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THE EFFECT OF THE ROOTSTOCK ON GROWTH, YIELDING AND FRUIT QUALITY OF THREE CULTIVARS OF SOUR CHERRY CULTIVATED IN THE WARMIA REGION

Jan Kopytowski and Bogumił Markuszewski

University of Warmia and Mazury in Olsztyn, Department of Horticulture
Prawocheńskiego 21, 10-957 Olsztyn, POLAND
e-mail: jan.kopytowski@uwm.edu.pl, bogumil.markuszewski@uwm.edu.pl

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A B S T R A C T

The experiment was conducted in 2006-2008 in the Didactic and Experimental Garden of the University of Warmia and Mazury in Olsztyn, Poland. The research materials were sour cherry trees of the 'Kelleris 16', 'Újfehértói Fürtös' and 'English Morello' cultivars, grafted on rootstock of Mahaleb seedling, Mazzard seedling and F12/1. The 'English Morello' cultivar grafted on the rootstock of Mahaleb seedling demonstrated the highest productivity. The same cultivar grafted on the rootstock of Mazzard seedling and F12/1, along with the 'Újfehértói Fürtös' cultivar on Mahaleb seedling and Mazzard seedling, had the lowest productivity. The largest sour cherry fruits were recorded for the 'Újfehértói Fürtös' cultivar. From all the cultivars examined, Mazzard seedling rootstock resulted in the largest fruit weight. A fruit quality evaluation based on their chemical composition revealed the highest content of ascorbic acid in fruits of the 'English Morello' grafted on F12/1, and the lowest value was recorded for the 'Újfehértói Fürtös' on Mahaleb seedling. The highest sugar content was found in fruits of the 'Újfehértói Fürtös'. Mahaleb seedling in all cultivars under examination had a favourable effect on sugar accumulation in fruits. Fruits of the 'Újfehértói Fürtös' cultivar grafted on the Mahaleb seedling contained the highest amount of organic acids, while 'Kelleris 16' on the same rootstock and 'English Morello' on F12/1 had the lowest.

Key words: sour cherry, cultivated variety, rootstock, growth, yield, fruit quality

INTRODUCTION

The cultivar is one of the factors affecting good, productive fruit-growing results. In the case of sour cherry trees, a basic cultivar used in industrial production in Poland is 'English Morello'. Other valuable cultivars include 'Nefris', 'North Star' and 'Kelleris 16' (Mika, 2006). Studies conducted by various authors have shown that both growth and yielding of sour cherry trees depend, to a large extent, on the choice of cultivars (Ostrowski et al., 1987; Ugolik and Hołubowicz, 1990; Świerczyński and Maćkowiak, 2000). Production features of sour cherry cultivars can be improved by using an appropriate rootstock which, to various degrees, can affect the growth and yielding of trees. The research conducted by Tylus et al. (1986) demonstrated that trees grafted on Mazzard seedling produced higher yields than those on Mahaleb seedling. According to Grzyb et al. (1997), sour cherries grafted on Mahaleb seedling grow less vigorously and are more fruitful than those on Mazzard seedling. A greater vigour of sour cherry cultivars grafted on Mazzard seedling, in comparison to Mahaleb seedling, was reported by Zalewski (1984). Grzyb et al. (1997) showed that sour cherries on F12/1 produced much lower yield than fruit trees on Mazzard seedling, while Tylus et al. (1986) claimed that F12/1 rootstock is conductive to good growth, fruit yield and reduction of dying out in the case of 'English Morello'.

The quality of sour cherry fruit, just like the growth of trees or yielding, can also depend on the choice of the cultivar, which has been confirmed by the research conducted by numerous authors. Rozpara et al. (1996) and Grzyb et al. (1997) demonstrated that fruits produced by 'English Morello' were larger than fruits of the 'Kelleris 16' cultivar. According to Żuraw et al. (2004), the cultivars 'English Morello' and 'Újfehértói Fürtös' had fruits of a similar size, although the authors found some differences in the extract content between the fruits, with the highest value for 'Újfehértói Fürtös'. The content of chemical compounds, such as dry matter, saccharides, organic acids, ascorbic acid and anthocyans in fruit depend, to a large extent, on the cultivar (Lenartowicz et al., 1985; Kmiecik et al. 1986). As regards seedling rootstocks for sour cherries, an additional factor affecting the fruit quality is the diverse origin of Mahaleb and Mazzard seedlings. Research carried out by Tylus et al. (1986) confirmed that the weight of the fruits produced by the 'English Morello' sour cherry cultivar differed depending on the origin of seedlings, and the largest fruits were obtained on trees grafted on Mazzard seedlings. Similar results were obtained by Grzyb et al. (1997) for 'English Morello', 'Northstar' and 'Kelleris 16'.

The aim of the experiment was to evaluate the growth and yielding of trees, as well as fruit quality of three cultivars of sour cherry, grafted on various rootstocks in the conditions prevailing in the Warmia region.

MATERIAL AND METHODS

The experiment was conducted in 2006-2008 in the Didactic and Experimental Garden of the University of Warmia and Mazury in Olsztyn, Poland. The research materials comprised sour cherry trees of 'Kelleris 16', 'Újfehértói Fürtös' and 'English Morello' cultivars, grafted on rootstock of Mahaleb seedling, Mazzard seedling, and F12/1. Trees were planted in the spring of 2004, in 3.8 x 1.5 m spacing, run at the wire net. The soil of the experiment was class IVb cropland. Interrows were covered with grass and pine bark mulch applied along the rows of trees. During ripening the sour cherry tree fruits were not protected against birds, which resulted in lower final yields.

The following tests were carried out each year: assessment of tree yielding, determination of the weight, height, width and thickness of fruits, content of organic compounds and trunk growth. Morphological traits were estimated on the basis of a sample of 100 fruits for replications. Tree trunk measurements were used as the basis to calculate the value of trunk cross-sectional area (TCSA), which was assumed as the feature representing the tree vigour. The yield of fruit harvested from the plot was converted into yield in kg per tree^{-1}. On the basis of the TCSA value and total yield, the productivity index of trees was calculated and expressed in kg·cm^{-2}. The following values were determined for fruits: dry matter content at 105 °C, total saccharides and monosaccharides – with the use of the Luff-Schoorl method, organic acids – according to Petersburski, expressed as malic acid equivalents, and ascorbic acid – using the Tillmans method with Pijanowski's modification. The laboratory sample used for analysing the chemical composition of the fruits of each combination was 0.5 kg.

The experiment was planned in a split-plot arrangement in seven replications, with two trees on each plot. Cultivar combinations were arranged on large plots, with allocation of rootstock variants. The results were statistically analysed using variation analysis according to the arrangement of the experiment. The differences between means were assessed by applying, *inter alia*, the Tukey's t-test at $p \leq 0.01$ for chemical analyses concerning the content of organic compounds and $p \leq 0.05$ for other features.

RESULTS AND DISCUSSION

Tree vigour and yielding, as well as the productivity index, depended on the sour cherry cultivar and the rootstock used (Tab. 1). The values of those features were strongly modified by the type of rootstock. The highest vigour rate was found for the cultivar 'Újfehértói Fürtös' (TCSA 16.2-21.9 cm^{-2}), which – with an average yield, as compared to other cultivars – demonstrated the lowest productivity factor (0.06-0.08 kg·cm^{-2}). The 'English Morello', with the lowest vigour rate on the rootstock of Mahaleb seedling (TCSA 11.6 cm^{-2}), bore highest fruit yield (6.9 kg·tree^{-1})

Table 1. Trunk cross-sectional area (TCSA) and cumulative yield of five-year-old sour cherry trees grafted on three rootstocks

Cultivar	Rootstock	TCSA 2006-2008 [cm^{-2}]	Cumulative yield 2006-2008 [$kg \cdot drzewo^{-1}$]	Productivity index 2006-2008 [$kg \cdot cm^{-2}$]
Kelleris 16	Mahaleb seedling	13.3 bc*	3.3 bc	0.08 bc
	Mazzard seedling	11.9 c	2.5 c	0.08 bc
	F12/1	12.2 c	3.5 bc	0.12 b
Újfehértói Fürtös	Mahaleb seedling	21.9 a	3.7 bc	0.07 c
	Mazzard seedling	16.2 abc	3.1 bc	0.06 c
	F12/1	19.7 a	4.4 b	0.08 bc
English Morello	Mahaleb seedling	11.6 c	6.9 a	0.21 a
	Mazzard seedling	17.3 abc	2.7 c	0.06 c
	F12/1	18.5 ab	2.6 c	0.07 c

*Means followed by the same letter do not differ at $p \leq 0.05$

Table 2. Biometric features of fruit of sour cherry grafted on three rootstocks in 2006-2008

Cultivar	Rootstock	Fruit weight [g]	Fruit height [cm]	Fruit width [cm]	Fruit thickness [cm]
Kelleris 16	Mahaleb seedling	3.9 e	1.70 cd	1.90 cd	1.68 d
	Mazzard seedling	4.2 cd	1.73 bc	1.91 c	1.71 cd
	F12/1	3.8 e	1.70 cd	1.84 de	1.67 d
Újfehértói Fürtös	Mahaleb seedling	4.3 bc	1.63 e	1.93 bc	1.70 d
	Mazzard seedling	4.6 a	1.78 ab	2.00 a	1.78 b
	F12/1	4.4 ab	1.69 cd	1.96 abc	1.76 bc
English Morello	Mahaleb seedling	4.0 de	1.67 de	1.82 e	1.69 d
	Mazzard seedling	4.5 ab	1.83 a	1.99 ab	1.86 a
	F12/1	4.1 d	1.68 cde	1.79 e	1.68 d

*Explanation, see Table 1

and demonstrated the highest productivity index (0.21 $kg \cdot cm^{-2}$). The high production values of the 'English Morello' grafted on the Mahaleb seedling was confirmed by Rozpara et al. (1996) and Wociór (2008). According to Tylus et al. (1986), Mazzard seedling and F12/1, resulted in higher yield of trees and productivity index compared to trees on Mahaleb seedling. These high results prove the higher productive suitability of Mazzard seedling and F12/1, for the 'English Morello'. A similar relationship between Mazzard seedling and Mahaleb seedling was reported by Ugolik and Kantorowicz-Bąk (1992).

Sour cherry fruit quality expressed by the weight of the fruit and fruit parameters depended on the cultivar and the rootstock (Tab. 2).

Table 3. The chemical composition of sour cherry fruit grafted on three rootstocks in 2006-2008

Cultivar	Rootstock	Dry matter [%]	Ascorbic acid [mg%]	Total sugars [%]	Simple sugars [%]	Organic acid [%]
Kelleris 16	Mahaleb seedling	11.53 b*	6.0 c	6.5 bc	4.6 abc	1.04 d
	Mazzard seedling	11.71 b	5.9 c	6.3 bcd	4.2 bcd	1.13 cd
	F12/1	11.57 b	6.0 c	6.2 bcd	4.8 ab	1.24 bc
Újfehértói Fürtös	Mahaleb seedling	12.57 b	5.3 d	7.6 a	5.1 a	1.58 a
	Mazzard seedling	16.45 a	5.8 c	5.7 cd	4.2 bcd	1.34 b
	F12/1	14.52 ab	6.2 bc	6.1 bcd	4.6 abc	1.24 bc
English Morello	Mahaleb seedling	14.26 ab	6.7 b	6.7 b	3.9 d	1.25 bc
	Mazzard seedling	14.38 ab	6.5 b	5.4 d	3.7 d	1.26 bc
	F12/1	13.25 ab	7.3 a	6.3 bcd	4.0 cd	0.99 d

*Means followed by the same letter do not differ at $p \leq 0.01$

The largest fruits were recorded for 'Újfehértói Fürtös', and the lowest were for 'Kelleris 16'. 'English Morello' fruits were of average size. Similar results as regards the difference between the size of fruits produced by 'English Morello' and 'Kelleris 16', improved on Mahaleb seedling, were obtained by Rozpara et al. (1996). For all cultivars under examination, Mazzard seedling in the described experiment resulted in the highest weight of the fruit, while the Mahaleb seedling had the lowest. Ugolik and Kantorowicz-Bąk (1992) obtained similar results when comparing 'Újfehértói Fürtös' and 'English Morello' grafted on the same rootstock. According to Wociór et al. (2008), the weight of fruit obtained from trees on the rootstock of Mahaleb and Mazzard seedlings for 'English Morello' was similar.

The chemical composition of sour cherry fruit revealed significant differences for individual cultivars and rootstock used for them (Tab. 3). The highest value of dry matter content in sour cherry fruit was found for the 'Újfehértói Fürtös' grafted on the Mazzard seedling rootstock. The lowest value of this component was recorded for 'Kelleris 16' fruit from trees grafted on all rootstocks. Fruits of 'English Morello' demonstrated average dry matter content, without any significant differences between various rootstocks. 'English Morello' fruits contained the highest amount of ascorbic acid, while F12/1 rootstock facilitated the highest accumulation of this component in fruit. The lowest content of ascorbic acid was found for 'Újfehértói Fürtös' grafted on the Mazzard seedling, and for 'Kelleris 16' on all rootstocks. The obtained results confirm the view of Bugarčič and Janda (1967) that late cultivars contain more ascorbic acid in fruits than early cultivars. The highest content of saccharides was found in fruits of the 'Újfehértói Fürtös' grafted on the Mahaleb seedling (7.6%). The other cultivars also had a higher content of this component in fruits from trees grafted on the same

rootstock. Milutinovic et al. (2008), while examining the effect of various rootstocks on fruit quality of 'Oblacinska', also revealed the highest sugar content in fruits produced by trees on the Mahaleb seedling. The lowest sugar content was recorded in fruits of 'English Morello' grafted on Mazzard seedling. Fruits of 'Újfehértói Fürtös' contained more organic acids, while Mahaleb seedling to the largest extent favoured accumulation of this component in this cultivar. The lowest content of acids was recorded in fruits of 'English Morello' grafted on F12/1, and of 'Kelleris 16' grafted on Mahaleb seedling. The research conducted by Kmiecik et al. (1986) demonstrated that the chemical composition of sour cherry fruits depends on the cultivar. By comparing the content of chemical compounds in fruits of various cultivars, the authors demonstrated that 'English Morello' contained the lowest amount of sugars in comparison to 'Kerezer', 'Nefris' and 'North Star'. As regards ascorbic acid and organic acids, their content in 'English Morello' fruit was similar to the values established for 'Nefris' and 'North Star' and higher than those of 'Kerezer'. The highest content of all the components mentioned above was recorded for fruits produced by the local cultivar 'Żmiąca'.

CONCLUSIONS

1. The highest productive value under the Warmia conditions has 'English Morello' sour cherry cultivar grafted on Mahaleb seedling rootstock. The 'Újfehértói Fürtös' grafted on each type of rootstocks applied, along with 'English Morello' on Mazzard seedling and F12/1, had the lowest productivity index.
2. 'Újfehértói Fürtös' produced the largest fruits and 'Kelleris 16' produced the smallest. The rootstock of Mazzard seedling for all cultivars under examination resulted in increased fruit weight.
3. Fruits of the 'Újfehértói Fürtös' cultivar grafted on the Mahaleb seedling contained the largest amount of saccharides and organic acids, and the lowest amount of ascorbic acid. 'English Morello' grafted on F12/1 revealed the highest content of ascorbic acid in its fruits. This cultivar, in combination with F12/1 rootstock, and 'Kelleris 16' grafted on the Mahaleb seedling contained the lowest amount of organic acids in their fruits.

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WPŁYW PODKŁADKI NA WZROST I PLONOWANIE DRZEW ORAZ JAKOŚĆ OWOCÓW TRZECH ODMIAN WIŚNI UPRAWIANYCH W WARUNKACH WARMII

Jan Kopytowski i Bogumił Markuszewski

S T R E S Z C Z E N I E

Doświadczenie przeprowadzono w latach 2006-2008 w Ogrodzie Dydaktyczno-Doświadczalnym Uniwersytetu Warmińsko-Mazurskiego w Olsztynie. Materiałem badawczym były drzewa trzech odmian wiśni: 'Kelleris 16', 'Groniasta z Ujfehertoi' i 'Łutówka' szczepione na podkładkach: antypki, czereśni ptasiej oraz F12/1. Drzewa 'Łutówki' szczepione na siewkach antypki miały najwyższy współczynnik plenności, a na podkładkach czereśni ptasiej i F12/1, podobnie jak 'Groniastej z Ujferhertoi' szczepionej na siewkach antypki i czereśni ptasiej miały najniższy współczynnik plenności. Największe wiśnie uzyskano u odmiany 'Groniasta z Ujferhertoi'. Siewka czereśni ptasiej u wszystkich badanych odmian wiśni wpływała na najwyższą masę owoców. Ocena jakości owoców wyrażona składem chemicznym wykazała najwyższą zawartość witaminy C w owocach odmiany 'Łutówka' szczepionej na podkładce F12/1, a najmniejszą u odmiany 'Groniasta z Ujferhertoi' szczepionej na siewkach antypki. Najwyższą zawartość cukrów odnotowano w owocach odmiany 'Groniasta z Ujferhertoi'. Siewki antypki u wszystkich badanych odmian sprzyjały gromadzeniu w owocach cukrów. W owocach odmiany 'Groniasta z Ujferhertoi' szczepionej na siewkach antypki było najwięcej kwasów organicznych, a najmniej u odmian 'Kelleris 16' na tej samej podkładce i 'Łutówka' szczepionej na podkładce F12/1.

Słowa kluczowe: wiśnia, odmiana, podkładka, wzrost, plonowanie, jakość owoców