Growth and yield of sweet cherry trees on different roostocks

Hrotkó K., Magyar L. & Simon G.

University of Horticulture and Food Industry
Department of Pomology Faculty of Horticulture,
1114 Budapest, Villányi str. 29, Hungary

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Summary: The first nine years' results of sweet cherry rootstock trial from Hungary are presented with the aim to select efficient rootstocks for the local ecological conditions. The trials were established in 1989 with 'Van' and 'Germersdorfi óriás' cultivars on the following rootstocks: mahaleb Sainte Lucie 64, Colt, MxM 14, MxM 97. All the trees were headed at 80 cm and trained to a modified Brunner-spindle system. Tree size and yield was measured every year, and the cumulative yield efficiency was calculated.

Based upon the results, mahaleb cherry SL 64 is a vigorous rootstock with good compatibility and productivity. In comparison to SL 64, the trunk cross-sectional area and canopy spread of the 'Van' trees decreased by 10-15% on rootstock Colt, while the trees of 'Germersdorfi óriás' on Colt roostock grew even larger than on SL 64. Considerable 30-40 % reduction of tree size was achieved on trees grafted on M x M hybrids. Trees of 'Germersdorfi óriás' showed a similar tendency without significant differences. The cumulative yield efficiency of 'Van' trees after nine years was highest on rootstock MxM 14, followed by Sainte Lucie 64. Trees on Colt and MxM 97 rootstocks showed low productivity. 'Germersdorfi óriás' produced the highest cumulative yield efficiency on SL 64, followed by MxM 14 and Colt and last MxM 97. Biennial bearing index of heavy cropping 'Van' trees was smaller than that of 'Germersdorfi óriás'. The trees of 'Van' on MxM 97 showed higher biennial bearing index, while 'Germersdorfi óriás' on different rootstocks showed similar tendency, but without significant differences.

MxM 14 and MxM 97 rootstocks reduced the crotch angle of the shoots on both sweet cherry varieties which is disadvantegous to spindle training. Slight suckering (1–3/year) of the rootstocks Colt, MxM 14 and MxM 97 were observed during the first few years.

Introduction

Reduction of tree size in sweet cherry growing became an important issue in the research objectives of the last decades. Rootstock is one of the possible growth controlling factors. Large number of new promising dwarf rootstocks are known from the world sortiment overwiewed by *Sansavini* (1984) and *Webster-Schmidt* (1996), but the adaptability to the local ecological conditions should be tested for each production area.

Sweet cherry growing in Hungary is located partly in a region with continental climatic influence and on soils with high calcium content and pH level, partly light sandy soils. In these conditions traditional mahaleb rootstock was used for sweet cherries and for the future growth reducing mahaleb rootstocks are needed.

The little breeding work on mahaleb cherry resulted in seedlings of selected seed trees *(Nyujtó* 1987, *Hrotkó* 1996, *Anonymous* 1990) and a few vegetatively propagated rootstocks. Among those Sainte Lucie 64 *(Thomas* and *Sarger* 1965) has spread in West-Europe with good compatibility and productivity *(Webster-Schmidt* 1996).

Another spreading rootstock in West-Europe is Colt, which proved its size reducing effect in UK *(Pennel* et al. 1983), however many cultivars show little growth reduction on it. It is sensitive to drought and calcareous soils *(Webster* and *Schmidt* 1996). In Hungary, this rootstock was not tested before.

Mahaleb x Mazzard hybrids MxM 14 and MxM 97 obtained in Oregon (*Westwood* 1978) were tested in USA and France. However, they proved to be promising semi dwarfing rootstocks in France (*Edin* et al. 1996), *Perry* (1985) reported of fruit size reduction on these rootstocks. Also *Edin* et al. (1986) found considerable fruit size reduction in overcropping years but it might be compensated by measures increasing annual growth and pruning techniques.

Based upon published data, at least three of the above mentioned rootstocks seemed to be promising for Hungarian conditions. With the aim to find growth reducing rootstocks for the ecological conditions chracterized above, field trials were established in 1989 at the Department of Pomology, Faculty of Horticulture, Budapest. The paper presents the first nine year's results of the trials planted in 1989.

Materials and methods

The plantation is located on a sandy soil with low (1.2 %) humus content, layered on alluvial soil next to the river Danube. In the soil of the orchard a high pH (7.82) and high $CaCO_3$ content (20–28 %) were measured. Average temperature of 50 years is 10.8 °C, total sunshine hours in a year is 1900, yearly precipitation is 520 mm.

The trial was planted with one year old trees grown in containers. Varieties are 'Van' and a Hungarian variety, 'Germersdrofi óriás' on rootstocks Sainte Lucie 64 (SL 64) as control, and Colt, MxM 14, MxM 97. Trees were spaced at 7 x 4 m with 20 cm of the rootstock exposed above soil line.

The trial was planted with randomized single tree plots, tree numbers see in *Table 1*.

Table 1 Survival of trees planted in 1989

Variety	Van		Germersdorfi óriás	
Rootstock	planted 1989	living in 1998	planted 1989	living in 1998
SL 64	24	22	12	10
Colt	26	22	12	8
MxM 14	24	17	16	14
MxM 97	25	24	7	7

All trees were headed at 80 cm and trained to a modified Brunner-spindle system *(Hrotkó* et al. 1998). The following data were collected annually: trunk circumference, canopy size and total yield per tree were measured. Following data are calculated: trunk cross-sectional area (TCSA), canopy projection area (CA), canopy volume (CV), cumulative yield and cumulative yield efficiency CYE (total cumulative yield devided by TCSA). From 1994 to 1998 on each rootstock biennial bearing index (BBI) was calculated as follows: yield difference per summed yield of two years x 100 *(Schumacher* 1965). Data are tabulated and statistically analysed using one way analysis of Statgraphics software.

Results

Survival of trees planted in 1989 see in *Table 1*. Since the tree number was small and single tree plot system was used, it is not possible to analyse statistically the loss of tree number. Differences between the rootstocks are not large.

Table 2 Tree size in the eighth year (1997) and cumulative yield efficiency in the nineth year (1998) of cherry trees on different rootstocks (Szigetcsép station, planting year 1989)

Rootstock	Trunk cross-sectional area TCSA (cm^2)	Area of canopy projection (m^2)	Canopy volume (m^3)	Cumulative yield kg/ tree	CYE by TCSA g/ cm^2
		Van			
SL 64	304,0 c	10,4 b	16,6 b	89.9 c	0,31 b
Colt	231,8 b	9,8 b	15,9 b	52.1 b	0,23 a
MxM 14	174,3 a	7,4 a	11,6 a	59.4 ab	0,36 c
MxM 97	172,2 a	7,4 a	11,3 a	45.2 a	0,27 ab
		Germersdorfi óriás			
SL 64	225,9 a	7,2 a	11,9 a	45.7 b	0,25 b
Colt	225,1 a	8,4 a	14,7 a	37.4 b	0,18 ab
MxM 14	203,5 a	6,8 a	11,9 a	35.0 b	0,18 ab
MxM 97	197,4 a	6,8 a	11,5 a	20.1 a	0,10 a

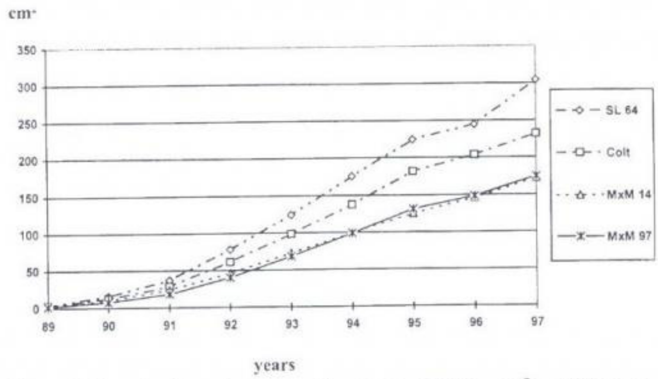

Figure 1 Growth of trunk cross-sectional area (TCSA, cm^2) of 'Van' on various rootstocks

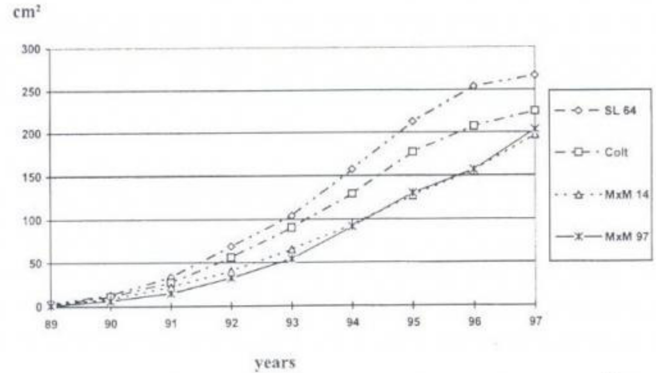

Figure 2 Growth of trunk cross-sectional area (TCSA, cm^2) of 'Germersdorfi óriás' on various rootstocks

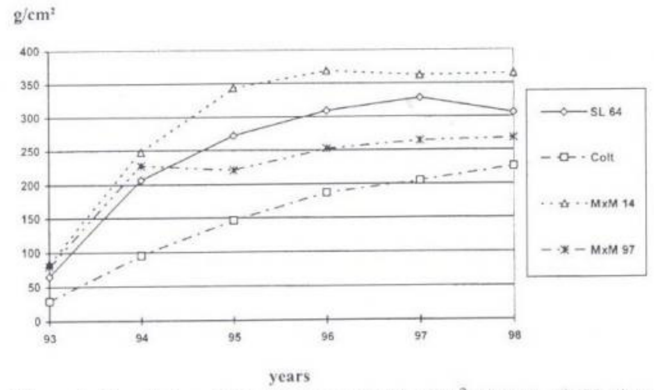

Figure 3 Cumulative yield efficiency (CYE g/cm^2 TCSA) of 'Van' on various rootstocks

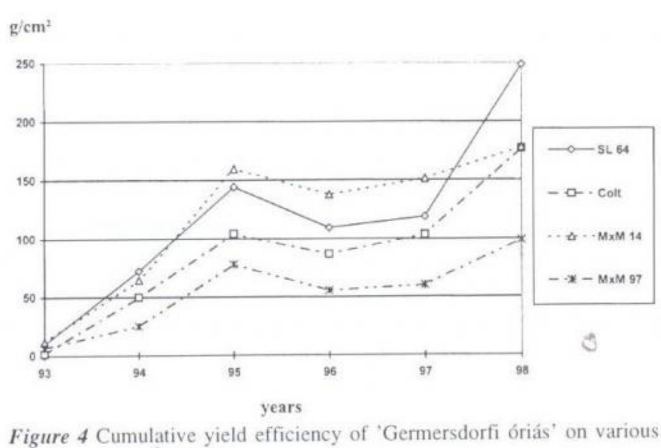

Figure 4 Cumulative yield efficiency of 'Germersdorfi óriás' on various rootstocks (g/cm^2. TCSA)

Figure 5 Van sweet cherry trees in spring 1998.
Rootstocks from left to right: MxM 97, Colt, MxM 14 and SL 64.

MxM 14 and MxM 97 rootstock was reduced by 30–40% *(Fig. 1, Table 2)*. Differences between the two MxM rootstocks were not significant. Trunk size of 'Germersdorfi óriás' trees showed a similar tendency but no significant differences are found between the rootstocks. Spread and volume of the canopy was larger on Colt than on SL 64.

Trees started cropping in the fourth year, the cumulative yield/tree of 'Van' trees was highest on the vigorous SL 64, followed by MxM 14, Colt and MxM 97 *(Table 3)*. The yield efficiency of the two cultivars performed differently. On trees of 'Van' the highest cumulative yield efficiency was calculated on the MxM 14 rootstock on TCSA basis, followed by SL 64 and Colt. The 'Germersdorfi óriás' trees produced higher

Table 3 Yield , kg/tree; cumulative yield, kg/tree; cumulative yield efficiency by trunk cross-sectional area, g/cm^2; cumulative yield efficiency by canopy volume, kg/m^3

Rootstock	Yield, kg/tree Years						Cum. yield kg/tree	CYE by TCSA g/cm^2	CYE by CV kg/m^3
	1993	1994	1995	1996	1997	1998			
'Van'									
SL 64	4.84 c	20.02 c	21.00 d	23.57 b	9.18 b	11.25 b	89.86 c	305.89 b	5.76 c
Colt	2.01 a	7.97 a	10.88 b	13.10 a	7.80 b	10.36 b	52.11 ab	225.59 a	3.26 a
MxM 14	3.80 bc	14.27 b	15.27 c	12.96 a	4.60 a	8.53 ab	59.43 b	364.46 c	5.55 c
MxM 97	3.11 ab	11.70 b	5.89 a	12.37 a	4.51 a	7.59 a	45.16 a	261.17 ab	4.38 b
LSD 5%	1.35	3.68	3.50	4.27	2.23	2.76	11.15	57.83	1.07
'Germersdorfi óriás'									
SL 64	0.68 b	10.94 b	11.50 c	0.17 a	8.23 b	15.01 ab	45.70 b	248.50 b	4.02 c
Colt	0.08 a	6.66 a	6.36 ab	2.33 a	4.86 ab	17.14 b	37.42 b	176.94 ab	2.62 ab
MxM 14	0.46 ab	5.71 a	8.99 bc	2.38 a	6.13 ab	11.85 a	35.04 b	177.94 ab	3.05 b
MxM 97	0.25 ab	2.31 a	4.57 a	0.10 a	2.36 a	10.50 a	20.09 a	98.91 a	1.77 a
LSD 5%	0.44	4.09	3.92	5.18	4.14	4.52	13.91	11.57	0.89

Table 4 Effect of rootstocks on biennial bearing index (BBI) of sweet cherry varieties

Rootstocks	SL 64	Colt	MxM 14	MxM 97
'Van'				
1994–1995	1.95	15.44	3.39	33.03
1995–1996	5.77	9.26	8.18	35.49
1996–1997	13.41	25.36	47.61	46.56
1997–1998	10.13	14.10	29.93	23.87
Average	7.82 a	16.04 a	22.28 a	34.74 b
'Germersdorfi óriás'				
1994–1995	2.50	2.30	22.31	32.85
1995–1996	97.09	46.38	58.14	95.72
1996–1997	95.95	35.19	44.07	91.87
1997–1998	29.17	55.82	31.81	63.30
Average	56.17 a	34.92 a	39.08 a	70.94 a

According to size of the trees *(Table 2)* 'Van' sweet cherry grown on different rootstocks could be devided into three groups. Rootstock SL 64 produced the largest trees, trees on Colt rootstock showed medium size, while tree size on the

cumulative yield efficiency on SL 64 in comparison to MxM 14 and Colt. The trees on MxM 97 showed a significantly lower yield efficiency with both cultivars.

The calculated biennial bearing index *(Table 4)* was lower on heavy cropping 'Van' than on 'Germersdorfi óriás'. Van showed on MxM 97 significantly higher biennial bearing index, while 'Germersdorfi óriás' trees did not show significant differences, except for a slight tendency.

Discussion

Concluding from the growth and development of trees, the above graft combinations tolarate the average weather conditions of our continentally influenced climate. There were no phenomena of incompatibility and significant suckering of the rootstocks observed during the first few years. Rootstocks as Colt, MxM 14 and MxM 97 produced 1–3 suckers on few trees which can be tolerated in a commercial orchard.

Corresponding to the published data *(Anonym* 1990, *Webster* and *Schmidt* 1996) from among the rootstocks examined, the mahaleb cherry SL 64 is vigorous. In relation to SL 64 as rootstock, Colt decreased the canopy spread slightly but the TCSA, significantly, of the cv. 'Van', however in cv. 'Germersdorfi óriás' the trees were of similar size on the two rootstocks mentioned. It can be concluded, that the size reduction effect of Colt is small and is influenced by the cultivar. Most (30–40 %) reduction of tree size was achieved on trees grafted on both MxM hybrids. The two cherry varieties are of different growth character, 'Van' is more spreading while 'Germersdorfi óriás' tends to upright growing. This might influence the rootstock effect on tree size of the two varieties.

First significant crops on the four rootstocks by the cultivars 'Van' and 'Germersdorfi óriás' were produced in the 4th year. Since the cumulative yield efficiency per TCSA after the eighth year performed differently, it was concluded that rootstocks cannot be evaluated with one cultivar. Yield efficiency was highest on the rootstock MxM 14, followed by Sainte Lucie 64 which is not surprising in our 'mahaleb soil' conditions. This data confirm the high productivity of MxM 14 rootstock reported by *Perry* (1985) and *Edin* et al. (1996). The low productivity of 'Van' trees on Colt rootstock which is in contradiction to the published data of *Webster* (1980) and *Pennel* et al (1983) might be caused by soil conditions and low rainfall, however, 'Germersdorfi óriás' trees were medium productive on Colt.

Bearing of cultivar 'Van' alternated less than that of 'Germersdorfi óriás', which confirm the information about the bearing of the cultivars *(Brózik* 1982). The differences in the calculated BBI on different rootstocks indicate a rootstock effect. MxM 97 increased the BBI of cv. 'Van' while similar tendency was observed on 'Germersdorfi óriás' trees too.

MxM 14 and MxM 97 rootstocks reduced the crotch angle of the shoot on both sweet cherry varieties which is disandvantegous to spindle training.

Based on these results, SL 64 and MxM 14 rootstocks seem to be promising to our ecological conditions for semi dense orchards trained to modified Brunner-spindle.

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