influence of semi-dwarf rootstocks, such as GiSelA 5, on the vigor and yield of sweet cherry trees in an orchard has been studied [1–7]. 'GiSelA 5' is considered to be a very effective and economically important semi-dwarf rootstock for intensive sweet cherry cultivation in moderate climate conditions [8–13]. It was confirmed [14] that its propagation using conventional methods is not effective, hence the need to use the in vitro method. However, as studies by some authors [15–17] have proved, with the appropriate treatment of softwood cuttings, 80% rooting can be achieved.

In previous research conducted in a nursery [18], rootstocks of different vigor (PHL-A, PHL-C, Colt, F12/1, *Prunus mahaleb*, *Prunus avium*) significantly influenced the growth parameters of maiden sweet cherry trees. Papachatzis [19] confirmed the limited growth of sweet cherry trees using the 'GiSelA 5' rootstock. The cultivation of sweet cherry of the 'Stella' variety on various rootstocks (GiSelA 5, GiSelA 4, Gi-195/20, Gi-497/8, Weiroot 10, Weiroot 13, Weiroot 53, Weiroot 72, Weiroot 158) showed the weakest growth on the 'GiSelA 5' rootstock. Another study published by Sitarek et al. [12] compared the growth of maiden sweet cherry trees of the 'Kordia' variety on rootstocks of different vigor (GiSelA 5, PHL-A, PHL-B, PHL-C, Weiroot 158, Tabel Edabriz), for which the slowest-growing sweet cherry trees were those grown on 'GiSelA 5' rootstock. Similarly, Biško et al. [20] showed the lowest vigor of six-year-old trees of 'Regina' and 'Kordia' varieties on the 'GiSelA 5' rootstock. Another experiment conducted in the orchard [21] highlighted the positive effect of the GiSelA 5 rootstock on the best tree yield. According to some researchers [22,23], the semi-dwarf rootstocks, including 'GiSelA 5', are recommended for orchards with increased density of tree planting, combined with the generally strong-growing sweet cherry varieties. However, their cultivation requires fertile soil and favorable climatic and soil conditions. They should not be used on shallow and light soils. The use of dwarf and semi-dwarf rootstocks results in more abundant flowering and, as a result, a higher yield of fruit trees [23–25]. Atkinson and Else [24] claimed that this impact is more intense in the case of rootstocks that reduce tree vigor, which has a clearly positive impact on economic aspects of large-scale fruit production. A good rootstock must be easily and cheaply propagated and must be physiologically compatible with sweet cherry varieties. It should also adapt well to changing climate and soil conditions. It is good to anchor the tree in the soil, which is a problem for semi-dwarf and dwarf rootstocks.

In the era of current scientific research, plant growth parameters should be confirmed by assessing the physiological parameters of the plants in question. Previous studies have documented the effect of rootstocks on the physiological processes of sweet cherry fruit trees [26–32]. This was also found while growing maiden trees in a nursery [33]. They resulted not only from different soil and climatic conditions, but also from the impact of the additional care treatments of trees, such as irrigation [34,35]. Higher parameters of physiological processes may confirm more intensive plant growth. In turn, the higher growth parameters of maiden trees lead to their better quality and, as a result, a higher selling price.

Due to the high importance of the 'GiSelA 5' rootstock in the orchard, its suitability for the production of maiden sweet cherry trees should be tested, especially taking into account rootstocks that were previously propagated using a cheaper stem cutting method. So far, this issue has not been studied in the case of nursery production. The aim of this experiment was to compare the efficiency of budding and growth of maiden sweet cherry trees depending on the method of GiSelA 5 rootstock propagation and the budded variety. The intention was also to confirm this usefulness by examining some of the physiological processes occurring in maiden cherry trees under the influence of the above-mentioned factors.

2. Materials and Methods

2.1. Plant Material and Growth Conditions

The field nursery experiment consisted of two production cycles conducted in years 2016–2018. This research took place at the Experimental Station of the Faculty of Agriculture, Horticulture and Biotechnology, University of Life Sciences in Poznan (52°24′24″ N and 16°55′47″ E).

One-year-old sweet cherry maiden trees of the varieties, 'Bellise', 'Earlise', 'Lapins', and 'Vanda' were grown on 'GiSelA 5' rootstock, which had previously been propagated using both softwood cuttings and the in vitro method. The experiment was carried out in a randomized block design, with eight treatment combination (4 varieties, 2 methods of rootstocks propagation). Each combination included 20 maiden sweet cherry trees in 4 replicates. Rootstocks were planted in the field in early spring (mid-March) at a spacing of 90 × 30 cm, and subjected to budding using the "T" method at the beginning of August. Two new, promising varieties ('Bellise', 'Earlise') and two that were appreciated by producers ('Lapins', 'Vanda') were selected for the research. These varieties also differed in their growth vigor.

The plants were grown on podzolic soil, classified as valuation class IVb. The mineral content of the soil was determined before planting the rootstocks and was phosphorus-107, potassium-145, calcium-520, and magnesium 96 (in $mg \cdot 100\ g \cdot soil^{-1}$) and the soil had a pH of 6.5. Before planting the rootstocks, potassium sulfate fertilizer was applied, at a dose of 140 $kg \cdot ha^{-1}$. Nitrogen was supplied in three divided doses, totaling 120 $kg \cdot ha^{-1}$. Immediately after planting the rootstocks, the soil was treated with the herbicide Sencor 80 WG at a dose of 0.25 $kg \cdot ha^{-1}$. Disease control was carried out through chemical treatments from May to August, at two-week intervals, using the following preparations: Zato 50 WG (0.15 $kg \cdot ha^{-1}$), Score 250 EC (0.2 $L \cdot ha^{-1}$), Syllit 65 WP (1.5 $kg \cdot ha^{-1}$), and Topsin M 500 SC (1.5 $L \cdot ha^{-1}$). Aphids were also controlled with Movento 20 SC (0.2 $L \cdot ha^{-1}$). The plants were not irrigated, the rainfall in 2017 totaled 590 mm, while in 2018, it was 320 mm. The average temperature from May to September was 17.2 °C in 2017 and 19.3 °C in 2018.

2.2. Plant and Physiological Parameter Measurements

At the end of October, during the second year of maiden tree production, measurements and observations were carried out on 10 randomly selected maiden trees from each plot with 4 repetitions. The following parameters were measured: tree height (cm), stem diameter (mm) at a height of 10 cm above the budding site, and the length of side shoots (cm). Additionally, the percentage of maiden trees obtained in relation to the budded rootstocks was calculated. Before leaf fall, all leaves from four selected maiden trees in each plots were collected, and their fresh weight (g) was measured with an accuracy of 0.01. The total leaf blade area (cm^{-1}) was then calculated using the Skwer program (Iksmodar, Poznan, Poland).

At the end of the growing season, the maiden trees were dug out from the nursery. The number of first-order roots was recorded, and the fresh weight of the maiden trees (kg) was estimated.

In both years of this study, physiological processes were examined in mid-July, by measuring the following parameters: net photosynthetic intensity (Pn, $\mu mol\ CO_2 \cdot m^{-2} \cdot s^{-1}$), leaf transpiration coefficient (E, $\mu mol\ H_2O \cdot m^{-2} \cdot s^{-1}$), conductivity stomata (C, $mol\ H_2O \cdot m^{-2} \cdot s^{-1}$), and internal carbon dioxide concentration (Int. CO_2, $mol\ CO_2 \cdot mol^{-1}$). These parameters were measured using CI 340 handheld photosynthesis system (CID Bio-Science, Camas, WA, USA).

The measurements were taken using fully developed, disease-free, and undamaged leaves located in the central part of the long shoots, from the southern, well-lit side of the maiden tree crowns. For each of the eight variety–rootstock combinations, measurements were taken from four randomly selected plants with similar growth dynamics.

2.3. Statistical Analyses

Statistical calculations were performed using the Statistica 13.1 software (Statsoft, Kraków, Poland). Duncan's multiple range test was used to analyze variance at the significance level of $\alpha = 0.05$. The results were subjected to a two-way analysis of variance with the factors being the year of this study and the two methods of propagation, separately for each variety considered. Data expressed as percentage (proportion of maiden trees obtained) were transformed using the arcsine transformation.

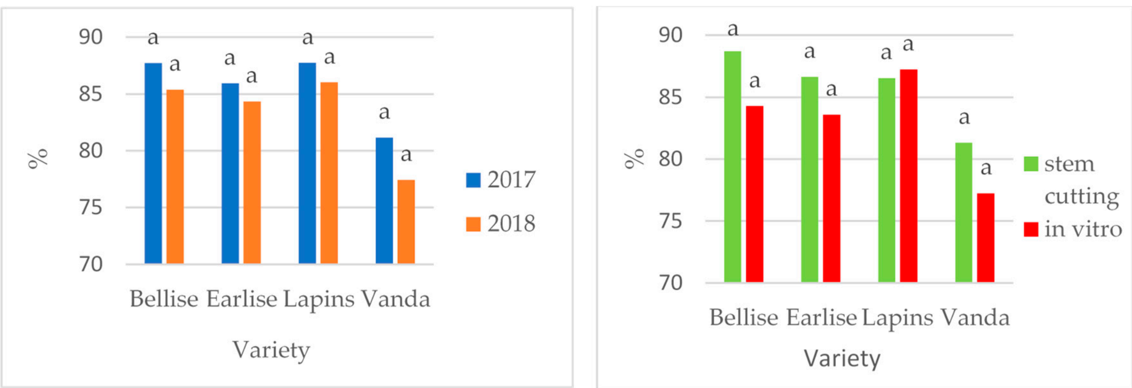
3. Results

This experiment assessed the growth of maiden sweet cherry trees depending on the method of rootstock propagation. Four sweet cherry varieties were evaluated during two years of study . The interaction between the method of rootstock propagation and the year of study had a significant impact on the stem diameter more frequently than on tree height (Table 1). The only exception, in favor of propagating the rootstock by shoot cuttings, was the 'Earlise' variety in the first year of this study. The percentage of maiden trees obtained did not differ significantly depending on the propagation method across the two years of the experiment (Figure 1a,b).

Table 1. The percentage and growth parameters of obtained sweet maiden trees depending on interaction, the method of propagation, and the year of experiment.

Variety	Year	Method of Propagation	Percentage of Obtained Maiden Trees	Height of Plants (cm)	Stem Diameter (mm)	Number of Side Shoots	Lenght of Side Shoots (cm)
'Bellise'	2017	Stem cutting	90.88 a	210.75 c	20.49 c	3.10 b	180.8 c
		in vitro	84.18 a	201.60 c	18.50 c	1.80 a	105.60 b
	2018	Stem cutting	86.35 a	152.75 b	15.06 b	1.55 a	32.25 a
		in vitro	81.39 a	122.25 a	12.76 a	0.65 a	19.85 a
'Earlise'	2017	Stem cutting	89.29 b	243.20 c	19.76 d	4.10 c	213.50 c
		in vitro	82.23 a	227.80 c	17.37 c	2.00 b	115.10 b
	2018	Stem cutting	83.77 ab	139.30 b	13.84 b	2.45 b	79.05 ab
		in vitro	84.91 ab	113.95 a	11.03 a	0.40 a	10.05 a
'Lapins'	2017	Stem cutting	87.59 a	151.35 a	15.73 b	0.00 a	0.00 a
		in vitro	87.90 a	143.55 a	10.27 a	0.00 a	0.00 a
	2018	Stem cutting	85.46 a	151.35 a	17.50 c	0.00 a	0.00 a
		in vitro	86.58 a	138.80 a	9.98 a	0.00 a	0.00 a
'Vanda'	2017	Stem cutting	83.08 b	213.30 c	18.15 b	6.45 c	321.75 c
		in vitro	79.17 ab	193.00 b	17.32 b	3.00 b	192.15 b
	2018	Stem cutting	79.52 ab	130.05 a	13.26 a	1.15 a	21.89 a
		in vitro	75.27 a	117.10 a	12.01 a	1.00 a	22.20 a

Note: Means marked with the same letters within individual parameter do not differ significantly at the level of $\alpha = 0.05$, using Duncan's test.



(**a**) (**b**)

Figure 1. The percentage of obtained sweet cherry maiden trees depending on the year (**a**) and the method of propagation (**b**). Means marked with the same letters within individual varieties do not differ significantly at the level of $\alpha = 0.05$, using Duncan's test.

The interaction of the two factors (method of propagation and year) did not generally have a significant effect on tree height. However, this interaction more often significantly influenced stem diameter (Table 1). For three out of four tested varieties, maiden trees in the first year showed a significantly higher height and larger trunk diameter (Figures 2a and 3a). The only exception was the 'Lapins' variety, where no significant differences were observed. Additionally, for three varieties, a larger trunk diameter was observed when the rootstock was propagated by shoot cuttings (Figure 3b).

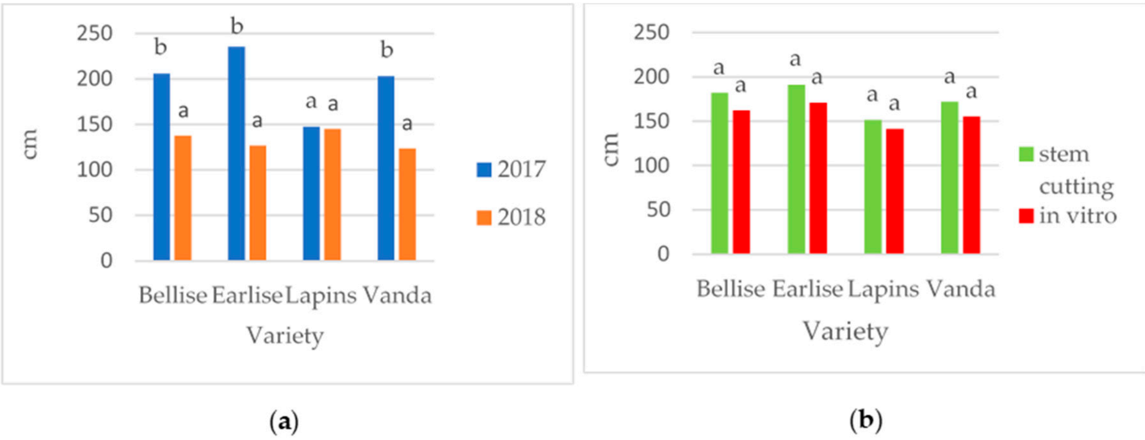


Figure 2. The height of obtained sweet cherry maiden trees depending on the year (**a**) and the method of propagation (**b**). Means marked with the same letters within individual varieties do not differ significantly at the level of α = 0.05, using Duncan's test.

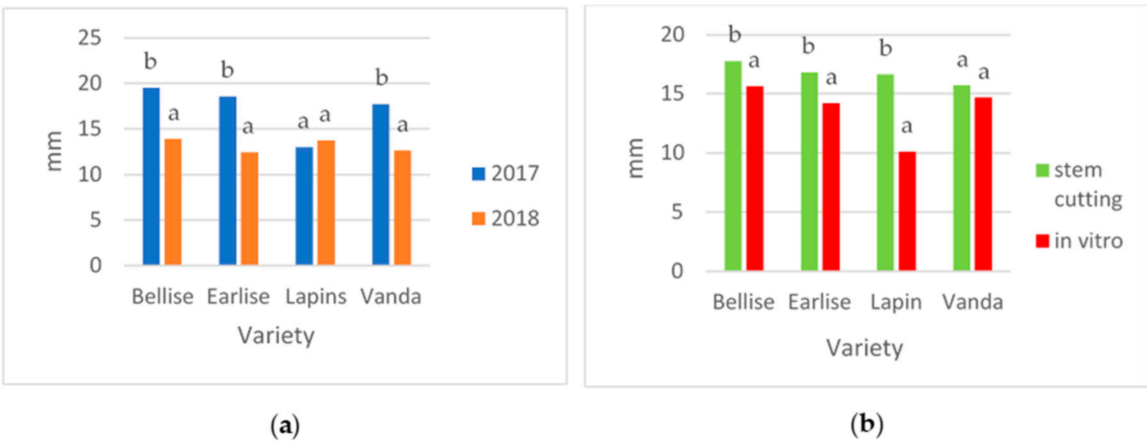
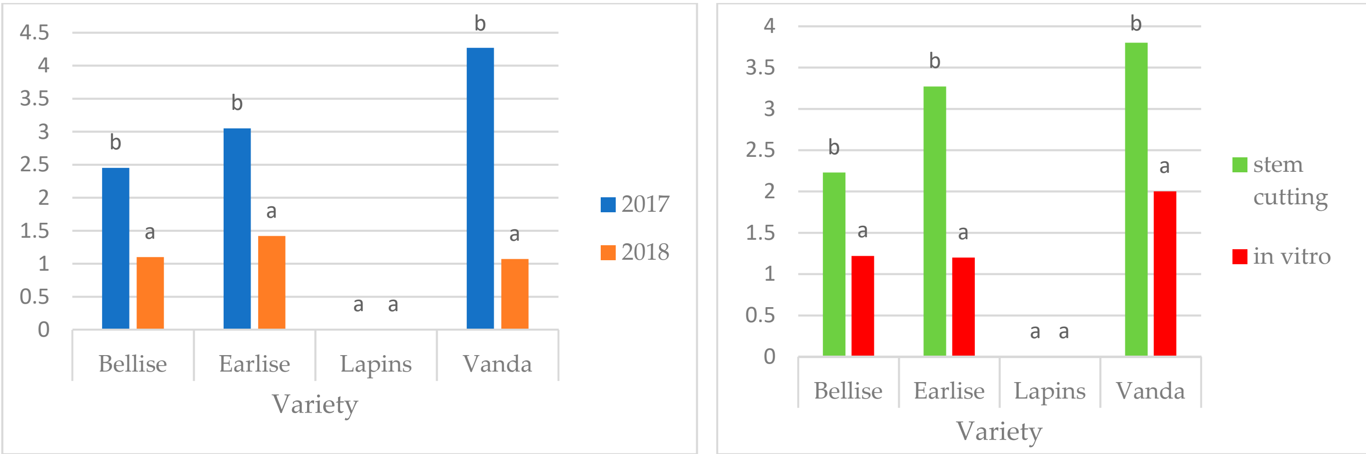


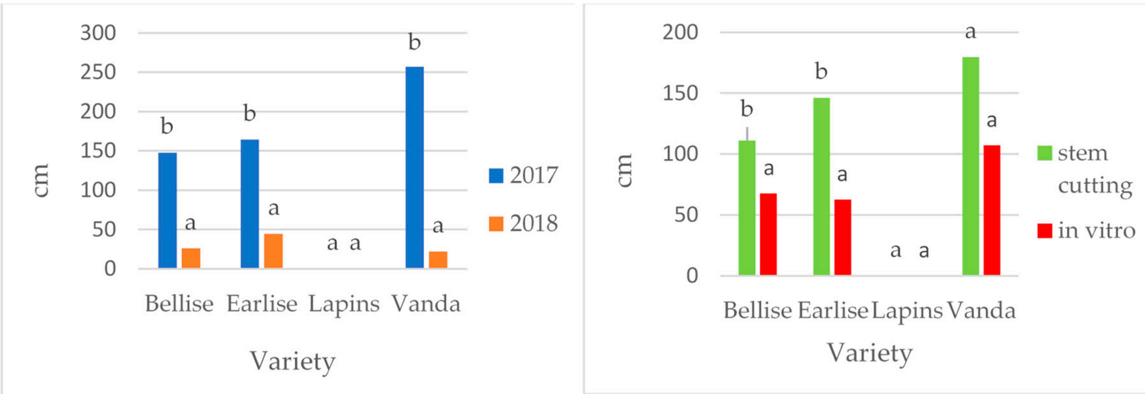
Figure 3. The diameter of obtained sweet cherry maiden trees depending on the year (**a**) and the method of propagation (**b**). Means marked with the same letters within individual varieties do not differ significantly at the level of α = 0.05, using Duncan's test.

In half of the cases, the interaction between the two factors had a significant impact on the number and total length of side shoots (Table 1). In the first year of study, three varieties ('Bellise', 'Earlise', 'Vanda') exhibited a significantly greater number and length of side shoots (Figures 4a and 5a). For these same three varieties, both the number of side shoots, and for two varieties ('Bellise' and 'Earlise'), the length of side shoots, were significantly higher when rootstocks were propagated by shoot cuttings (Figures 4b and 5b).



(**a**) (**b**)

Figure 4. The number of side shoots of the sweet cherry maiden trees depending on the year (**a**) and the methods of propagation (**b**). Means marked with the same letters within individual varieties do not differ significantly at the level of α = 0.05, using Duncan's test.



(**a**) (**b**)

Figure 5. The sum of length of side shoots of sweet cherry maiden trees depending on the year (**a**) and the method of propagation (**b**). Means marked with the same letters within individual varieties do not differ significantly at the level of α = 0.05, using Duncan's test.

The interaction of the two factors also significantly influenced the fresh weight of the maiden trees and two leaf parameters (Table 2). For three of the varieties ('Bellise', 'Lapnis' 'Vanda'), maiden trees grown on rootstocks propagated by shoot cuttings had significantly more roots (Figure 6b). A significantly higher fresh weight of maiden sweet cherry trees was recorded for all tested varieties during the first year of the experiment (Figure 7a). The only exception was the 'Earlise' variety, for which rootstocks propagated by shoot cuttings were associated with a significantly higher fresh mass of maiden trees (Figure 7b). For all varieties, the fresh weight of leaves and their leaf blade area were significantly greater in the first year of observation (Figures 8a and 9a). However, the method of rootstock propagation did not significantly affect the leaf mass or leaf blade area (Figures 8b and 9b).

Table 2. The number of roots and fresh mass of obtained sweet cherry maiden trees and the parameters of their leaves depending on interaction, the method of propagation, and the year of experiment.

Variety	Year	Method of Propagation	Number of Roots	Fresh Mass of Trees (kg)	Fresh Mass of Leaves (g)	Leaf Blade Area (cm^{-1})
'Bellise'	2017	Stem cutting	13.20 b	1.28 b	264.10 c	9754.52 b
		in vitro	11.40 a	1.18 b	262.10 c	9889.68 b
	2018	Stem cutting	12.70 b	0,72 a	157.01 b	6428.16 a
		in vitro	10.80 a	0.61 a	143.46 a	6210.45 a
'Earlise'	2017	Stem cutting	14.20 b	1.33 c	256.34 c	9393.50 b
		in vitro	13.45 ab	1.01 b	253.34 c	9312.58 b
	2018	Stem cutting	12.60 ab	0.61 a	150.30 b	5885.37 a
		in vitro	11.90 a	0.53 a	133.08 a	5811.48 a
'Lapins'	2017	Stem cutting	17.40 b	1.10 c	274.67 b	9872.21 b
		in vitro	15.10 a	0.88 b	172.67 b	9883.03 b
	2018	Stem cutting	17.80 b	0.71 a	160.25 a	6319.30 a
		in vitro	15.90 ab	0.68 a	149.32 a	6381.47 a
'Vanda'	2017	Stem cutting	17.40 c	1.35 b	271.65 b	9652.63 b
		in vitro	14.50 ab	1.25 b	262.25 b	9542.65 b
	2018	Stem cutting	16.30 bc	0.98 a	146.87 a	5777.47 a
		in vitro	13.30 a	0.92 a	142.97 a	5768.61 a

Note: Means marked with the same letters within individual parameter do not differ significantly at the level of α = 0.05, using Duncan's test.

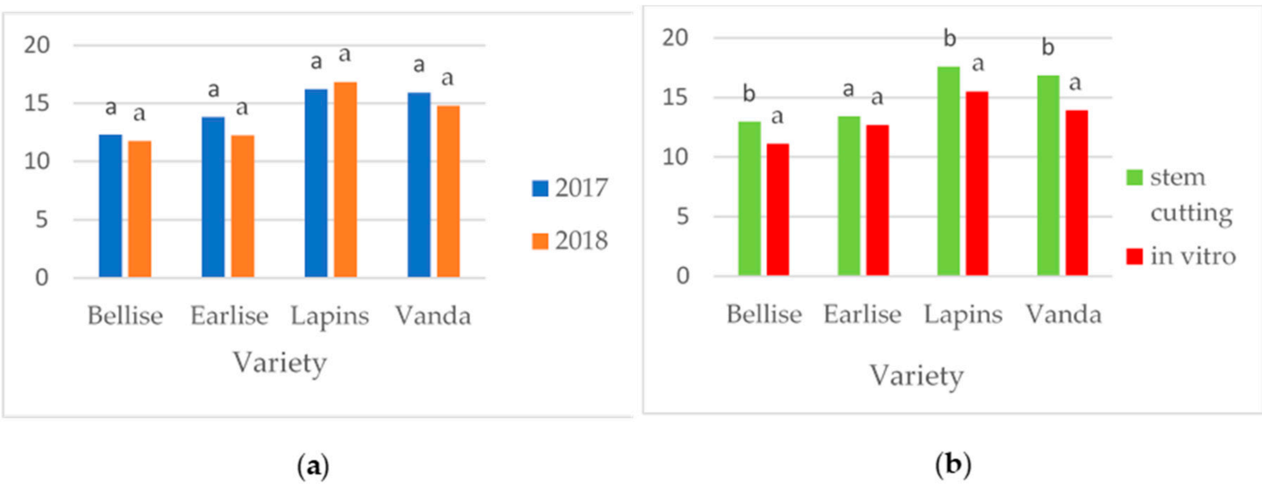
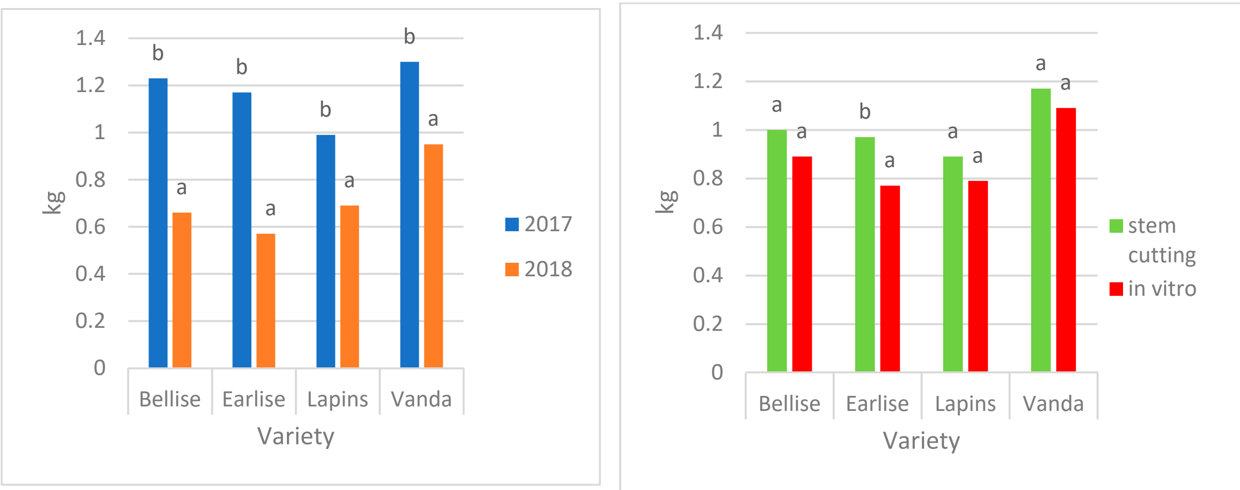


Figure 6. The number of roots of sweet cherry maiden trees depending on the year (**a**) and the method of propagation (**b**). Means marked with the same letters within individual varieties do not differ significantly at the level of α = 0.05, using Duncan's test.

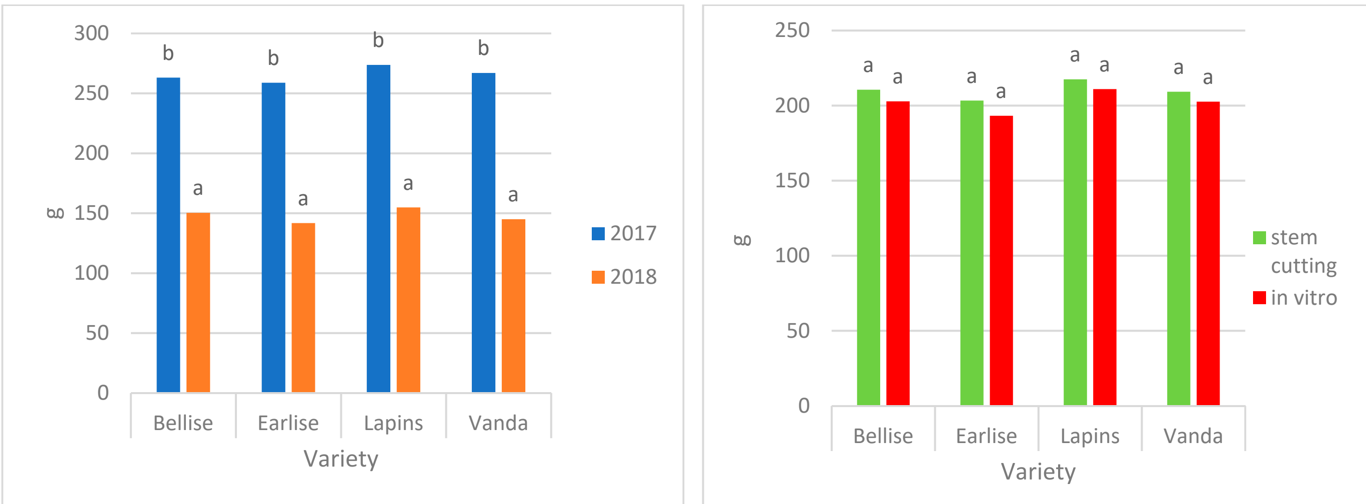
The impact of the tested interaction on the physiological indicators of maiden sweet cherry trees was quite diverse (Table 3). Three of the physiological indicators measured in the leaves of maiden trees of the 'Bellise' variety had higher values when the rootstock propagation was performed by cuttings, compared to the in vitro method (Figures 10b, 11b and 12b). The only exception was the last parameter tested (Int. CO_2) (Figure 13b). For this variety, two indicators did not differ significantly over the two years, while the remaining two showed variability (Figures 10a, 11a, 12a and 13a). In the first year of research, maiden trees of the 'Earlise' variety achieved only a significantly higher Int. CO_2 value (Figure 13a). Two physiological indicators (Pn, Int. CO_2) were significantly higher for the 'Lapins' variety in the first year of the experiment (Figures 10a and 13a). For this variety, all indicators were significantly higher when the rootstock was propagated by in vitro method (Figures 10b, 11b, 12b and 13b). For the last tested variety 'Vanda', all parameters except (C) were significantly higher in 2017 (Figures 10a, 11a, 12a and 13a).

Additionally, two of the four considered indicators (Pn, E) were higher for the shoot cuttings method (Figures 10b and 11b).



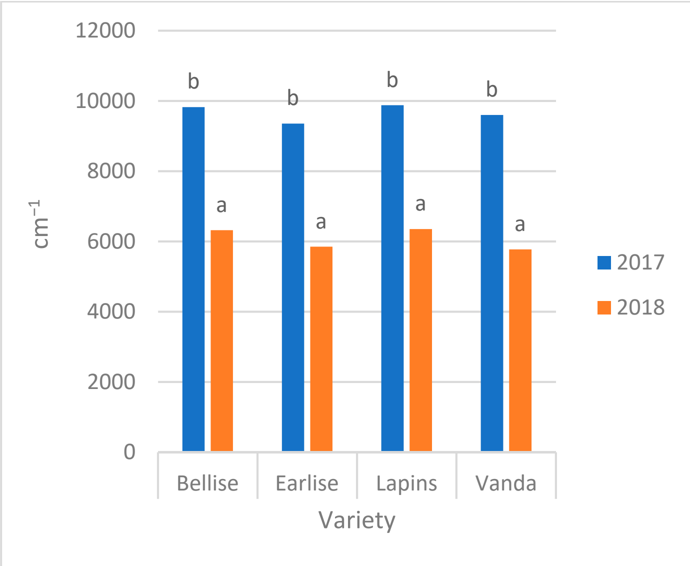
(**a**) (**b**)

Figure 7. The fresh mass of sweet cherry maiden trees depending on the year (**a**) and the method of propagation (**b**). Means marked with the same letters within individual varieties do not differ significantly at the level of α = 0.05, using Duncan's test.

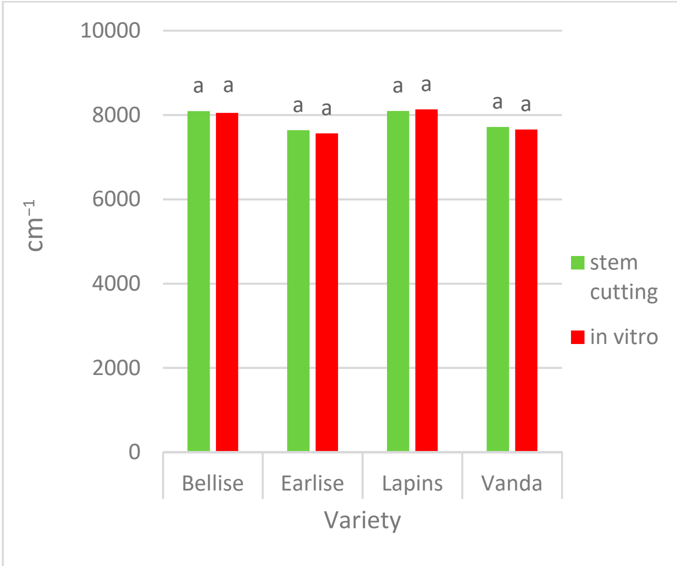


(**a**) (**b**)

Figure 8. The fresh mass of leaves of sweet cherry maiden trees depending on the year (**a**) and the method of propagation (**b**). Means marked with the same letters within individual varieties do not differ significantly at the level of α = 0.05, using Duncan's test.



(a)



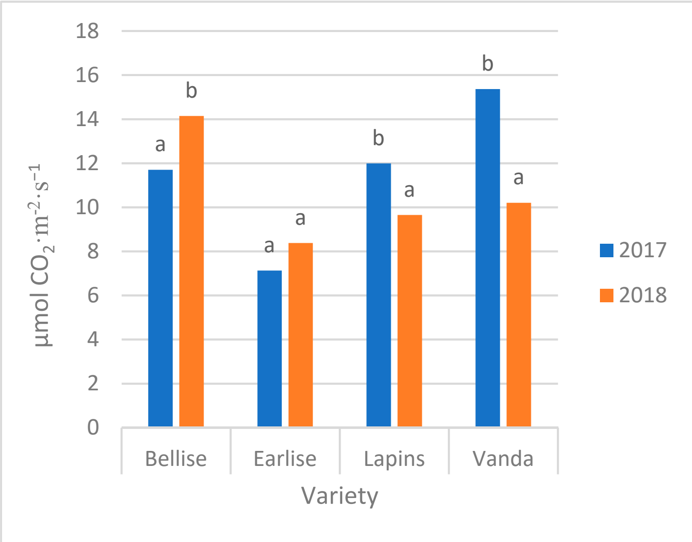
(b)

Figure 9. The leaf blades area of sweet cherry maiden trees depending on the year (**a**) and the method of propagation (**b**). Means marked with the same letters within individual varieties do not differ significantly at the level of α = 0.05, using Duncan's test.

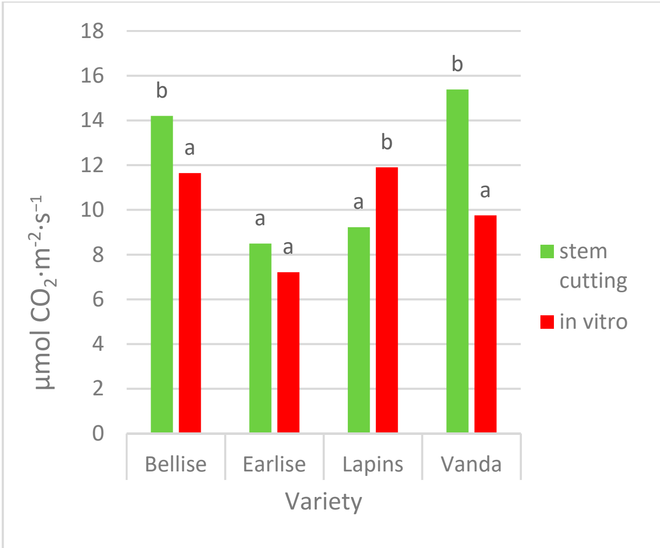
Table 3. Values of selected physiological indicators of maiden trees depending on the method of propagation and the year of experiment.

Variety	Year	Method of Propagation	Physiological Indicators			
			Pn	E	C	Int. CO_2
'Bellise'	2017	Stem cutting	13.26 b	2.86 d	10.84 d	410.28 c
		in vitro	9.69 a	1.04 a	26.62 a	429.01 d
	2018	Stem cutting	15.41 c	2.33 c	84.19 c	145.66 b
		in vitro	13.15 b	1.75 b	72.16 b	65.64 a
'Earlise'	2017	Stem cutting	10.87 b	2.19 b	71.09 b	412.08 c
		in vitro	5.26 a	1.30 a	27.93 a	425.09 c
	2018	Stem cutting	6.10 a	1.29 a	32.91 a	111.28 a
		in vitro	10.01 b	2.09 b	79.42 b	151.76 b
'Lapins'	2017	Stem cutting	10.06 b	1.88 a	70.74 a	424.54 a
		in vitro	13.12 c	2.98 c	89.29 c	443.10 b
	2018	Stem cutting	8.70 a	2.07 a	78.50 b	425.09 a
		in vitro	10.59 b	2.62 b	88.76 c	424.73 a
'Vanda'	2017	Stem cutting	20.61 d	3.61 c	128.71 c	414.19 b
		in vitro	8.36 a	1.82 a	32.19 a	470.03 c
	2018	Stem cutting	9.41 b	2.26 b	84.27 b	216.73 a
		in vitro	11.14 c	1.92 a	132.28 c	215.27 a

Note: Means marked with the same letters within individual indicator do not differ significantly at the level of α = 0.05, using Duncan's test. Pn—net photosynthetic intensity (μmol $CO_2 \cdot m^{-2} \cdot s^{-1}$); E—leaf transpiration coefficient (μmol $H_2O \cdot m^{-2} \cdot s^{-1}$); C—conductivity stomata (mol $H_2O \cdot m^{-2} \cdot s^{-1}$); Int. CO_2—internal carbon dioxide concentration (mol $CO_2 \cdot mol^{-1}$).

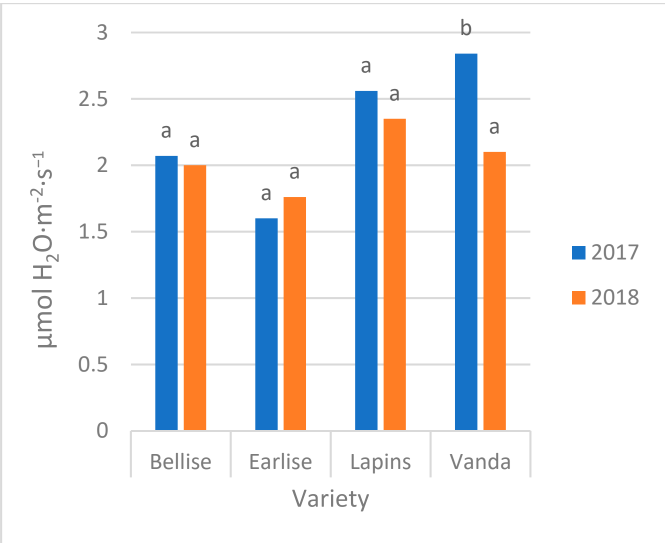


(a)

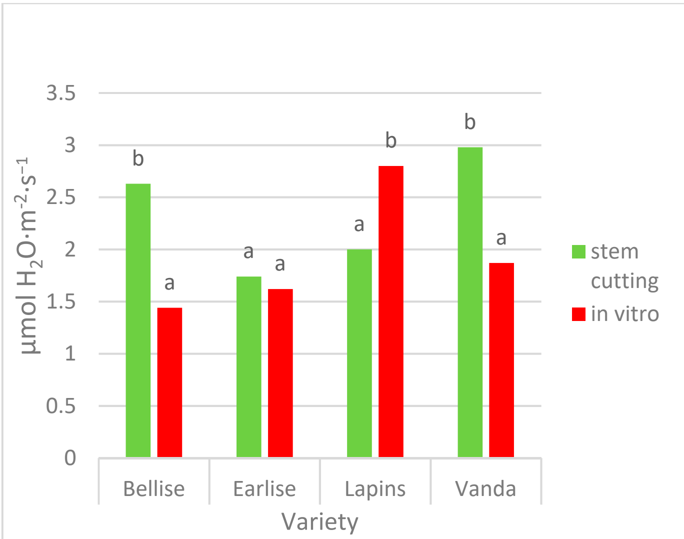


(b)

Figure 10. Net photosynthetic intensity depending on the year (**a**) and the method of propagation (**b**). Means marked with the same letters do not differ significantly at the level of α = 0.05, using Duncan's test.

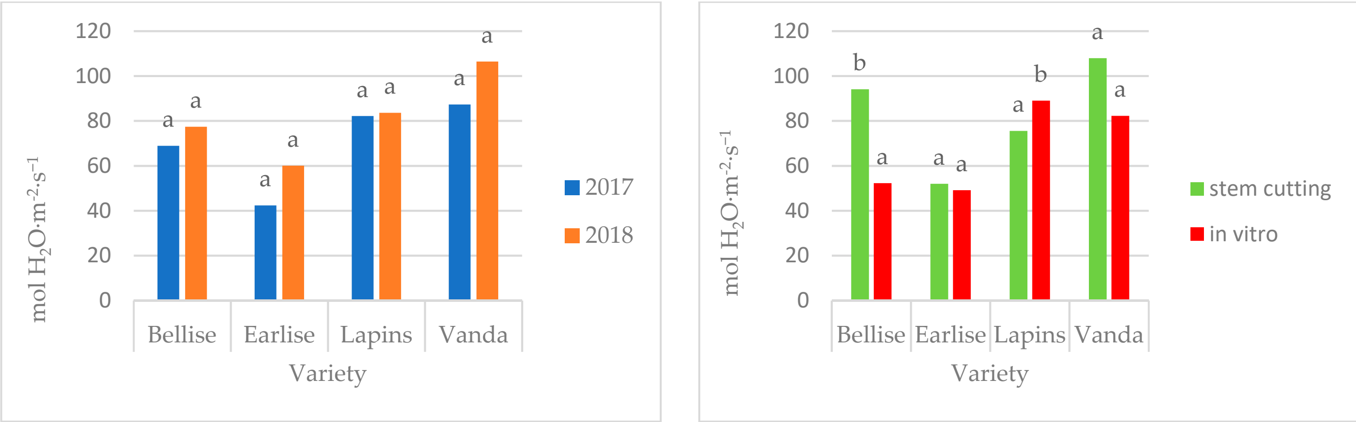


(a)



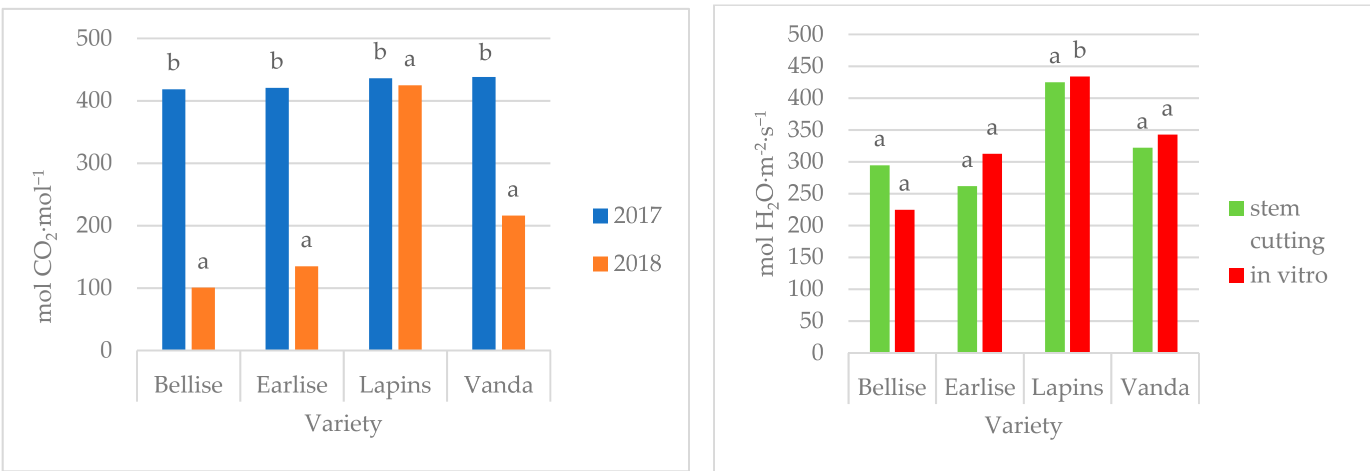
(b)

Figure 11. The leaf transpiration coefficient depending on the year (**a**) and the method of propagation (**b**). Means marked with the same letters do not differ significantly at the level of α = 0.05, using Duncan's test.



(**a**) (**b**)

Figure 12. The stomatal conductivity depending on the year (**a**) and the method of propagation (**b**). Means marked with the same letters do not differ significantly at the level of α = 0.05, using Duncan's test.



(**a**) (**b**)

Figure 13. The internal carbon dioxide concentration depending on the year (**a**) and the method of propagation (**b**). Means marked with the same letters do not differ significantly at the level of α = 0.05, using Duncan's test.

4. Discussion

An important factor influencing the potential for using a given rootstock for propagating sweet cherry varieties is the high percentage of maiden trees obtained [18]. In the experiment under consideration, the 'GiSelA 5' rootstock demonstrated very good compatibility with the tested sweet cherry varieties, which is consistent with the findings of other authors [36,37]. The high efficiency of maidens of the 'Lapins' variety, which was very similar in both years, supports the opinion of Sitarek [38] regarding the good compatibility of this variety with the 'GiSelA 5' rootstock. In the described experiment, the efficiency of maiden trees depended on the variety, with values ranging from 75.3 to 89.3%. The aforementioned author [38] also observed a similar budding efficiency, ranging from 74.0 to 97.0% depending on the variety, with no significant influence of the rootstock, as was also the case in the present experiment. A more varied budding efficiency of maiden sweet cherries trees on the 'GiSelA 5' rootstock was observed by Zengibal et al. [39], who reported efficiencies ranging from 33.3% to 100.0% depending on the variety and the year of this study. However, in their investigations during the two years, these values were significantly varied between individual varieties. In contrast, in the present experiment, the values were similar. This did not depend on the method of rootstock propagation nor, to a small extent, on the year of this study. In a similar experiment, Bryła et al. [40] found varying budding efficiency of maiden trees from one sweet cherry variety, which were influenced by the type of rootstock used and the year of observation. Over three years of observation, these authors reported a high percentage (90.8%) of maiden trees of the 'Regina' variety on the 'GiSelA 5′ rootstock in just one year, with the percentage in the remaining years not exceeding 60%. Similarly, Bujdosó and Hrotkó [41] observed variable budding efficiencies of maiden sweet cherry trees on the 'GiSelA 5′ rootstock, depending on the variety considered (56.0–86.0%). The findings of most of the above-mentioned researchers, as well as others [39,42], confirmed the differential impact of the budded variety on maiden efficiency. This was particularly related to the genetic diversity of the tested varieties. Moreover, it is believed that differences in budding efficiency may result from physiological incompatibility between the rootstock and the variety, which has already been observed in sweet cherries by some researchers in nurseries [43,44]. Additionally, the high number of maiden trees obtained in the present experiment contrasts with the findings of Janes and Pae [45], who reported lower effectiveness of maiden trees from three sweet cherry varieties on the 'GiSelA 5′ rootstock (an average of 60%). These authors attributed this outcome to prolonged drought, high summer temperatures, and low winter temperatures. In the present experiment, the lowest winter temperature was only −15 °C, and no such adverse weather conditions were recorded as in the study by the aforementioned authors, where the winter temperature dropped to −32 °C. Such a low temperature could have caused the freezing of established leaf buds, resulting in a lower number of maiden trees obtained.

In an experiment conducted on 'Gisela 5′ rootstock propagated using stem cuttings, maiden sweet cherry trees with a larger trunk height and diameter were obtained. In the case of most of the tested varieties ('Bellise'; 'Earlise' and 'Vanda'), these differences were statistically significant. The trunk diameter of the maiden sweet cherry trees reported by Janes and Pae [45] varied to a lesser extent (from 16.48 to 19.41 mm) depending on the variety and the year of study. A similar height for maiden trees of several sweet cherry varieties on 'GiSelA 5′ rootstock was observed in a nursery by Zengibal et al. [39], ranging from 136.70 to 204.33 cm. These values did not change significantly across the year of observation. A significantly lower height of maiden sweet cherry trees on 'GiSelA 5′ rootstock was reported by Bujdosó and Hrotkó [41], who obtained highest results ranging from 103 cm to 149 cm, depending on the seven varieties tested. A similar height of approximately 145 cm for maiden trees of the 'Lapins' variety on the rootstock under consideration was observed by Sitarek and Grzyb [46]. However, in the study by these authors, maiden trees of the 'Lapins' variety were much taller than the other examined varieties, whose heights were similar. In the present experiment, in the first year of observation, the 'Lapins' variety was much shorter, while in the second year, it was slightly taller than the other varieties. Baryla et al. [6] reported sweet cherry maiden trees of the 'Regina' variety on 'GiSelA 5′ rootstock with a diameter of 14.2 mm. This value falls between the measurements from the first and second year of experiment under consideration. A smaller diameter (11–14 mm) for maiden trees on 'GiSelA 5′ rootstock was reported by Bujdosó and Hrotkó [41]. It should be noted, however, that a smaller diameter obtained by these authors was due to the higher measurement point, which was 30 cm above the budding site, whereas in the present experiment the diameter was measured only 10 cm above the budding site. The differences in the results of the compared experiments were primarily due to differing soil and climatic conditions, which influenced the growth of maiden trees. Additionally, differences may result from the genetic variation in the compared varieties, as confirmed by other authors [7,39,42,44]. In the present experiment, the growth results of maiden trees of individual sweet cherry varieties were not statistically compared, but they did show variation. These results are consistent with findings from Gjamovski et al. [47] and Milić et al. [48], where trees of the 'Kordia' and 'Summit' varieties exhibited stronger vigor than 'Regina' trees on 'GiSelA 5′ rootstock.

The most important quality parameter of maiden trees are the number and length of side shoots. As stated by Baryła et al. [6], the vigor and intensity of the branching of maiden trees depend on both the rootstock and the variety. Research conducted by these authors on the maiden trees of the 'Regina' variety showed a total length of side shoots of 160 cm. This result was worse than that observed in the first year of present experiment, but much better than the result in the second year. Zec et al. [7] obtained a 3–4 times higher number of side shoots in maiden sweet cherry trees of three varieties ('Carmen', 'Kordia', and 'Regina'), which varied depending on the variety and ranged between 8.3 and 20.0 shoots. The number of side shoots changed almost two-fold over the two years of study, similar to the results in the present experiment. Bajdusó and Hrotkó [41] did not observe lateral branches on the maiden trees of six sweet cherry varieties on the 'GiSelA' 5 rootstock, which is inconsistent with the present study, where only one of the four varieties did not produce side shoots. This discrepancy underscores the significant influence, especially of climatic factors, on the stimulation of said shoot formation in a given year. In the current study, greater rainfall in the first year promoted the growth of side shoots. Other factors, such as soil quality and applied care treatments, also influenced side shoots formation but are difficult to compare across different experiments. The small number of side shoots in some maiden trees may also be attributed to the low vigor of 'GiSelA 5' rootstock, which results in the formation of short and thin side shoots, not reflecting the full growth potential of the tested sweet cherry varieties. This was also noted in the study by Zec et al. [7]. According to these researchers, the low vigor of the 'GiSelA' rootstock, characterized by short and thin side shoots, is largely genetically determined but may also be influenced by poor soil quality and inadequate care treatments during the growth of maiden trees. This opinion is shared by other authors [7,49], who found that the 'Gisela 5' rootstock requires good soil conditions and careful management, and does not perform well under suboptimal conditions. In the first year of the experiment, the fresh weight of maiden trees and their leaves was similar to that previously reported by Świerczyński et al. [33] who obtained 1.4 kg and 225 g for the 'Vanda' variety. This confirms the growth potential of this variety in the nursery compared to others. It can be assumed that the stronger-growing sweet cherry varieties show greater differences in the examined growth parameters due to the method of rootstock propagation. The differences were less noticeable in the slower-growing 'Lapins' variety. However, the factor that most limited the growth of maiden trees was the less favorable weather conditions in 2018. During that year, the method of rootstock propagation did not play a significant role in differentiating the growth results. In contrast, in 2017, more frequent rainfall and lower summer temperatures favored the growth of maiden trees, leading to more noticeable differences between the rootstock propagation methods and greater variation in the genetic growth potential of the varieties. Under favorable climatic conditions, the method of propagation by cuttings resulted in the stronger growth of maiden trees. There was also a greater growth potential in the stronger-growing varieties. The reason for the different growth patterns of budded varieties on two types of rootstocks can be attributed mainly to the different nature of the root system. Rootstocks propagated by the in vitro method had many small roots, while those propagated by shoot cuttings had longer roots—this parameter was not assessed in the described experiment. The longer roots of stem-cutting rootstocks resulted in better access to water and nutrients. It should be noted that maiden sweet cherry trees on semi-dwarf and dwarf rootstocks require supplemental irrigation during years with less rainfall due to their weak root system.

As stated by several researchers [30–32], sweet cherry rootstocks influence the parameters of photosynthesis in the leaves. Measurements of the physiological processes in maiden trees showed differences between the years compared and the method of rootstock propagation for some varieties. As a rule, a higher intensity of these life processes was observed in maiden trees from the first year of study, which confirmed the much more intense growth of maiden trees during that year. However, this trend was not observed for all varieties. More often, maiden trees propagated by the cutting method exhibited higher values for two or three of four parameters assessed ('Bellise' and 'Vanda'). Only for the 'Earlise' variety was this relationship reversed. Similar research conducted by Świerczyński et al. [32] analyzed the impact of biostimulants on the photosynthetic activity parameters of maiden sweet cherry trees of the 'Vanda' variety. Their study confirmed variable values for the assessed parameters, which did not always align with the growth dynamics of maiden trees. Comparing results from different years is difficult due to variations in the climatic and soil conditions. Nevertheless, many authors have confirmed the relationship between increased photosynthetic intensity and higher stomatal conductance [50–52], a relationship not demonstrated in the present experiment. However, a strong correlation was observed between stomatal conductance and internal carbon dioxide concentration, as previously noted by Świerczyński et al. [53]. According to some researchers [52,54], greater intensity in plant physiological processes generally results in stronger tree growth, although this was not always confirmed in the present experiment with the assessed maiden sweet cherry trees. The experiment did not examine different genotypes of sweet cherry rootstocks, as was performed by Gonçalves et al. [27] who found that stronger growing rootstocks were characterized by higher values of net CO_2 assimilation rate, stomatal conductance, and intercellular CO_2 concentration. They demonstrated that photosynthesis in sweet cherries is mainly influenced by the rootstock genotype. Under conditions of drought or salt stress, other researchers [55] observed different photosynthesis responses depending on the rootstock with high variability, which aligns with the results obtained in this experiment—particularly in the case of insufficient irrigation of maiden cherry trees in the nursery, especially in the second year of this study. Additionally, other researchers [56] reported that the 'Lapins' variety is characterized by low water conductivity in shoots and sap flow, which affects its poor vegetative growth. This finding was also confirmed in the present study. The variability in the physiological indicators studied resulted from several factors, especially the differing growth dynamics of sweet cherry varieties. Moreover, it was influenced by the variable climatic conditions prevailing during each year of this study. Therefore, it is difficult to draw definitive conclusions in this regard.

5. Conclusions

Taking into consideration that maiden sweet cherry trees propagated from the 'GiSelA 5' rootstock by shoot cutting most often had a larger stem diameter (ranging from 23% to 29%), a greater number of side shoots (ranging from 73% to 172%) and a higher number of roots (ranging from 13.5% to 21.2%) compared to those obtained through the in vitro method, the usefulness of this more cost-effective propagation method can be suggested. This method is not inferior to the more expensive in vitro technique. The shoot cutting method significantly reduces production costs for this rootstock while maintaining the quality of the maiden sweet cherry trees produced. However, it is difficult to compare these results with those of other studies, as this rootstock propagated by shoot cuttings has not been previously studied, unlike the in vitro method. The measurement of the physiological processes in the leaves of maiden sweet cherry trees is not always a reliable indicator of growth dynamics. However, in this case, better measurement results were more frequently obtained for trees propagated by shoot cuttings, although statistical differences from the in vitro method were not always significant. In addition to the influence of variable soil and climatic factors, there is a further correlation between the rootstock and the variety. Therefore, more research is needed to optimize growth conditions for the plants, such as ensuring constant irrigation. The number of sweet cherry varieties tested with varying growth potentials should also be increased. Moreover, measurements of physiological processes should be conducted throughout the entire period of maiden trees' growth in the nursery.

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