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PRELIMINARY RESULTS ON EARLY CROP LOAD AND GROWTH RESPONSES OF 'LAPINS' SWEET CHERRY CULTIVAR (*PRUNUS AVIUM* L.) GRAFTED ON 'GISELA 5' AND 'GISELA 6' ROOTSTOCKS IN A DRIP IRRIGATED FIELD TRIAL

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Abstract

The growth responses of 'Lapins' sweet cherry cultivar (Prunus avium L.) grafted on 'Gisela 5' and 'Gisela 6' rootstocks was evaluated in drip irrigation conditions in Bistrita Fruit Region, in Northern Transylvania Romania, during 2020-2021, in a high density field trial, trees were trained as spindle bush with 1250 trees/ha density. During the study the following parameters were evaluated, trunk cross section area, volume of the tree crown, leaf area, length of shoots, number of shoots, height of trees, leaf area/fruit, crop load, yield, fruit number/tree, average fruit size and main quality characteristics of the fruits. Preliminary data showed that trees grafted on 'Gisela 6' when compared with 'Gisela 5' proved to be more vigorous when considering trunk cross sectional area and canopy volume indicators. Data showed that generally in both rootstock combinations a high fruit number per tree was observed at 'Lapins' cultivar and fruit size was largely a function of crop load and leaf area: fruit ratio. In order to obtain a good fruit size most probably, crop load of self fertile 'Lapins' cherries on Gisela rootstocks must be regulated by different pruning treatments. Drip irrigation had a crucial influence on the vegetative development of the trees and completed the physiological need of plants mainly in critical summer drought periods.

Key words: *crop, cherry, rootstocks, cultivar, crop load, fruits.*

INTRODUCTION

Sweet cherry cultivation worldwide is focusing lately on using special training systems and specific rootstock combinations which effectively control tree size and maximizes yield. Among several rootstocks available in modern fruit growing in many countries Gisela rootstock is used and from thousands of *Prunus cerasus* and *Prunus canascens* selections, `Gisela 5` and `Gisela 6` and others were patented. After many years of testing, worldwide it was proved that induces tree size control, precocious bearing and it is very productive (Franken Bambenek, 1998). In order to remain economically viable, beside complex orchard management techniques of fertigation (Neilsen, 2004,2010) and other techniques in the fruit growing world the reduction of tree size is crucial, it is highly needed to achieve higher yields, increased labor efficiency and productivity (Lang, 2000; Webster, 1995; A.S.A. Santos et al., 2007; A. Kankaya et al., 2008, Robinson, 2008). Rootstocks influences not just growth characteristics but also fruit quality (Valter Martins, 2021). `Gisela 5` performed well worldwide in different soil and climate conditions producing trees about 50 % weaker than *Prunus avium* and in Germany half of the newly established intensive orchards are planted on `Gisela 5` with different grafted cultivars. `Gisela 5` also needs good soil and site conditions and recent results showed that sweet cherry in dry seasons necessitates irrigation system (Blaya Ros et al., 2021; Victor Blanco, 2020) to complete the physiological processes of trees. `Gisela 6` rootstock is a more vigorous rootstock than the previous rootstock mentioned earlier, being between *Prunus avium* and `Gisella 5` regarding the tree vigor. Researchers from Consortium Deutschen Baumschulen state that trees grafted on `Gisela 6` crop early and as rootstock is less demanding on soil quality and site conditions and could work without irrigation system. Worth mentioning is that `Gisela 6` is intensely used in the USA as a new size controlling rootstock. The objective of

the present research was to study the early bearing capacity of `Lapins` cultivar grafted on `Gisela 5` and `Gisela 6` rootstocks and the vegetative growth and development of trees in drip irrigation conditions in Bistrita Fruit Region, Northern Transylvania, Romania.

MATERIALS AND METHODS

The study was carried out during 2020-2021 in a 3 years old, drip irrigated sweet cherry experimental orchard (*Prunus avium* L.) planted with 'Lapins' cultivar grafted on 'Gisela 5' and 'Gisela 6' rootstocks (knip trees), in a high density plot, planted at 4 x 2m distance, the adopted training system was the spindle bush. The research plot is located in Bistrita, Northern Transylvania, Romania. The soil is a deep eutricambosoil with medium NPK and organic matter content. During the study standard orchard management techniques were applied regarding weed management with herbicide sprays and appropriate fertigation (Solfert, macroelements 20% N; 20% P; 20% K and microelements B (0.01%); Cu-EDTA (0.0055%); Fe-EDTA (0.05%); Mn-EDTA (0.025%), Mo-EDTA (0.035%); Zn-EDTA (0.0075%) and phytosanitary treatments. Biometrical measurements were made on: the height of tree, trunk cross-sectional area 15 cm above grafting point, volume of trees, length of shoot growth, and there were calculated the yield per tree (kg/tree). Fruit maturation occurred between 13-17 th July 2020 and harvest day in 21.07.2020. In the following year in 2021 fruit maturation occurred a week earlier between 05-10 th July 2021 and harvest day in 13.07.2021. The measurements were done in September at the final of vegetation period, on 14 trees of the `Lapins` cultivar grafted on the two different rootstocks, in the 2th year after planting. The trees were subjected to two different irrigation treatments (T1-standard irrigation, T2- standard+25 %) with different amounts of water in 2020 (T1-209 mm;T2-261mm) and in 2021 (T1-164 mm;T2-205mm) based on adjusted coefficients of Class A pan evapotraspiration. Drippers 2 L h^{-1} flow rate, were placed in line, 1 m apart.

The trunk diameter was measured with a digital caliper and the height of trees and length of the branches was measured using a tape measure. The pruning was at minimum level applied, since the experimental orchard is very young, mainly the too developed branches were thinned and some other branches stub cut to equilibrate the growing and fruiting processes. Canopy volume calculations were effectuated with specific software based on calibrated digital images taken from the cherry trees. The software called Tree analyser, version 1.20b was elaborated by researchers from Institute Nationale de la Recherche Agronomique, France. The software calculates the geometrical parameters of tree crown starting with black& white photographs executed from different angles but precisely determined toward cardinal angles. For every tree it was needed 6 successive photographs around the tree. Photographs were taken on digital cameras placed on tripod at 1 m height and from 4 m distance toward the tree, with a vertical angle of 10°. The background of trees was shielded with a white panel in order to produce black& white photos. The color photos with a resolution of 1600 x 1200 were transformed in black & white photos and loaded in the Tree Analyser software. The statistical analyses were performed using XLSTAT software version 2018.1 (Addinsoft, Paris, France).

RESULTS AND DISCUSSIONS

Drip irrigation (Figure 1) generally had a great impact on the development of trees in both rootstock combinations affecting both vegetative and generative physiological processes. Especially the increased T2 irrigation (standard + 25%) had a distinguished effect on the development of main stem, canopy, shoot number, shoot length.

Figure 1. Irrigation coordination center

Research results showed that the highest vegetative development (Figure 2) was recorded at `Lapins` cultivar grafted on `Gisela 6` in T2 irrigation condition in both the experimental years when analysing the trunk cross sectional area parameter (Table 1). Data showed in T2 irrigation condition a TCSA value of 8.48 cm^2 in 2020 and 17.50 cm^2 in 2021. In 2020 the other research variants at `Gisela 5` combinations had close values being in the same statistical class.

Figure 2. Canopy measurement of 'Lapins' sweet cherry cultivar grafted on 'Gisela 5' rootstock

In 2021 after the best recorded TCSA value of `Lapins`/`Gisela 6`- T2-combination (17.50 cm2) followed the normal irrigation variant T1 (15.04 cm^2) at the same `Gisela 6` rootstock combination. The other variants grafted on `Gisela 5` had lower TCSA values.

Figure 3. Measurement of TCSA at 'Lapins' sweet cherry cultivar

It seems that the `Gisela 6` rootstock induced higher vigour (Figure 3) and the root system had the possibility to use the applied irrigation water more efficiently in terms of TCSA development (Table 1).

Table 1. Measurement data on TCSA at 'Lapins' sweet cherry cv grafted on 'Gisela 5' and '6'

Treatment variant	TCSA (cm^2)	
	2020	2021
T1-Lapins /Gisela 5	3.39 **b**	11.52 **b**
T2-Lapins /Gisela 5	5.43 **b**	11.58 **b**
T1-Lapins /Gisela 6	5.76 **b**	15.04 **ab**
T2-Lapins /Gisela 6	8.48 **a**	17.50 **a**

Regarding the number of shoots (Table 2), results showed that `Gisela 6` rootstock in both in 2020 induced more shoot growth than `Gisela 5` (average values of 6.28-10.28).

Figure 4. Shoot growth measurement of 'Lapins' sweet cherry cultivar grafted on 'Gisela 6' rootstock

In 2021 interestingly the increased irrigation level (normal T1 + 25 %) influenced also in `Gisela 5` a higher number of shoots, thus the two irrigation levels induced in both rootstock combinations a good vegetative growth (Fig 4).

Table 2. Measurement data on number of shoots at 'Lapins' sweet cherry cv grafted on 'Gisela 5' and '6'

Treatment variant	Number of shoots	
	2020	2021
T1-Lapins /Gisela 5	5.16 **b**	8.16 **c**
T2-Lapins /Gisela 5	7.28 **b**	8.28 **b**
T1-Lapins /Gisela 6	6.71 **b**	6.28 **c**
T2-Lapins /Gisela 6	10.00 **a**	10.28 **a**

The shoot length growth (64-65 cm) in 2020 was intensive in `Gisela 6` rootstock combination in both irrigation levels (Table 3), followed by `Gisela 5` combination (42-49 cm).

Table 3. Measurement data on length of shoots at 'Lapins' sweet cherry cv grafted on 'Gisela 5' and '6'

Treatment variant	Length of shoots (cm)	
	2020	2021
T1-Lapins /Gisela 5	42.70 **b**	52.09 **c**
T2-Lapins /Gisela 5	49.15 **b**	66.41 **b**
T1-Lapins /Gisela 6	64.00 **a**	67.61 **b**
T2-Lapins /Gisela 6	65.59 **a**	85.77 **a**

In 2021 as the trees developed, higher measurements were recorded in T2-`Gisela 6` category (85.77 cm) followed by normal T1 category in `Gisela 6` and the two `Gisela 5` rootstock combinations. Elevated irrigation thus had an effect also on the length of shoots (Table 3).

Table 4. Measurement data on tree height at 'Lapins' sweet cherry cv grafted on 'Gisela 5' and '6'

Treatment variant	Height of trees (cm)	
	2020	2021
T1-Lapins /Gisela 5	2.02 **b**	1.96 **b**
T2-Lapins /Gisela 5	2.39 **ab**	2.04 **b**
T1-Lapins /Gisela 6	2.53 **a**	2.36 **a**
T2-Lapins /Gisela 6	2.58 **a**	2.53 **a**

In 2020 the recorded height of trees showed similar growth characteristics (2.53-2.58) in `Gisela 6` combination and slight lower values at `Gisela 5`. In 2021 the higher vigor rootstock produced quite the same height values as in 2020 despite the irrigation effect, `Gisela 5` produced trees with lower height than Gisela 6 (Table 4).

The canopy enlargement can be observed at the more vigorous `Gisela 6` cultivar in T2 irrigation variant (Table 5) in both experimental years showing values ranging 0.61-1.16 m^3.

Table 5. Measurement data on canopy volume at 'Lapins' sweet cherry cv grafted on 'Gisela 5' and '6'

Treatment variant	Canopy volume (m^3)	
	2020	2021
T1-Lapins /Gisela 5	0.36 **b**	0.73 **c**
T2-Lapins /Gisela 5	0.48 **ab**	0.81 **b**
T1-Lapins /Gisela 6	0.49 **ab**	0.87 **b**
T2-Lapins /Gisela 6	0.61 **a**	1.16 **a**

In 2020 the increased irrigation level in `Gisela 5` combination and the standard T1 irrigation level at `Gisela 6` canopy showed very close values (0.48-0.49). In early development stages it seems that the rootstock effect it is not so pronounced. In 2021 we can observe that the growing and expanding tendency remains, less canopy value is recorded at T1 standard irrigation level in `Gisela 5` rootstock combination, whereas in `Gisela 6`the canopy has a greater volume.

One of the most important technical-economical indicator is the yield per tree (kg/tree) value and in our experiment results data showed that it is possible to achieve early production of the young trees in the 2-3rd leaf stage (Table 6) with knip trees.

Table 6. Measurement data on yield per tree (kg/tree) at 'Lapins' sweet cherry cv grafted on 'Gisela 5' and '6'

Treatment variant	Yield per tree (kg/tree)	
	2020	2021
T1-Lapins /Gisela 5	0.18 **c**	0.91 **b**
T2-Lapins /Gisela 5	0.32 **bc**	0.92 **b**
T1-Lapins /Gisela 6	0.36 **b**	1.13 **ab**
T2-Lapins /Gisela 6	0.53 **a**	1.42 **a**

Results showed that the higher vigor `Gisela 6` rootstock induces in both experimental years higher yield (0.53-1.42 kg/tree) than `Gisela 5` grafted trees, due to more intensive tree development in elevated T2 conditions.

In normal irrigation conditions the yield per tree was also good at `Gisela 6` with close values to T2 but the watering contributed well to production. In Gisela 5 in both the irrigation variants the recorded yield had similar values. Early observations showed that a high number of fruits/branches seems to be characteristic for the `Lapins` sweet cherry cultivar (Figure 5). Further researches will elucidate if there is a need for more specific pruning techniques in order to regulate the crop load.

Figure 5. Yield of 'Lapins' sweet cherry cultivar grafted on 'Gisela 6' rootstocks

Table 7. Fruit weight (g) of 'Lapins' sweet cherry cv grafted on 'Gisela 5' and '6'

Treatment variant	Fruit weight (g)	
	2020	2021
T1-Lapins /Gisela 5	8.47 **a**	7.96 **c**
T2-Lapins /Gisela 5	8.28 **a**	8.17 **bc**
T1-Lapins /Gisela 6	8.02 **a**	8.34 **b**
T2-Lapins /Gisela 6	8.64 **a**	8.73 **a**

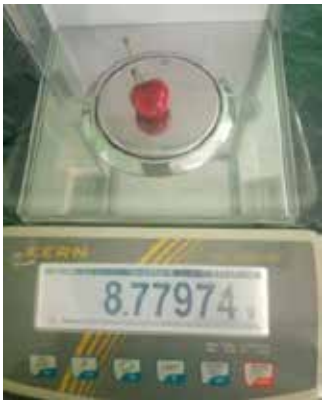

Figure 6. Weighing the 'Lapins' cultivar fruits

Regarding fruit weight (Table 7) we can observe that the `Lapins` cultivar has medium sized fruits (8.64-8.73 g), maybe due to the intensive crop load, thus in 2020 there were no statistical differences between variants, trees being in the first production year.

In 2021 the T2 drip irrigated `Lapins`/`Gisela 6` trees presented fruits weighing 8.73 g followed by the T1 variant with 8.34 g fruits (Figure 6). Quite similar fruit weight values were observed in T2 irrigated `Gisela 5` grafted trees (8.17) followed by the T1 irrigated trees on `Gisela 5` (7.96 g).

CONCLUSIONS

Under our experimental conditions tree establishment of `Lapins` sweet cherry cultivar was very effective on both rootstocks, `Gisela` 6 was more vigorous when compared with `Gisela 5`, in terms of TCSA development, shoot number, shoot length, height of trees, canopy volume. However, during the first production year (2020), yield was smaller, irrigation completed the physiological need of plants and in the elevated T2 irrigation variant the root system of `Gisela` rootstocks used very effectively the applied water amount. In the second experimental year (2021) the recorded yield was higher at `Gisela 6` rootstock variant, but `Gisela 5` behaved also well. Similar results have obtained also by other researchers (Cordeiro et.al, 2007) in the 3rd leaf stage, the recorded yield was 2.53 kg/tree, at tree height of 2.80 m and 26.5 cm^2 TCSA. Bujdoso et al. (2007) obtained in early years 1.5 kg/tree at cultivar `Germersdorfi 3` grafted on `Gisela 5` rootstock in an experiment established in Hungary. Preliminary researches showed that `Gisela 5` and `Gisela 6` are precocious, size controlling and early productive rootstocks for sweet cherry cultivation but optimal specific soil and orchard management conditions must exist in order to fully provide the physiological and technological elements for optimal tree development.

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