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Influence of some rootstocks and interstocks on the growth and fruiting of cherry cultivar Summit

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Abstract

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During the period 2018-2020, the influence of Gisela 5, Gisela 6, Weiroot 10 and F12 / 1 rootstocks was studied, including when they are used as interstocks (with a length of about 30 cm) on the manifestations of the sweet cherry cultivar Summit. Trees of the same cultivar grafted directly on seedlings of IK-M9 (a local mahaleb rootstock) were used as a control. The trees were planted in the spring of 2008 at distances of 4.0 x 3.0 m, were formed in free-growing crowns and during the study period were grown without irrigation. It was found that at the end of the 13th year the trees grafted on F12/1, used as rootstock, had the thickest stems, and those of Gisela 5 and Gisela 6 the thinnest, and the differences with the control were proven. However, no significant differences were found in the cross-section of the trunk of the trees with interstocks and control trees. The highest cumulative yield was obtained from the trees directly grafted on F12/1 and IK-M9, and all other combinations have proven lower yields. Trees with Gisela 5, Gisela 6 and Weiroot 10 as interstocks were more productive compared to the variants in which they were used as rootstocks. In terms of cumulative yield efficiency, the trees on IK-M9 significantly surpassed all other combinations. No significant differences in fruit biometric parameters were found between the studied variants.

Keywords: Prunus mahaleb; Gisela 5; Gisela 6; Weiroot 10; F 12/1; cultivar/rootstock combinations; yield

Introduction

The growth of cherry trees and yield depend mainly on the cultivar and used rootstock. The right choice of the most appropriate cultivar/rootstock combinations for the specific habitat is a major factor in the successful production of cherry fruits. Vigorous sweet cherry trees still predominate in the fruit orchards of Bulgaria. Seedlings of *Prunus mahaleb* L. and *Prunus avium* L. are the major rootstocks for grafting sweet cherry cultivars but the trees on them are difficult to maintain, especially for harvesting (Koleva, 2001). Many new cherry rootstocks are available today, thanks to different national and international breeding programs, which give growers new opportunities (Bujdosó & Hrotkó, 2019). The dwarfing and semi-dwarfing rootstocks such as Gisela 5, Gisela 6, Weiroot, CAB series and others induce precocity and decrease the vigor of scion, allows higher planting density, and higher yields per unit area compared to seedling rootstocks (Lang, 2001; Lanauskas et al., 2012; Pal et al., 2017; Sotirov, 2020). However, the less growing rootstocks have many negative features – requires fertile soil, irrigation and support, and are often prone to over-cropping and reduce fruit size. In addition, some of them do not induce sufficient cold resistance of cherry cultivars in the winter (Lichev and Papachatzis, 2006).

To solve these problems and mainly to reduce the growth of cherry trees, where dwarf and semi-dwarf rootstocks do not adapt well, a number of studies have been conducted on their use as interstocks grafted on vigorous rootstocks (Hrotkó et al.,1997; Rozpara et al., 2011; Lichev et al., 2014; Sotirov, 2015). In some experiments, the effect of interstock length on the scion cultivars was also studied (Kaymakanov, 2014; Kaymakanov et al., 2015). It has also found that the interstocks can also affect the vitality of grafted cherry trees (Larsen et al., 1987, Magyar & Hrotkó, 2008).

As a result of these and many other experiments it has been proven that the use of interstocks could significantly change cherry industry by expanding the areas where sweet cherries can be grown.

This study aimed to evaluate the growth, productivity and fruit size of the cherry cultivar Summit during the period of full fruiting, when it was grafted on different rootstocks and intertocks.

Materials and Methods

The study was conducted during the period 2018-2020 in an experimental scion/rootstock plantation of the Institute of Agriculture in Kyustendil. Summit cherry trees were grafted on Gisela 5, Gisela 6, Weiroot 10 and F 12/1 rootstocks. They were also used as interstocks (with a length about 30 cm) in combination with the local mahaleb rootstock IK-M9. Trees grafted on rootstock IK-M9 with an intermediate part of the same rootstock were used as controls. The trial was planted in the spring of 2008 at distances 4.0 × 3.0 m in Chromic Luvisoils, sandy-loamy soil with slight acid reaction (pH 5.0-5.2 in KCl). The trees were shaped in free-growing crowns with a height of stems 80 cm. Each graft combination was presented with five trees and each one was treated as a repetition. The orchard was cultivated with standard technology. The soil surface between rows was maintained in clean cultivation, and in the row strips with foliar herbicide. During the studied period the plantation was not irrigated.

During the three-year period the following characteristics were studied: the circumference of the scion and interstocks at 15 cm above the graft union; length of 1-year-old shoots (cm); yield/tree (kg); average weight (g) and diameter of the fruit (mm) – on random samples of 30 fruits from each combination. Trunk cross-sectional area (TCSA, cm^2) of the two components (interstocks and scion), cumulative yield per tree (kg) and cumulative yield efficiency (kg/cm^2 of TCSA) were calculated. The health condition of the trees at the end of the last year was also reported.

The data were statistically processed using analysis of variance (ANOVA) and LSD multiple range test at $p \leq 0.05$ to determine significance of differences between the means.

Results and Discussion

The trunk diameter is an essential, indicator of the whole vegetative potential of the trees. The results of the thickening of the trunk of the Summit cherry trees grafted on different rootstocks and interstocks are presented in Table 1. At the end of the 13th year after planting, the largest trunk cross-sectional area (TCSA) in the zone of interstock had the trees with interstocks F 12/1 and Weiroot 10, and the differences between them and the control trees were not statistically proven. The thickening of the trunk under the influence of Gisela 5 and Gisela 6 as interstocks was 24.2 and 39.4% lower, respectively, compared to the control IK-M9, and also differed significantly from the other two interstocks.

Table 1. Rootstock/Interstock effect on Summit cherry trees trunk growth at the end of the 13th year (2020)

Rootstock/Interstock	Trunk cross-sectional area, cm^2			
	Interstock	Scion	Diffence	Index
IK-M9 /IK-M9 – control	169.6 a	174.3 b	+ 4.7	100
IK-M9 / Gisela 5	128.6 b	169.6 b	+ 41.0	97.3
Gisela 5	–	113.0 c		64.8
IK-M9 / Gisela 6	102.8 c	174.2 b	+71.4	99.9
Gisela 6	–	118.6 c		68.0
IK-M9 / Weiroot 10	162.8 a	165.6 b	+2.8	95.0
Weiroot 10	–	173.2 b		99.4
IK-M9 / F12/1	171.9 a	165.8 b	- 6.1	95.1
F12/1	–	237.7 a		136.4

Note: Values followed by the same letter in a column were not statistically different ($P \leq 0.05$)

The thickness of the scion in the variants with interstocks (measured at 15 cm above the interstock union) was greater than in the zone of the interstock, with the exception of F 12/1, above which the cross- section of the stems was reduced by about 6 cm^2. The smallest difference between the two graft components was in the variant with Weiroot 10 (2.8 cm^2), which is an indicator of very good compatibility between the scion cultivar and this interstock. Followed by the control (4.7 cm^2), and it was the most pronounced in Gisela 6 (71.4 cm^2) and Gisela 5 (41.0 cm^2). The difference in thickening between the interstock and the scion are the probable cause of cracking of the bark and wood, most often in the area above the interstock, in some trees. In general, the results showed that the interstocks used in combination with IK-M9 do not lead to a significant weakening of the growth of Summit trees (expressed by the cross section of the trunk) compared to those grafted directly on IK-M9 (Table 1).

The use of Gisela 6 and Gisela 5 as direct rootstocks for the Summit cultivar reduced to a greater extent the thickening of the tree's trunk (by about 32-33%), compared to the variants when they were used as interstocks in combination with the IK-M9 mahaleb. Between Weiroot 10 combinations, as a rootstock and an interstock, the difference in cross section was insignificant (only 4.4%), while in F 12/1 used as a rootstock, the trees had significantly stronger growth (by 43%), compared to the variant with interstock and by 36.4% compared to grafted ones on IK-M9 (Table 1).

In the first year of the study, the trees of all combinations had a stronger 1-year growth, which weakened over the next two years (Table 2). This was due to the restrictive pruning carried out in the spring of 2017 that stimulated the vegetative growth in the next 1-2 years, as well as compromising the fruit harvest in 2018, as a result of late spring frost.

Table 2. Rootstock/Interstock effect on the growth of 1-year-old shoots of Summit cherry trees, cm (11-13 vegetations)

Rootstock/Interstock	2018	2019	2020	Average
IK-M9/ИК-M9 – control	13.1 b	10.7 bc	7.2 abc	10.3 ab
IK-M9 / Gisela 5	16.9 ab	13.8 a	7.9 abc	12.9 a
Gisela 5	11.3 bce	6.1 ef	5.3 bc	7.6 bc
IK-M9 / Gisela 6	8.1 de	8.4 cde	6.5 bc	7.7 bc
Gisela 6	6.8 de	4.9 f	6.5 bc	6.1 bc
IK-M9 / Weiroot 10	5.8 e	4.7 f	4.6 c	5.0 c
Weiroot 10	12.5 abc	5.1 f	8.5 ab	8.7 abc
IK-M9 / F12/1	8.3 ce	6.9 def	7.0 bc	7.4 bc
F 12/1	19.0 a	9.1 cd	10.6 a	12.9 a

Both in the individual years and on average for the period, the trees with Gisela 5 and Gisela 6 as interstocks had a higher 1-year shoots growth compared to those in which they were used as direct rootstocks. This is due to the strengthening influence of the stronger growing IK-M9 rootstock, compared to them. In the combinations of Weiroot 10 and F 12/1 the result was the opposite – the trees with interstock had lower growth of the shoots, compared to the trees directly grafted on them, although the differences were not always significant.

The averaged data showed that F 12/1 used as a rootstock and Gisela 5 used as an interstock on ИК-M9 rootstock induced the strongest 1-year shoots growth (22.9 cm), which did not differ significantly from that of the control, but was superior to the other variants. In the case of the dwarfing Gisela 5 rootstock, this can be explained by the reduced number of shoots per tree, and for F 12/1 with the fact that it is a branch of the strongly growing wild cherry (Mazzard). The trees with Weiroot 10 as interstock proved to have the weakest shoot growth.

The average fruit yields from the studied rootstock/interstock/scion combinations varied widely in the individual years. In the first two years, yields were unsatisfactory due to significant damages caused by late spring frosts. The largest total three-year yield was obtained from the trees grafted directly on F 12/1 and on mahaleb IK-M9, between which there was no significant difference, and these combinations have been shown to be better than the others (Table 3). The lowest yields were reported for the variants of Gisela 6 and Gisela 5 used as rootstocks. When they were used as interstocks on IK-M9 the yields were significantly higher. The differences in the cumulative yield were not statistically proven between the different variants with intermediates, but in all of them the yield was proved to be lower than that of the control.

A similar trend was observed with regard to the calculated cummulative yield efficiency (CYE) in kg/cm^2 of the trunk cross-sectional area of the scion. The highest productivity coefficient had the trees from the control variant which value differed significantly from the other combinations. The variants with interstocks on rootstock IK-M9 had a slight advantage over the variants in which they were used as rootstocks but the differences were not always significant (Table 3).

In this study, the tested rootstocks, as well as their use as interstocks in combination with the IK-M9 mahaleb rootstock, did not significantly affect on the average mass and dimentions of the fruit of Summit cherry cultivar, probably due to the relatively low yields during the studied period (Table 3).

By the end of the 13th year after planting, although there were no dead trees, in most combinations had severe damage to the stems, expressed in cracking of the bark and wood,

Table 3. Rootstock/Interstock effect on productivity and fruit size of Summit cherry trees

Rootstock/Interstock	Yield/tree, kg				CYE, kg/cm^2 TCSA	Fruit	
	2018	2019	2020	Cumulative		Mass, g	Width, mm
IK-M9/IK-M9 – (c)	6.8 bc	2.6 cde	20.1 a	29.5 a	0.17 a	9.4 a	27.1 a
IK-M9 / Gisela 5	4.6 de	2.4 de	16.7 ab	23.7 b	0.14 b	10.5 a	28.0 a
Gisela 5	0.8f	0.5 f	11.4 d	12.7 c	0.11 c	10.6 a	28.5 a
IK-M9 / Gisela 6	4.2 e	1.8 e	12.7 cd	18.7 b	0.11 c	10.4 a	28.8 a
Gisela 6	0.8 f	3.1 cd	7.3 e	11.2 c	0.09 c	10.1 a	26.6 a
IK-M9 /Weiroot 10	8.1 ab	2.4 de	12.5 cd	23.0 b	0.14 b	9.9 a	27.8 a
Weiroot 10	4.3 e	11.0 a	3.5 f	18.8 b	0.11 c	9.5 a	26.5 a
IK-M9 / F12/1	6.0 cd	3.4 c	14.2 bcd	23.6 b	0.14 b	9.8 a	27.7 a
F12/1	9.4 a	4.9 b	15.7 bc	30.0 a	0.13 b	10.4 a	27.4 a

most often in the part above the interstock. In the variant with Gisela 6 as an interstock, the percentage of the trees with damaged stems was the highest (67%), followed by those with Gisela 5 (50%) and F 12/1 (25%), and with least damaged trees were variants of Weiroot 10 and the control (20%). When Weiroot 10 was used as a rootstock, there was no damaged trees, and in the variants with Gisela 5, Gisela 6 and F 12/1 as rootstocks, the affected trees were 27, 20 and 37%, respectively. This is probably due to late incompatibility, which is expressed in the different thickening between the different components (rootstock, interstock and scion) and obstruction of the free movement of assimilates from the graft cultivar through the interstock to the rootstock, as well as nutrients from the soil to the grafted cultivar.

Conclusion

The best rootstock in this experiment turned out to be the mahaleb IK-M9, which, in addition to being the most adaptable to local conditions, showed moderate growth and dominated the other rootstocks in terms of productivity. The use of Gisela 5, Gisela 6, Weiroot 10 and F 12/1 as interstocks, in combination with IK-M9, did not lead to a significant weakening of tree growth, did not have a positive effect on the yield and fruit size of the Summit cherry cultivar, compared to the trees directly grafted on IK-M9. With the exception of Weiroot 10, the other rootstocks, including their use as. interstocks, caused significant damages to the trees trunk. All these negative characteristics make these rootstocks ineffective in combination with the Summit cultivar, iwhen grown in the specific soil and climatic conditions of the region of Kyustendil.

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