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EVALUATION OF SWEET AND SOUR CHERRY CULTIVARS ON GERMAN DWARFING ROOTSTOCKS IN HUNGARY

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A B S T R A C T

At the experimental farm of the Research Institute for Fruitgrowing and Ornamentals a trial was planted in 1997 with the aim to investigate foreign bred cherry rootstocks for adaptability to pedoclimatic condinations of Hungary and to study their effect on scion varieties.

The trial plot helds 6 German bred dwarfing rootstocks (Weiroot-13, Weiroot-53, Weiroot-72, Weiroot-154, Weiroot-158, GiSelA-5) and as a control the mahaleb stock ’Cema’ (syn. C.500) wide spread in Hungary. The scion varieties are three sweet cherries (’Germersdorfi-3’, ’Linda’, ’Katalin’) and a sour cherry selection (IV-2/152 ’Piramis’).

Previous investigations showed that in Hungary in intensive cherry orchards the moderately vigorous rootstocks (not more that 30 to 40% dwarfing effect compared to ’Cema’) gave the best yields and fruit quality. Hungary’s some dryer climate than Western-Europe and the rather calcareous soils should also been taken into consideration when choosing dwarfing rootstocks.

The highest cumulative yield efficiency was produced on GiSelA-5 but trees on this rootstock showed some negative features (early blooming time, tendency to overloading and barewood formation) which might be caused by site and our pedoclimatic conditions. According to some disadvantages the use of this rootstock is hazardous in Hungary.

In this regard Weiroot-158 gave the best results among the stocks producing healthy trees. This one effected 15 to 45% dwarfing compared to the trees budded onto ’Cema’. The early years’ yields were on Weiroot-158 1.2 to 6 times higher

depending on the scion/stock combination. The fruit diameter was also some larger. The cumulative yield efficiency index was 0.03 to 0.23 kg/cm^2 in each Weiroot-158/scion combination, which is also 2 to 5 times higher than the control combinations.

Our results also confirm that cherry rootstock selection for growers depends on site and cultivars. As there is a great number of novel dwarfing cherry rootstock series on market so it is of highest importance to get information of the interactions between rootstock and scion on each growing region and site.

Key words: sweet and sour cherry, dwarfing rootstocks, yield, fruit diameter, cumulated yield efficiency index

INTRODUCTION

Nowadays, Hungarian fruit growers prefer to plant intensive orchards of dwarf cherry and other fruit species. Dwarf trees have many advantages. Pathogen and pest control in intensive orchards is easier, more effective, and less harmful to the environment because the trees that need to be treated are smaller than traditional trees. Dwarfing is accomplished by grafting on dwarfing rootstocks.

The Research Institute for Fruitgrowing and Ornamentals is screening foreign-bred dwarfing rootstocks for its new sweet cherry cultivars and hybrids. The rootstocks should grow well in the local climate and ensure high yields of high-quality fruit. They should also be lime-tolerant and drought-resistant, since Hungarian soils are calcareous and the weather is drier than in Western Europe. Root-scion interactions are also important.

MATERIAL AND METHODS

Starting in 1997, at the Experimental Farm of the Research Institute for Fruitgrowing and Ornamentals, a trail was carried out with a Hungarian Mazzard seedling rootstock (*Cerasus avium* ‘C. 2493’), and six German dwarfing rootstocks (Weiroot-13, Weiroot-158, Weiroot-154, Weiroot-72, Weiroot-53, and GiSelA-5). ‘Cema’, the Mahaleb rootstock used in 70% of Hungarian sweet cherry orchards, served as the control. Three sweet cherry cultivars (‘Germersdorfi-3’, ‘Linda’, and ‘Katalin’) and one sour cherry hybrid (IV-2/152 ‘Piramis’) were grafted on the rootstocks tested.

Weiroot-13, Mazzard seedling, and ‘Cema’ rootstocks were planted 6 x 6 m apart, and all other rootstocks 3 x 5 m apart. Each trial block consisted of three trees of each rootstock-cultivar combination, with two replicates. Trees were trained as slender spindles with a central leader. Pruning was carried out in the winter until 2001, and in the summer after then.

The trial site receives 1950 hours of sunshine a year. Mean annual temperature is 10°C. During the growing season, average temperature is 16.8°C. Annual precipitation is between 550 and 700 mm. The soil is a pseudomyceliar calcareous chernozem soil (pH 8,5%, $CaCO_3$, 2.3-2.5% humus) (Ambrózy and Kozma, 1990; Szűcs, 2001).

Growth was measured as trunk diameter 20 cm above the graft. Fruit diameter was recorded as the average diameter of sixty random fruits per rootstock-cultivar combination. The effect of rootstock on cultivar productivity is expressed as the cumulative yield efficiency index, which is the ratio of combined yields for 2001, 1002 and 2003 to the trunk cross sectional area in 2002.

Crown diameter and tree height were measured when the trees had reached their final size at the seventh leaf stage. Optimal spacing between trees in a row is equal to the crown diameter. Optimal spacing between rows is determined by the following formula: 2(H-1), where H equals final tree height (Winter, 1986; Hrotkó, 2002).

Data were analyzed using Statgrafics 5.1 (ANOVA, regression analysis, analysis of variance, and multifactor of variance).

RESULTS

Trunk cross-sectional areas of the rootstock-cultivar combinations are presented in Table 1.

Of the rootstocks tested, Weiroot-158 (15-45% dwarfing compared to ‘Cema’) proved to be the best for sustainable fruit production in Hungary’s climate. Cultivars grafted on Weiroot-158 are drought tolerant and regenerate well after summer pruning.

Table 1. Trunk cross-sectional area of rootstock-cultivar combinations Érd-Elvira major, 2003

Rootstock	Trunk cross-sectional area [cm^2]			
	Germersdorfi-3	Linda	Katalin	IV-2/152 Piramis
Cema	93.2 c	122.2 g	83.4 c	84.0 d
Mazzard seedling	93.3 c	115.1 fg	71.1 b	65.4 d
Weiroot-13	94.3 c	108.4 ef	93.3 c	49.3 c
Weiroot-158	81.0 bc	79.7 bcd	60.4 a	46.3 c
Weiroot-154	64.9 ab	76.5 cde	58.1 a	35.1 b
Weiroot-72	50.2 a	68.1 abc	49.2 a	-
Weiroot-53	57.2 a	59.1 ab	46.9 a	43.3 abc
GiSelA-5	53.5 a	53.7 a	53.8 a	24.1 a

The Mazzard seedling rootstocks (0-15% dwarfing), and Weiroot-13 (0-12% dwarfing) are too vigorous. When ‘Germersdorfi-3’ was grafted on Mazzard seedling rootstock, and when ‘Katalin’ was grafted on Weiroot-13, the trunk cross-sectional areas were higher than if the cultivars had been grafted on ‘Cema’. his may have been because these combinations had poor yields, so that more energy was diverted to tree growth.

Weiroot-72 (42-47% dwarfing), Weiroot-53 (39-52% dwarfing), and GiSelA-5 (36-57% dwarfing) rootstocks induced too much dwarfing. They also had shallow root systems, which reduced drought tolerance. The shallow root systems also make the trees susceptible to uprooting in high winds. In this trial, some trees grafted on Weiroot-53 were uprooted. Trees grafted on GiSelA-5 blossomed too early, tended to be overloaded, and formed barewood. These results agree well with earlier studies (Treutter et al., 1993; Franken-Bembenek, 1995; Stehr, 1996; 2003; Blazkova and Hlusickova, 2001; Lichev, 2001).

The dwarfing effect of the rootstocks on sweet and sour cherry cultivars varied. This is the ranking of the rootstocks from most vigorous to most dwarfing: ‘Cema’, Mazzard seedling, Weiroot-13, Weiroot-158, Weiroot-154, Weiroot-72, Weiroot-53, and GiSelA-5.

The sour cherry hybrid IV-2/152 ‘Piramis’ grew well only on ‘Cema’ and Weiroot-13. On other rootstocks, the trunk cross-sectional area was too small. Other rootstocks were too dwarfing with IV-2/152 ‘Piramis’, for example, Weiroot-158 (45%), Weiroot-154 (59%), Weiroot-53 (49%) and GiSelA-5 (72%).

In our trial, trees still had not filled the space allotted to them even when they had reached their final size at the seventh leaf stage. Table 2 shows actual tree densities in our trial and optimal tree densities calculated for high intensity cultivation. Table 3 shows actual cumulated yields in our trial and yield recalculated for the optimal tree densities from Table 2.

Table 2. Actual and optimal tree densities [trees/ha] according to proposed spacing model, Érd. Elvira major, 2003

Rootstock	Germersdorfi- 3		Linda		Katalin		IV-2/152 Piramis	
	actual density	optimal density	actual density	optimal density	actual density	optimal density	actual density	optimal density
Cema	277	427	277	252	277	565	277	457
Mazzard seedling	277	420	277	312	277	416	277	549
Weiroot-13	277	480	277	496	277	352	277	651
Weiroot-158	555	769	555	561	555	465	555	776
Weiroot-154	555	651	555	488	555	617	555	766
Weiroot-72	555	1033	555	694	555	771	-	-
Weiroot-53	555	801	555	637	555	476	555	771
GiSelA-5	555	905	555	771	555	685	555	1035

Of the sweet cherry cultivars tested, ‘Linda’ produced the biggest cumulative yield on all rootstocks, fillowed by ‘Katalin’ and ‘Germersdorfi-3’. Yields were highest on GiSelA-5, followed by Weiroot-158. When grafted on GiSelA-5, cultivars yielded 125% to 400% of what they yielded when they were grafted on ‘Cema’. When grafted on Weiroot-158, they yielded 64% to 500% of what they yielded when they were grafted on ‘Cema’. The reason for this is that ‘Katalin’ bears earlier on dwarfing rootstocks than on ‘Cema’. The sour cherry hybrid IV-2/152 ‘Piramis’ yielded the same on Weiroot-13 than on ‘Cema’, 20% more on Weiroot-158, and 60% less on GiSelA-5. IV-2/152 ‘Piramis’ yielded very poorly on dwarfing rootstocks, which important to when considering the use of dwarfing rootstocks in intensive sour cherry cultivation.

Table 3. Actual and optimal cumulative yields [t/ha] according to proposed spacing model, Érd. Elvira major, 2001-2003

Rootstock	Germersdorf- 3		Linda		Katalin		IV-2/152 Piramis	
	actual yield	optimal yield	actual yield	optimal yield	actual yield	optimal yield	actual yield)	optimal yield
Cema	0.3	0.5	0.5	0.4	0.5	1.0	0.4	0.7
Mazzard seedling	0.3	0.5	0.8	0.8	1.3	2.0	0.3	0.5
Weiroot-13	0.8	1.4	6.0	10.9	2.8	3.5	0.4	1.0
Weirot-158	1.7	2.3	10.7	10.8	4.0	5.0	1.0	1.4
Weiroot-154	1.8	2.2	6.7	5.9	4.2	4.6	0.8	1.2
Weiroot-72	0.8	1.6	5.2	6.5	4.3	6.0	-	-
Weiroot-53	1.0	1.4	5.5	6.3	4.0	3.4	0.5	0.7
GiSelA-5	1.5	2.4	13.2	18.3	5.0	6.2	0.3	0.6

When cumulative yields are recalculated for the optimal tree densities from Table 3, the differences in potential yield are even greater. There were enormous differences in potential yield between the different rootstock-cultivar combinations.

The effect of the rootstocks on fruit quality was estimated by fruit diameter. Of the sweet cherry cultivars tested, ‘Germersdorfi-3’ produced the largest fruits, but had the lowest yield. Fruits of ‘Linda’ and ‘Katalin’ were generally about 24 mm. When ‘Linda’ was grafted on GiSelA-5, fruit diameter was rather small because of the unfavorable leaf-fruit ratio. Fruits of the sour cherry hybrid IV-2/152 ‘Piramis’ were generally about 22.5 mm in diameter (Figures 1, 2, 3 and 4).

Fruits of cultivars grafted on Weiroot-72 were the largest, with 28% of the fruits measuring 26 mm or more. With ‘Cema’, 5% of the fruits measured 26 mm or more. With GiSelA-5, 3.5 % measured 26 mm or more. With Weiroot-158, 6.5% measured 26 mm or more. Fruit size was smallest with GiSelA-5, mainly because this rootstock is not adapted to Hungarian soil and climate conditions. The relative frequency of fruit sizes of ‘Linda’ on the different rootstocks is presented in Table 4. The significance of the effect of yield on fruit size has to be taken into consideration.

The effect of rootstock on yield was estimated by the cumulated yield efficiency index, which is the ratio of combined yields for 2001, 1002 and 2003 to the trunk cross sectional area in 2002 (Stehr, 1996; 2003; Vogel, 1995). Based on the cumulated yield efficiency index, cultivars grafted on GiSelA-5 and Weiroot-158 performed the best (Figures 5, 6, 7 and 8). When cultivars were grafted on GiSelA-5, their cumulated yield efficiency indices were eight times higher than when they were grafted on ‘Cema’. When grafted on Weiroot-158, their cumulated yield efficiency indices were two to five times higher.

DISCUSSION

In intensive fruit production, not only the scion cultivars but also the rootstocks should be chosen carefully. In the rootstock trial at the Research Institute for Fruitgrowing and Ornamentals, six German dwarfing rootstocks (Weiroot-13, Weiroot-158, Weiroot-154, Weiroot-72, Weiroot-53, and GiSelA-5) were evaluated for their ability healthy trees in Hungarian soil and climate conditions. Weiroot-158 performed the best. Weiroot-158 is 15% to 45% dwarfing when compared to ‘Cema’. Cumulative three-year yields were 1.2 to 6 times higher than other rootstock-cultivar combinations. Fruit diameters were also generally larger. When cultivars were grafted on Weiroot-158, their cumulative yield efficiency indices ranged from 0.03 to 0.23 kg/cm^2, which is two to five times higher than when the were grafted on Cema.

Cultivars grafted on GiSelA-5 had the highest cumulative yield efficiency indices, but blossomed too early, tended to be overloaded, and formed barewood. This may have been due to site-specific factors, such as soil and climate conditions. GiSelA-5 is therefore not recommended for use in Hungary.

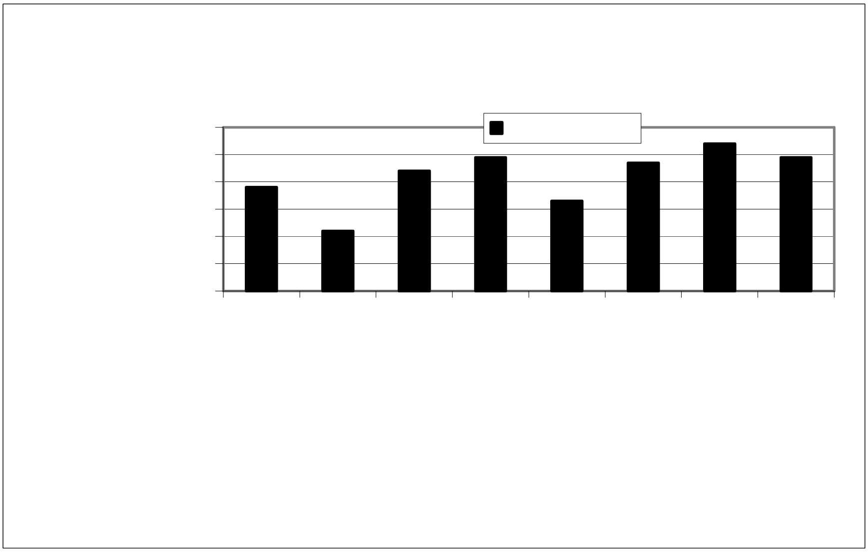

Figure 1. Fruit diameter of ‘Germersdorfi-3’ on different rootstocks (Érd-Elvira major, average of 2001-2003 years)

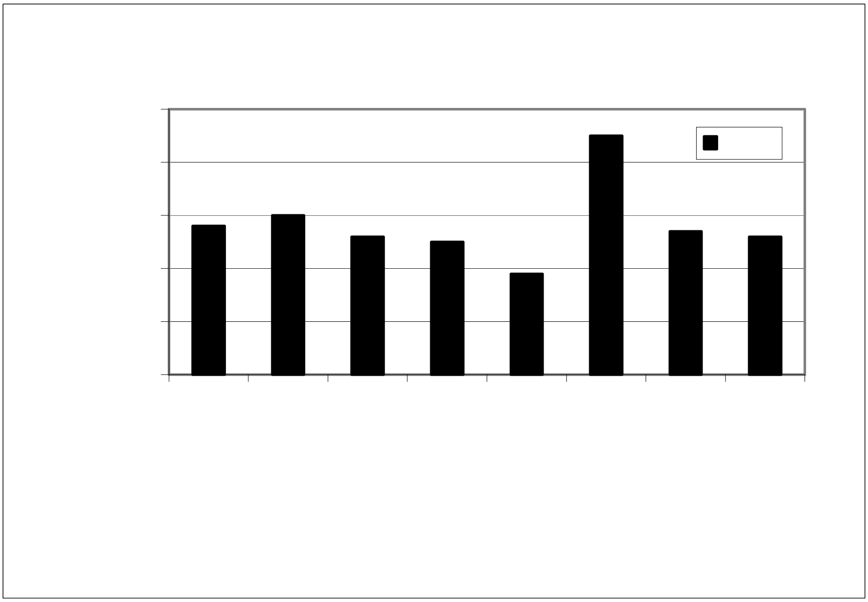

Figure 2. Fruit diameter of ‘Linda’ on different rootstocks (Érd-Elvira major, average of 2001-2003 years)

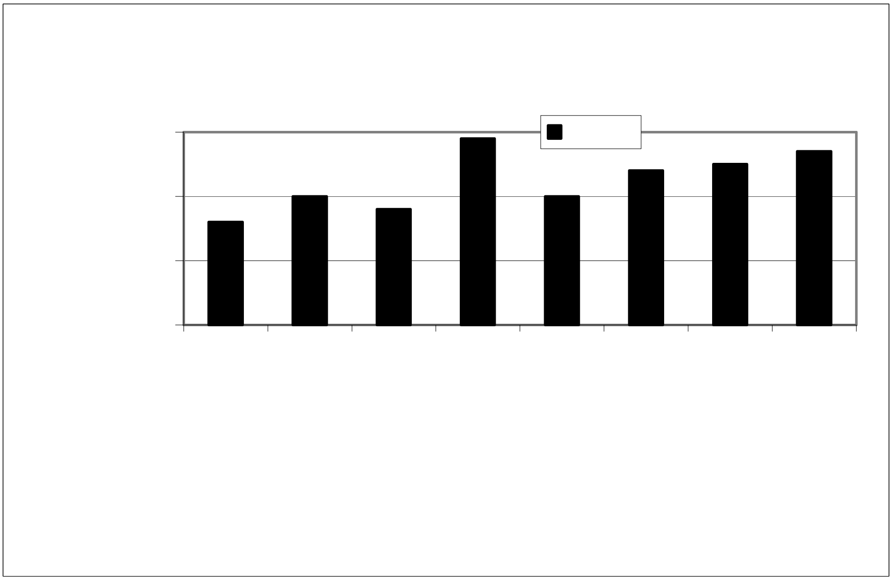

Figure 3. Fruit diameter of ‘Katalin’ on different rootstocks
(Érd-Elvira major, average of 2001-2003 years)

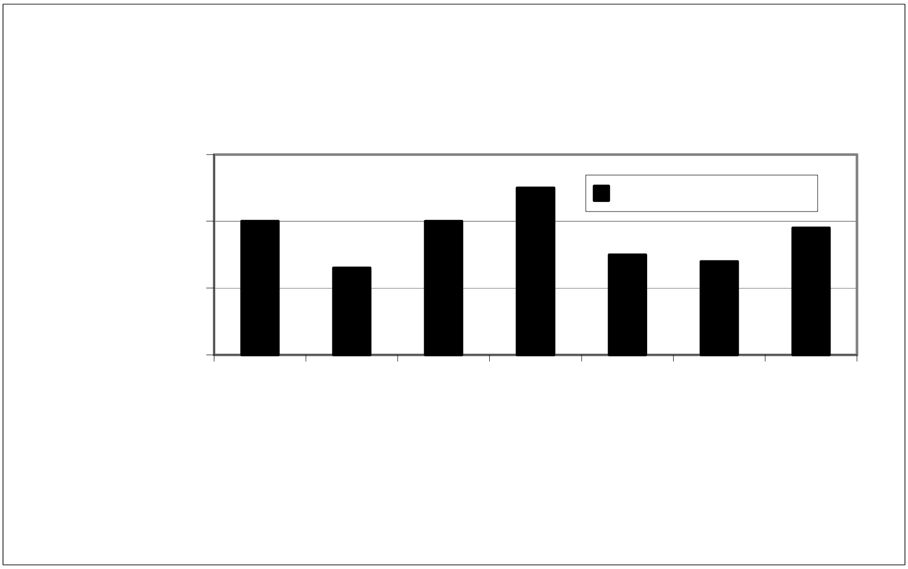

Figure 4. Fruit diameter of IV-2/152 ‘Piramis’ on different rootstocks
(Érd-Elvira major, average of 2001-2003 years)

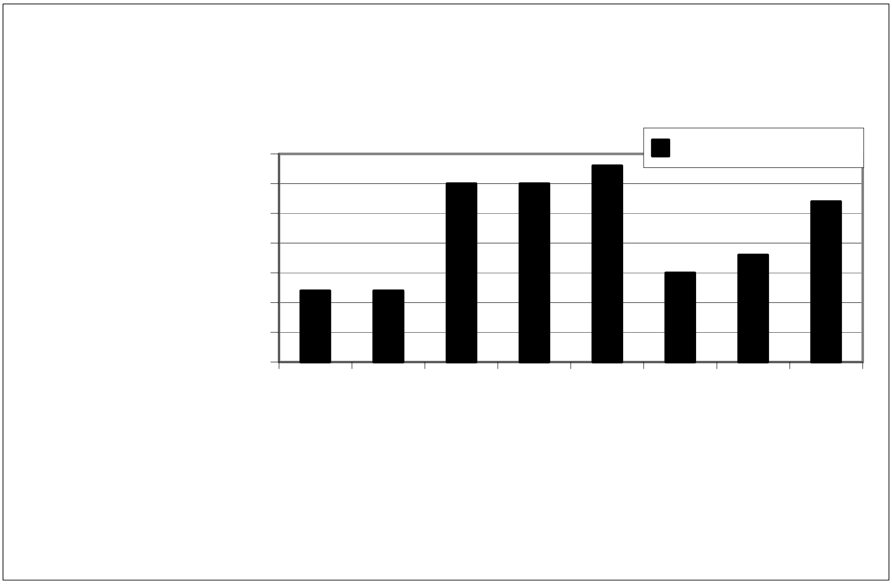

Figure 5. Cumulated yield efficiency index of 'Germersdorfi-3' on different rootstocks (Érd-Elvira major, average of 2001-2003 years)

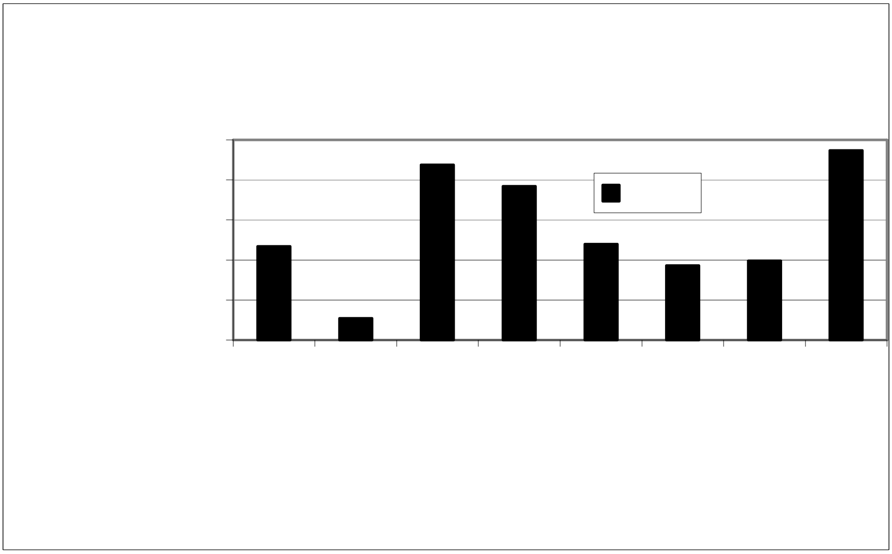

Figure 6. Cumulated yield efficiency index of 'Linda' on different rootstocks (Érd-Elvira major, average of 2001-2003 years)

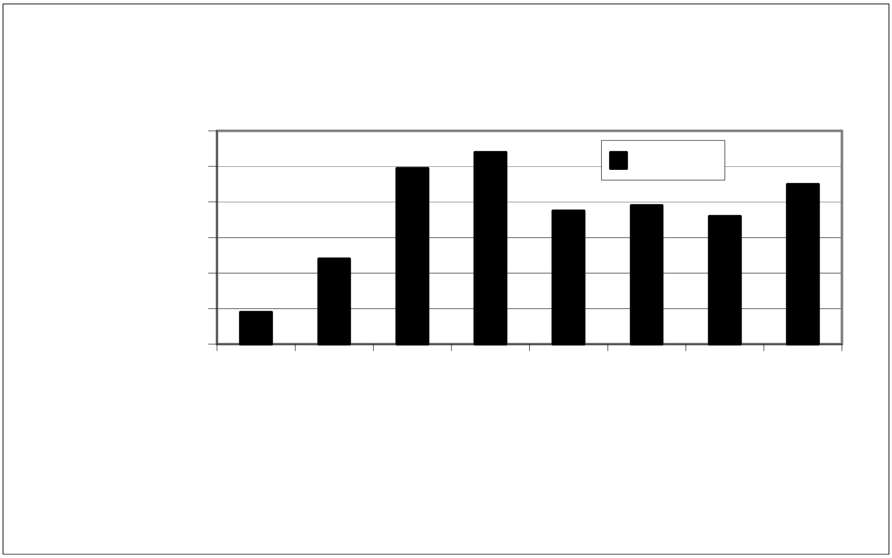

Figure 7. Cumulated yield efficiency index of 'Katalin' on different rootstocks (Érd-Elvira major, average of 2001-2003 years)

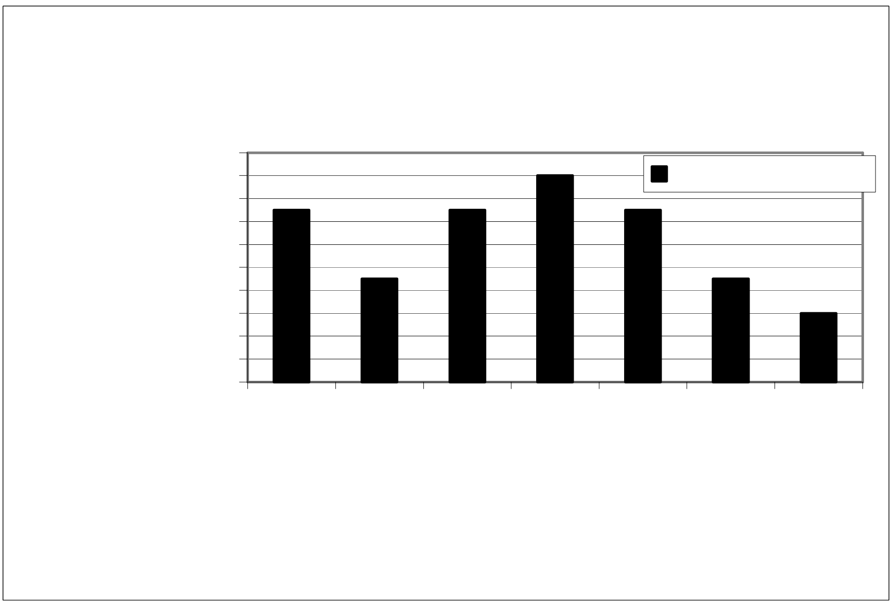

Figure 8. Cumulated yield efficiency index of IV-2/152 'Piramis' on different rootstocks (Érd-Elvira major, average of 2001-2003 years)

Table 4. Relative frequency of fruit diameter [mm] of 'Linda' sweet cherry in sixth and seventh leaf stage, Érd-Elvira major, average of 2002 and 2003

Rootstock	Relative frequency of fruit diameter [%] per size class				
	20-22	22-24	24-26	26-28	28-30
Cema	1.0	44.5	49.5	5.0	
Mazzard seedling	10.5	22.5	46.5	20.5	
Weiroot-13	19.5	51.5	23.5	5.5	
Weiroot-158	24.0	46.0	23.5	6.5	
Weiroot-154	19.5	70.5	10.0		
Weiroot-72	1.5	18.5	52.0	26.5	1.5
Weiroot-53	24.4	24.5	47.0	4.5	
GiSelA-5	7.0	60.0	29.5	3.5	

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PRZYDATNOŚĆ PODKŁADEK KARŁOWYCH DLA ODMIAN CZEREŚNI I WIŚNI W WARUNKACH WĘGIER

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STRESZCZENIE

Badania nad przydatnością wybranych podkładek karłowych czereśni do warunków klimatycznych Węgier rozpoczęto w roku 1997. Podkładki serii Weiroot (numer 13, 53, 72, 154, 158) oraz GiSelA-5 porównywano z szeroko stosowaną podkładką 'Cema' (syn. C.500). Badano przydatność każdej podkładki i jej wpływ na wzrost i plonowanie trzech odmian czereśni ('Germersdorfi-3', 'Linda', 'Katalin') oraz klonu selekcyjnego wiśni 'Piramis' (IV-2/152).

Uzyskane wyniki wskazują, że lepiej dostosowane do warunków glebowych i klimatycznych Węgier są podkładki o średniej sile wzrostu. Czereśnie szczepione na takich podkładkach plonują dobrze i dają owoce bardzo dobrej jakości. Czereśnie szczepione na podkładce GiSelA-5 okazały się bardzo plenne, jednak wpływ tej podkładki na inne cechy był niekorzystny. Drzewa kwitły zbyt wcześnie, co narażało je na uszkodzenia przez przymrozki, wykazywały też skłonność do nadmiernego zawiązywania owoców oraz do ogałacania się konarów. Jak się wydaje stosowanie tej podkładki w warunkach Węgier może być ryzykowne.

Najlepsze rezultaty uzyskano przy stosowaniu podkładki Weiroot-158. Wskaźniki wzrostu i owocowania oraz jakości plonu w przypadku drzew szczepionych na tej podkładce były najlepsze. W początkowych latach plon uzyskany z drzew na tej podkładce był 1,2 do 6 razy wyższy, w zależności od naszczepionej odmiany, w porównaniu do drzew rosnących na standardowej podkładce 'Cema'. Wskaźnik plenności w kombinacji drzew na podkładce Weiroot-158 był dwu-, do pięciokrotnie wyższy niż w kombinacji kontrolnej.

Na podstawie uzyskanych wyników trzeba stwierdzić, że wybór podkładki do sadu powinien być dokonywany rozważnie, zawsze z uwzględnieniem warunków stanowiska i odmiany.

Słowa kluczowe: czereśnia, wiśnia, podkładka, adaptacja do środowiska, owocowanie, wielkość owoców, wskaźnik plenności