

'SUMMIT' SWEET CHERRY CULTIVAR ON DIFFERENT ROOTSTOCKS**Dimitar Sotirov**

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Corresponding author: dkstirov@yahoo.com**Abstract**

The goal of this study was to examine the effect of seven cherry rootstocks ('Gisela 5', 'Gisela 6', 'CAB 6P', 'Alkavo 2', 'F 12/1', 'MaxMa14' and 'MaxMa 60') on the growth and productivity of 'Summit' sweet cherry cultivar. The trees were planted in the spring of 2008 at distances of 4.0 x 3.0 m, shaped in freely growing crown and irrigated by spraying over the crowns. Tree vigour (trunk cross-sectional area and crown volume), yield, yield efficiency and fruit quality were recorded each year in the period 2008-2016. The results clearly showed the influence of rootstocks on the trees growth. Nine years after planting the most vigorous rootstock was 'MaxMa 60' and the weakest were 'Gisela 5' and 'Gisela 6'. The highest 4-year cumulative yield per tree was obtained with 'MaxMa 60', followed by 'CAB 6P' and 'MaxMa 14'. Rootstocks 'Gisela 5' and 'Gisela 6' negatively influenced yield and fruit size.

Key words: Canopy dimensions, yield, yield indices, fruit weight.

Introduction

Many improvements have been made in rootstocks used for sweet cherry in the second half of the 20th century. Clonal rootstocks selected from *Prunus avium*, *Prunus mahaleb* and *Prunus cerasus* as well as and from interspecific hybridizations have become increasingly popular (Hrotko, 2008; Sansavini and Lugli, 2014). The relationships between the rootstocks and grafted cultivars are important from a horticultural point of view, because they provide a basis for selecting the best scion/rootstock combination, and it is crucial for the production of cherries. Tree vigor continues to be a major concern in cherries production and may be controlled by several ways, which include use of dwarfing rootstocks. These rootstocks have a large effect on precocity and tendency of high tree productivity of sweet cherry, easier application of cultivation procedures, harvest and protection from rainfall and birds, and makes them more suited to high planting density (Grzyb et al., 1998; Bujdosó and Hrotkó, 2005; Fajt et al., 2014; Lang, 2001; Weber, 2001; Whiting et al., 2005). Few research have been done with dwarfing or semi-dwarfing clonal cherry rootstocks in Bulgaria and they are still not sufficient to be choose the best of them for cultivation of sweet cherries (Lichev, 2001; Lichev and Papachatzis, 2011; Sotirov, 2015 a,b).

The main objective of this work was to determine the impact of different rootstocks on tree growth, yield potential and fruit weight of 'Summit' sweet cherry cultivar.

Material and methods

The present study was carried out at the Institute of Agriculture in Kyustendil (Bulgaria) during the period 2008-2016 with sweet cherry cultivar 'Summit' grafted on 'Gisela 5', 'Gisela 6', 'CAB 6P', 'Alkavo 2', 'F 12/1', 'MaxMa14' and 'MaxMa 60' rootstocks. The experimental orchard was established in the spring of 2008. The trees were planted at distances of 4.0x3.0 m and grown on Chromic Luvisols soil with a light sandy loamy texture, weakly acidic (pH 5.0-5.2 in KCL). 'F 12/1' rootstock was chosen as a standard for comparison. The trees were trained in freely growing crowns. The only pruning was done after planting to cut the tree stems at a height of 80 cm and then the trees were left to freely manifest their growth and reproductive characteristics. Standard management practices (soil cultivation, weed, pest and disease control) were followed in the experimental orchard. Irrigation was applied by spraying upon the tree crowns in July and August.

Five representative trees from each cultivar-rootstock combination were selected for data collection. At the end of the growing seasons were measured and calculated the parameters: trunk cross-sectional area (TCSA) - 30 cm above the grafting zone; canopy dimensions (height, width, volume and horizontal projection area); average and cumulative yields per tree; yield indices (kg cumulative yield/cm² of TCSA), kg/m³ of canopy volume and kg/m² of the canopy horizontal area) and average fruit weight - determined on random samples of 30 fruit from each cultivar-rootstock combination. Formation of root suckers of the trees was also recorded.

Data were statistically evaluated by analysis of variance (ANOVA) and means were separated by Duncan's multiple range test at $p \leq 0.05$.

Results and discuss

The results obtained showed that rootstock affects significantly the growth of experimental sweet cherry trees concerning the trunk cross-sectional area (Table 1). 'MaxMa 60' was the most vigorous rootstock, exceeding the control 'F 12/1' by 31.6% at the end of 9th growing season. 'Gisela 6' and 'Gisela 5' were the most vigor-controlling rootstocks, reducing TCSA to 49.5 and 52.1% of 'F 12/1'. The trees on 'Alkavo 2' had about 36% less TCSA than trees on 'F 12/1' but they not differed significantly than those on 'Gisela 5' and 'Gisela 6'. 'CAB 6P' and 'MaxMa 14' were intermediate in their vigor control, reducing TCSA to 71.9 and 95.2% of 'F 12/1', respectively.

The dimensions of tree crowns are important indicators for determining the mutual influence of rootstock and scion. The results for height, width, volume and horizontal projection area of the crowns at studied scion/rootstock combinations confirmed the expressed differentiation among the rootstocks manifested in TCSA.

Table 1. Rootstock effect on trunk cross-sectional area (cm²) of 'Summit' sweet cherry trees in the period 6th-9th growing season

Rootstock	2013	2014	2015	2016	% of F 12/1
F 12/1 (c)	78.2	128.2	145.0	184.8 c	100
CAB 6P	65.0	114.0	125.4	132.9 ab	71.9
Alkavo 2	60.8	90.6	101.5	118.4 a	64.1
Gisela 5	56.3	84.1	91.6	96.2 a	52.1
Gisela 6	50.7	80.2	87.4	91.4 a	49.5
MaxMa 14	83.3	155.4	168.5	175.9 bc	95.2
MaxMa 60	110.4	179.7	206.0	243.2 d	131.6

Means followed by the same letter in columns are not significantly different at $p \leq 0.05$ (Duncan's test).

Nine years after planting, with the exception of the trees on the two 'Gisela' rootstocks, the crowns height was about 4.0 m and along with the stem the trees reached about 4.80- 5.0 m height. The width of the crowns varied from 3.0 to 4.0 m (Table 2). This led to overlapping and poor lighting of the trees at these planting distances, and necessitates limiting the size of the crowns by pruning.

Differences in the height were more pronounced than those of the crown width, but for both indicators there were significant differences between most variants. 'MaxMa 60', 'CAB 6P' and 'MaxMa 14' induced larger tree sizes and their crown volume exceeded that of 'F 12/1' with 48.8, 42.1 and 24.8%, respectively. 'Gisela 5', 'Gisela 6' and 'Alkavo' 2 had a reducing effect. On these rootstocks the crown volume was reduced by 47.1, 29.8 and 12.4%, compared to 'F 12/1'. The differences between 'F 12/1' and the other rootstocks were statistically proven. The results of the crown horizontal projection areas showed that the scion/rootstock combinations followed the trend of the crown diameter increase.

'CAB 6P' rootstock showed the highest root suckering ability - average 6.0 – 12.2 number per tree in the row lines (width 1.50 m), average for the period 6th-9th leaf. In combinations with 'F 12/1', 'MaxMa 60', 'MaxMa 14' and 'Alkavo 2', were also recorded root suckers but to a much lesser extent – 2.5-4.8 suckers per tree. No root suckers were recorded in variants with 'Gisella 5' and

'Gisella 6' rootstocks.

Table 2. Canopy dimensions of 'Summit' sweet cherry trees on different rootstocks, at the end of 9th growing season

Rootstock	Height (m)	Width (m)	Volume (m ³)	Volume (%) of F 12/1	Projection area (m ²)
F 12/1 (c)	4.0 c	3.4 b	12.1 d	100	9,1 b
CAB 6P	4.1 cd	4.0 d	17.2 f	142.1	12.6 d
Alkavo 2	4.2 de	3.1 a	10.6 c	87.6	7.5 a
Gisela 5	2.7 a	3.0 a	6.4 a	52.9	7.1 a
Gisela 6	3.0 b	3.3 b	8.5 b	70.2	8.5 b
MaxMa 14	4.0 c	3.8 c	15.1 e	124.8	11.3 c
MaxMa 60	4.3 e	4.0 d	18.0 f	148.8	12.6 d

Means followed by the same letter in columns are not significantly different at $p \leq 0.05$ (Duncan's test).

During the studied period, the rootstocks had a tremendous effect on trees productivity, and most of the differences between the different variants were very well expressed and statistically proven (Table 3). Good yields were recorded only in the 8th year (2015), and in the remaining years they were severely reduced as a result of late spring frosts. With higher productivity in the individual years and total for the period stand out the trees grafted on 'MaxMa 60', 'CAB 6P' and 'MaxMa 14'. On these rootstocks, the cumulative yield was between 20 and 30% higher than that of 'F 12/1'. Good cumulative yield was also recorded on 'Alkavo 2', which was only 5% lower and does not differ significantly from that of F 12/1. The least productive were the trees on about Gisela rootstocks. Cumulative yields on 'Gisela 5' and 'Gisela 6' were around 62 and 73% than that of 'F 12/1'.

Table 3. Rootstock effect on average and cumulative yield, and fruit weight of 'Summit' sweet cherry trees in the period 6th-9th growing season

Rootstock	Yield (kg/tree)					Fruit weight (g)				
	2013	2014	2015	2016	Cumulative	2013	2014	2015	2016	Average
F 12/1	4,0cd	9,7bc	36,3ab	3,7c	53,7bc	10,5	9,7	7,9	9,7	9,5a
CAB 6P	8,0e	16,3e	40,3b	1,9b	66,5d	7,3	7,5	7,1	10,1	8,0a
Alkavo 2	1,9b	12,1cd	36,1ab	1,0ab	51,1b	10,2	12,2	6,8	10,5	9,9b
Gisela 5	0,2a	3,8a	28,5a	0,6a	33,1a	12,1	7,7	5,7	9,9	8,9a
Gisela 6	2,8bc	8,5b	26,8a	1,1ab	39,2a	10,2	8,1	5,6	7,8	7,9a
MaxMa14	5,0d	14,8de	42,9b	1,6ab	64,3cd	8,8	9,0	6,5	11,1	8,9a
MaxMa60	5,5d	9,8bc	50,5b	4,0c	69,8d	8,9	8,7	8,4	10,8	9,2a

The correlations between the yield and the trunk-cross sectional area (Figure 1) and the yield and canopy volume (Figure 2) showed a direct link between these components and give some advantage to the more vigorous rootstocks. These results confirm other our studies, in which also was found that the yield from more vigorous cultivar/rootstock combinations was higher than the lesser ones (Sotirov, 2015 a,b) and differed from the opinion of other authors who established that trees on 'Gisela 6' and 'Gisela 5' were more productive than vigorous Mazzard (Whiting et al., 2005).

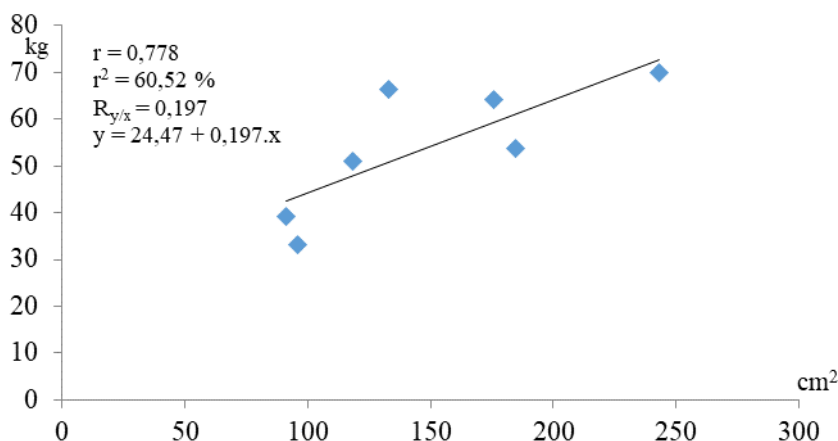


Figure 1. Correlation between the trunk-cross sectional area (cm²) and the yield (kg/tree) of 'Summit' sweet cherry trees on different rootstocks

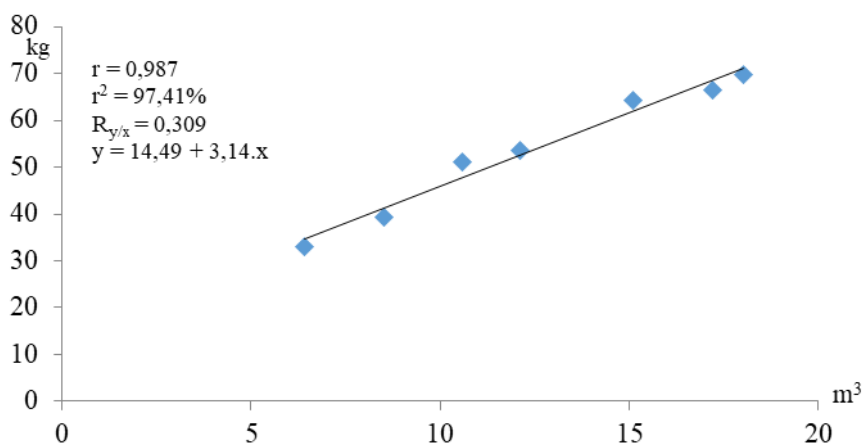


Figure 2. Correlation between the canopy volume (m³) and the yield (kg/tree) of 'Summit' sweet cherry trees on different rootstocks

The highest cumulative yield efficiency was calculated for trees on 'CAB 6P' (0.50 kg/cm²) and the lowest on 'F 12/1' and 'MaxMa 60' (0.29 kg/cm²). On the remaining rootstocks was achieved medium yield efficiency (0.34-0.43 kg/cm²) and the differences among them were not significant (Table 4). 'Gisela 5' had the highest cumulative yield per unit crown volume due primarily to its weaker vigour. The lowest were the values for 'CAB 6P' and 'MaxMa 60', but the differences between the different variants were not significant. The best result in regard to yield per unit canopy horizontal projection area was obtained for 'Alkavo 2'. 'Gisela 5' and 'Gisela 6' exhibited the lowest values of this parameter. Trees on the other rootstocks also had a good specific yield.

The average fruit weight varied considerably over the years, with some differences between the rootstocks, but there was no one-sidedness of the results (Table 3). In the first and last years, the fruit weight was the greatest, because of the lowest yields, which is logical. During the year with a normal yield (2015), the weight of the fruits was higher on 'MaxMa 60', 'F12/1' and 'CAB 6P'. On these three rootstocks there was a tendency to keep their fruit weight relatively constant at a substantial variation in the yields. At the same time, 'Gisela 5' and 'Gisela 6' showed a tendency to reduce the fruit weight when the trees were overloaded. The decrease in the fruit weight under their influence in 2015 is about ½ compared to 2013. On average, for the period of the study, the fruit of the trees on 'Alkavo 2' were proven to be larger, while the differences between the other rootstocks were not significant.

Table 4. Yield indices of ‘Summit’ sweet cherry trees on different rootstocks, at the end of 9th growing season

Rootstock	Cumulative yield per:		
	TCSA (kg/cm ²)	canopy volume (kg/m ³)	canopy area (kg/m ²)
F 12/1 (c)	0,29 a	4,44 a	5,90 ab
CAB 6P	0,50 b	3,87 a	5,28 ab
Alkavo 2	0,43 ab	4,82 a	6,81 b
Gisela 5	0,34 ab	5,17 a	4,66 a
Gisela 6	0,43 ab	4,61 a	4,61 a
MaxMa 14	0,37 ab	4,26 a	5,69 ab
MaxMa 60	0,29 a	3,88 a	5,54 ab

Conclusions

The results of this study showed that the rootstock has a significant impact on the growth and productive manifestations of ‘Summit’ sweet cherry cultivar. According to trunk-cross sectional area and the canopy volume, ‘MaxMa 60’, ‘MaxMa 14’ and ‘CAB 6P’ were the most vigorous, and ‘Gisela 5’ and ‘Gisela 6’ - the most dwarfing rootstocks. Higher yields were obtained from the trees on more vigorous rootstocks, as confirmed by the high correlation coefficients - $r = 0.778$ between the yield and the trunk-cross sectional area and $r = 0.987$ between the yield and the canopy volume. The highest cumulative yield efficiency (kg/cm² of TCSA) had the trees on ‘CAB 6P’ and the lowest on ‘F 12/1’ and ‘MaxMa 60’. The highest yield per 1 m³ of the crown volume was calculated for ‘Gisela 5’ due to its smallest volume. The trees of ‘Alkavo 2’ had the highest yield per 1 m² of the crown projection area. The differences on these three yield indices were insignificant between the other rootstocks.

Except for ‘Alkavo 2’, no significant differences were found in average fruit weight between the tested rootstocks, although in years of higher load, ‘Gisela 5’ and ‘Gisela 6’ lead to a reduction in the fruit weight, probably due to a disturbed balance between the leaf area and the yield. The results of this study are not yet sufficient to conclude which of these rootstocks is the best suited for Summit sweet cherry cultivar for the specific conditions of the experiment, so the researches should continue.

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