Effect of Rootstocks on Blooming Capacity and Productivity of Apple Cultivars

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SUMMARY

The experiment with three different rootstock cultivars was set up in a commercial apple orchard at Nagykutas, which is situated in the western part of Hungary. The aim of our two-year-study was to determine the effect three different growing rootstock cultivars (M9, MM106 and seedling) on the flowering and productivity of 33 apple cultivars. Our observations included the following measurements: the date of the beginning and the end of flowering, flower density, fruit density, fruit numbers per tree and tree productivity. According to our results, it was found that the different growing rootstocks have a great determining effect on the above measurements. Our results showed that the flowering period was similar for all cultivars on the three different rootstocks. However, the flowering and the fruit setting decreased in the order M9, MM106 and seedling rootstocks. In contrast, the fruit number per tree followed, in decreasing order, MM106, seedling and M9 rootstocks.

Keywords: *apple, date of flowering, flower density, fruit density, numbers per tree, tree production*

INTRODUCTION

Today, we recognise the importance of the rootstock, which has an essential value for fruit yield (Hrotkó et al., 1995). The rootstock, together with the grafted cultivar, influences the vegetative and generative mass and the profitability of fruit production (Nyéki et al., 1997). Moreover, the rootstock determines the ecological fitness of the tree. Their effects can be recognised in the health status of critical tree phonological stages, tree kilter and tree sensitivity to pests and diseases (Holb, 2000, 2002), moreover in the efficiency of pest and disease management programs and fruit yield (Holb et al., 2003a,b). Rootstocks with good ecological fitness are increasingly important in environmentally-friendly fruit production (Soltész, 1997, 1998).

Several earlier works showed that rootstock has no effect on flowering time of apple cultivars; however, other studies proved that the weaker the growing vigour of a rootstock is, the earlier the start of blooming. The reason is that rootstock with weaker growing vigour has lower heat requirements for blooming compared to that of rootstock with stronger growing vigour (Kozma et al., 2003; Nyéki and Soltész, 1996; Nyéki et al., 2002, 2004; Szabó and Nyéki, 2003).

The aim of our two-year-study was to determine the effect three different growing rootstock cultivars (M9, MM106 and seedling) had on the flowering and productivity of 33 apple cultivars.

MATERIALS AND METHODS

Assessments were made in a commercial apple orchard at Nagykutas, in the western part of Hungary. The orchard was planted with the tree spacing of 3.2 x 0.54 m in 1999. Trees were grafted on weak, moderate and strong growing vigour of apple rootstocks (M9, MM06 and seedling, respectively). 33 apple cultivars (Granny Smith, Arlett, Green Sliws, Boscoop, Idared, Braeburn Hill Well, Jonagored, Braeburn Scheider, Jonica, Elstar, Mollie's Delicious, Gala del bar, Novayo, Gala Imperial, Pink Lady, Gala Mundial, Prima, Gala Prince, Red Elstar, Gala Royal, Rubinette, Galaxi, Sampion, Gloster, Smoothy, Golden B, Earligold, Golden FGA, Summerred, Golden Reinders, Topáz, Golden Rust, Vista Bella) were grafted on each rootstock, in a total 99 rootstock and grafted cultivar combinations. There were 50 trees for each combination (in total 4950 trees). Trees were pruned to a spindle shape and grass alleyways were used in the rows.

Assessments were made in four replicates with 5 trees per replicate in 2002 and 2003. The assessed parameters were: date of the beginning of bloom, full bloom and end of bloom (petal fall). Moreover, flower and fruit density were observed with a qualitative scale. On the scale, values graded from 1-10. The scale was created similarly to the study of Holb et al. (2003) for disease severity assessment of apple scab. At harvest time, the number of fruit per tree was also counted for each rootstock and grafted cultivar combination.

RESULTS

Effects of rootstocks on date of flowering

Almost all cultivars start to bloom at the same date (*Tables 1, 2 and 3, Figures 1-2*). In 2003, blooming started and ended 5 and 6 days later, respectively, than these of in 2002. This was due to a long winter and a cold, early spring. However, it can be seen that almost all cultivars grafted on MM106

and seedling rootstock started to bloom earlier than those grafted on M9 rootstock. Blooming started 1.87 days later on M9 rootstocks compared to the other two. The effect of rootstock on the date of petal fall was stronger than on the date of beginning of bloom (*Tables 1, 2 and 3*). Petal fall was the earliest on MM106 and the latest on seedling rootstock.

Effects of rootstocks on flower density

Flower density was the highest on M9 (mean density grade was 6.62) and the lowest on seedling rootstock (mean density grade was 3.62). In 2002, the highest flower density value was 5; however, it was 9 in 2003 (*Tables 1, 2 and 3*). For the average of 33 cultivars, flower density was the highest on M9 and the lowest on seedling rootstock. The difference was large for some cultivars. For instance, flower density of cv. 'Golden Rust' was the highest on MM106 and the lowest on M9 rootstock (*Figures 3-4*).

Effects of rootstocks on fruit density and numbers per tree

Fruit density was the highest on M9 and lowest on seedling rootstocks (*Tables 1, 2 and 3*). However, the number of fruits per tree was the highest on seedling rootstock and the lowest on M9 rootstock. Year difference was considerable on fruit density and number. Yield in 2003 was double that of 2002 (*Figures 5-6*).

The increasing order of fruit density and number was M9, MM106 and seedling rootstock in most cases in 2002. However, this was changed in 2003, as the highest fruit density was on M9, and the lowest on seedling rootstock (*Table 4*).

Table 1

Date of beginning of bloom, flower density and the number of fruit per tree on 33 apple cultivars grafted on M9 rootstock (Nagykutas, 2002-2003)

Cultivar	Date of beginning of bloom		Fruit density (1-10)		Number of fruit per tree	
	2002	2003	2002	2003	2002	2003
Arlet	02 April	22 April	5	4	41.2	51.2
Boskoop	03 April	22 April	4	7	11.9	41.7
Braeburn Hillwell	09 April	24 April	5	5	21.4	15.6
Braeburn Schneider	15 April	25 April	5	7	13.0	10.1
Elstar	09 April	24 April	2	9	2.2	68.4
Gala Delbard	15 April	24 April	3	7	27.7	69.0
Gala Imperial	15 April	25 April	4	8	8.2	54.0
Gala Mundial	08 April	24 April	3	9	26.5	52.2
Gala Prince	15 April	24 April	5	9	20.9	55.1
Gala Royal	15 April	25 April	5	7	28.0	58.0
Galaxy	09 April	24 April	4	7	11.4	44.5
Gloster	15 April	23 April	2	5	45.4	58.4
Golden B	15 April	26 April	4	8	18.1	52.4
Golden FGA	15 April	26 April	4	6	46.7	67.2
Golden Reinders	09 April	24 April	4	6	38.6	38.9
Golden Rust	05 April	24 April	5	4	33.1	37.5
Granny Smith	15 April	26 April	2	8	15.3	63.9
Green Sliws	03 April	23 April	5	4	16.9	32.4
Idared	02 April	22 April	4	8	7.0	43.9
Jonagored	08 April	24 April	4	8	29.3	51.4
Jonica	03 April	23 April	5	8	15.0	48.5
Mollie's Delicious	09 April	23 April	4	7	10.1	43.6
Novayo	03 April	23 April	4	7	9.3	47.1
Pink Lady	05 April	23 April	5	6	74.5	50.7
Prima	02 April	22 April	5	5	55.8	54.1
Red Elstar	15 April	24 April	2	7	21.1	72.6
Rubinette	08 April	23 April	5	6	51.0	33.2
Smoothee	09 April	25 April	3	9	44.3	63.7
Snygold (Earligold)	03 April	23 April	5	4	20.3	29.4
Summerred	08 April	23 April	5	6	65.4	35.3
Šampion	08 April	23 April	5	6	33.6	38.3
Topaz	08 April	23 April	5	4	23.0	52.5
Vista Bella	05 April	22 April	1	8	6.1	48.2

Table 2

Date of beginning of bloom, flower density and the number of fruit per tree on 33 apple cultivars grafted on MM106 rootstock (Nagykutas, 2002-2003)

Cultivar	Date of beginning of bloom		Fruit density (1-10)		Number of fruit per tree	
	2002	2003	2002	2003	2002	2003
Arlet	03 April	22 April	5	5	29.0	66.6
Boskoop	05 April	23 April	2	3	2.1	10.6
Braeburn Hillwell	09 April	24 April	4	3	72.4	13.3
Braeburn Schneider	09 April	24 April	5	3	69.6	6.5
Elstar	09 April	24 April	1	7	2.2	80.0
Gala Delbard	08 April	23 April	2	9	30.3	67.3
Gala Imperial	15 April	24 April	3	9	20.4	72.7
Gala Mundial	08 April	24 April	4	7	46.8	83.7
Gala Prince	09 April	23 April	2	9	17.8	75.0
Gala Royal	09 April	24 April	1	9	17.0	84.0
Galaxy	09 April	24 April	3	6	28.1	75.0
Gloster	15 April	24 April	1	5	19.9	54.2
Golden B	08 April	24 April	4	6	24.3	44.9
Golden FGA	08 April	25 April	2	5	73.8	44.1
Golden Reinders	09 April	24 April	3	6	60.0	54.4
Golden Rust	08 April	24 April	2	9	30.4	85.0
Granny Smith	15 April	26 April	1	7	10.4	46.4
Green Sliws	02 April	22 April	5	3	24.6	45.1
Idared	02 April	22 April	4	8	12.9	51.0
Jonagored	05 April	23 April	4	6	20.4	45.8
Jonica	05 April	22 April	3	8	18.9	62.1
Mollie's Delicious	05 April	22 April	5	2	23.5	29.8
Novayo	05 April	22 April	4	7	20.2	47.0
Pink Lady	05 April	23 April	3	7	34.6	51.3
Prima	02 April	22 April	4	4	60.0	60.8
Red Elstar	09 April	23 April	1	7	2.1	74.8
Rubinette	05 April	22 April	4	5	97.3	54.5
Smoothee	08 April	24 April	3	6	45.4	54.1
Snygold (Earligold)	02 April	22 April	3	3	21.3	36.6
Summerred	02 April	22 April	5	2	84.7	7.8
Šampion	03 April	22 April	5	5	44.0	41.7
Topaz	05 April	22 April	3	6	20.1	48.8
Vista Bella	05 April	23 April	2	7	10.4	51.9

Table 3

Date of beginning of bloom, flower density and the number of fruit per tree on 33 apple cultivars grafted on seedling rootstock (Nagykutas, 2002-2003)

Cultivar	Date of beginning of bloom		Fruit density (1-10)		Number of fruit per tree	
	2002	2003	2002	2003	2002	2003
Arlet	03 April	22 April	4	3	34.2	30.4
Boskoop	03 April	22 April	3	1	4.4	1.3
Braeburn Hillwell	09 April	24 April	3	3	32.9	29.7
Braeburn Schneider	09 April	24 April	5	5	30.1	36.5
Elstar	09 April	24 April	2	1	14.0	39.9
Gala Delbard	08 April	23 April	4	6	19.2	58.4
Gala Imperial	15 April	24 April	3	6	44.7	72.5
Gala Mundial	08 April	24 April	3	7	27.8	58.1
Gala Prince	09 April	24 April	4	6	90.0	53.5
Gala Royal	08 April	23 April	4	6	76.1	81.6
Galaxy	08 April	23 April	2	4	36.4	50.1
Gloster	15 April	24 April	1	3	13.5	28.6
Golden B	09 April	25 April	3	3	86.9	41.5
Golden FGA	08 April	25 April	3	2	29.7	24.3
Golden Reinders	09 April	24 April	3	3	26.3	66.9
Golden Rust	05April	24 April	3	6	30.3	72.4
Granny Smith	08 April	24 April	2	4	32.0	16.6
Green Sliws	03 April	23 April	5	2	31.6	81.6
Idared	02 April	22 April	4	4	70.4	32.1
Jonagored	03 April	23 April	3	3	17.9	45.7
Jonica	05 April	22 April	4	2	30.3	39.4
Mollie's Delicious	08 April	23 April	3	2	35.1	29.6
Novayo	03 April	22 April	4	3	25.8	42.6
Pink Lady	05 April	23 April	3	5	28.2	73.0
Prima	03 April	23 April	3	5	19.9	71.6
Red Elstar	09 April	23 April	1	2	25.0	41.9
Rubinette	05 April	23 April	3	1	103.0	28.1
Smoothee	15 April	26 April	2	4	30.2	55.4
Snygold (Earligold)	03 April	23 April	4	2	23.7	46.9
Summerred	03 April	23 April	2	5	5.6	39.1
Šampion	03 April	22 April	5	5	35.4	76.8
Topaz	08 April	23 April	3	3	10.1	39.7
Vista Bella	05 April	22 April	2	4	15.3	44.7

Figure 1: **Distribution of apple cultivars according to marginality of the beginning of bloom on M9 rootstock (MM106 rootstock)**

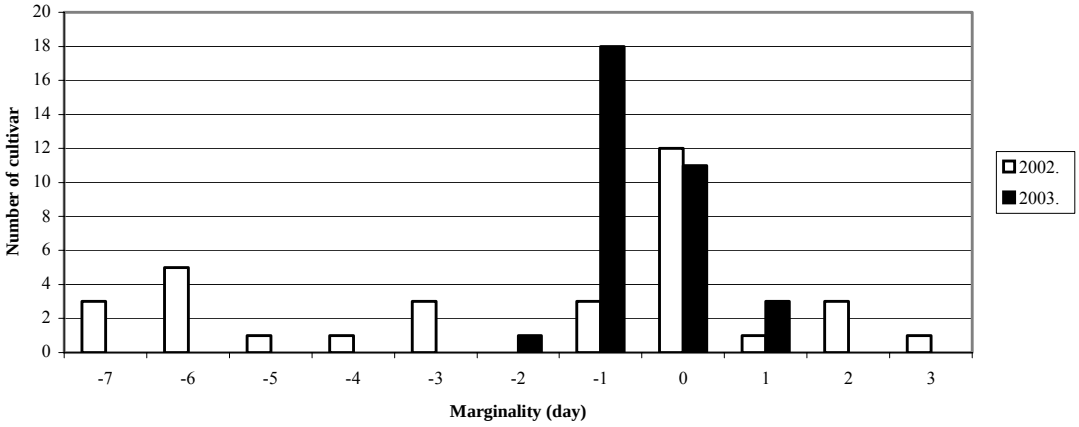

Figure 2: **Distribution of apple cultivars according to marginality of the beginning of bloom on M9 rootstock (seedling rootstock)**

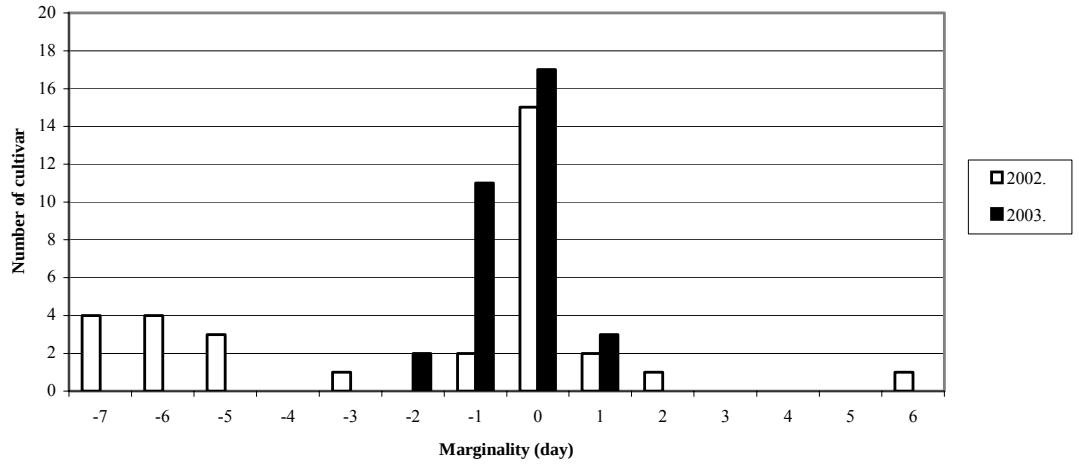

Figure 3: **Classification of cultivars according to flower density (2002)**

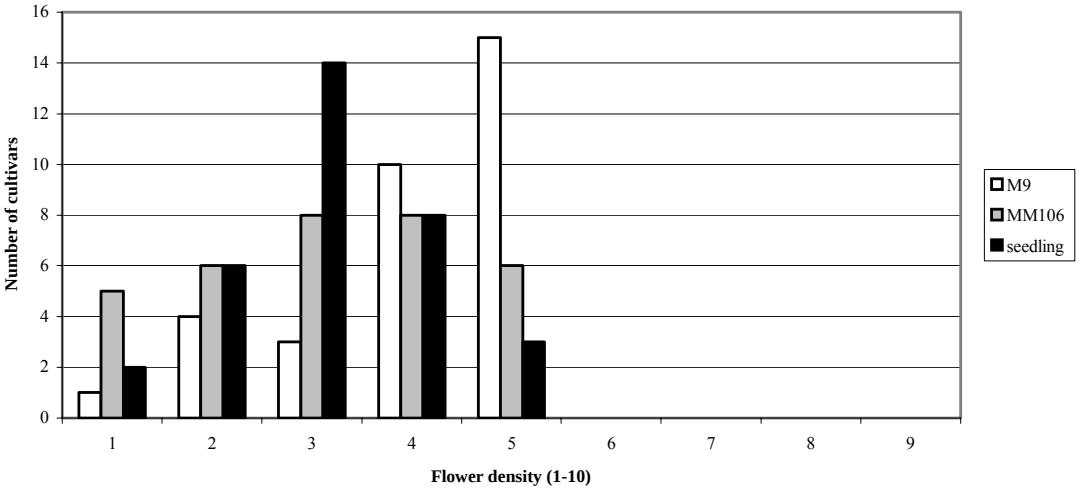

Figure 4: **Classification of cultivars according to flower density (2003)**

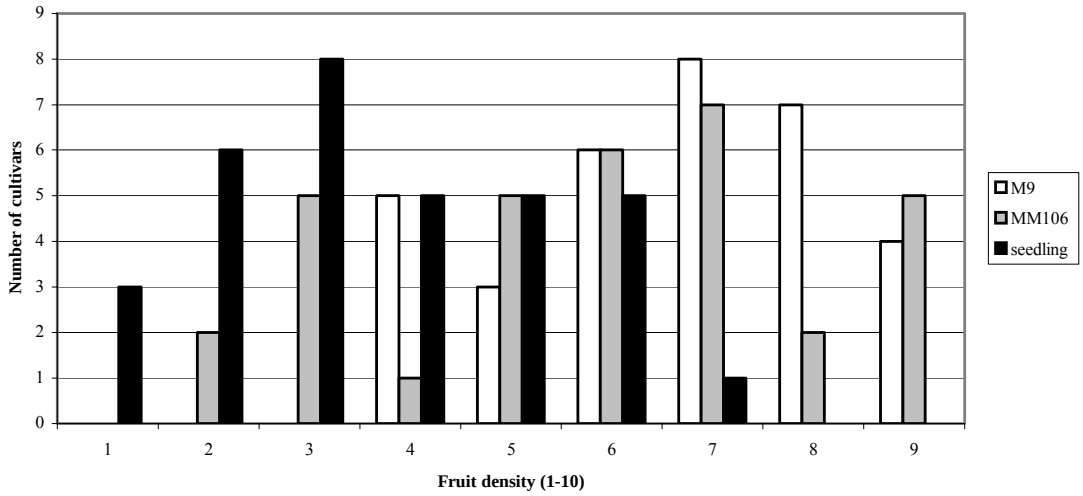

Figure 5: **Classification of cultivars according to fruit production per tree (2002)**

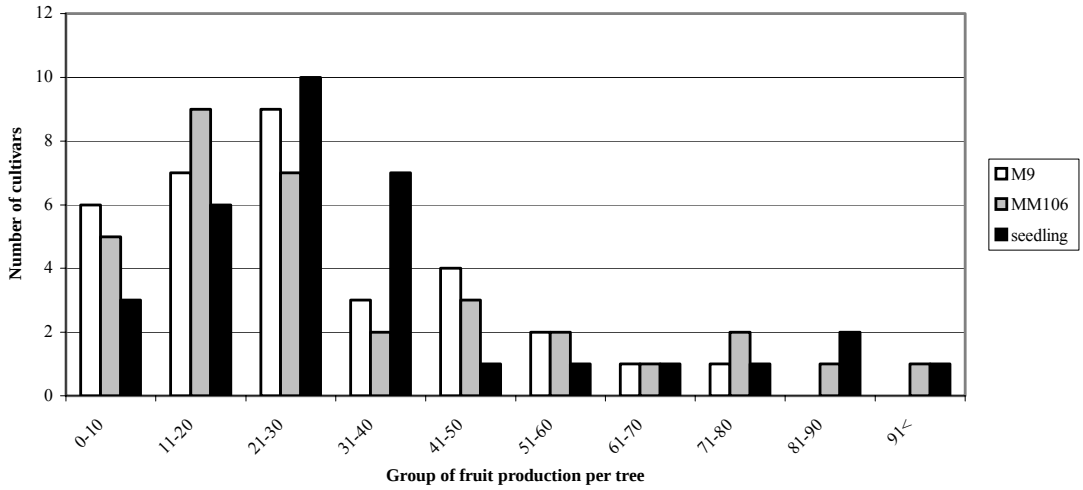

Figure 6: **Classification of cultivars according to fruit production per tree (2003)**

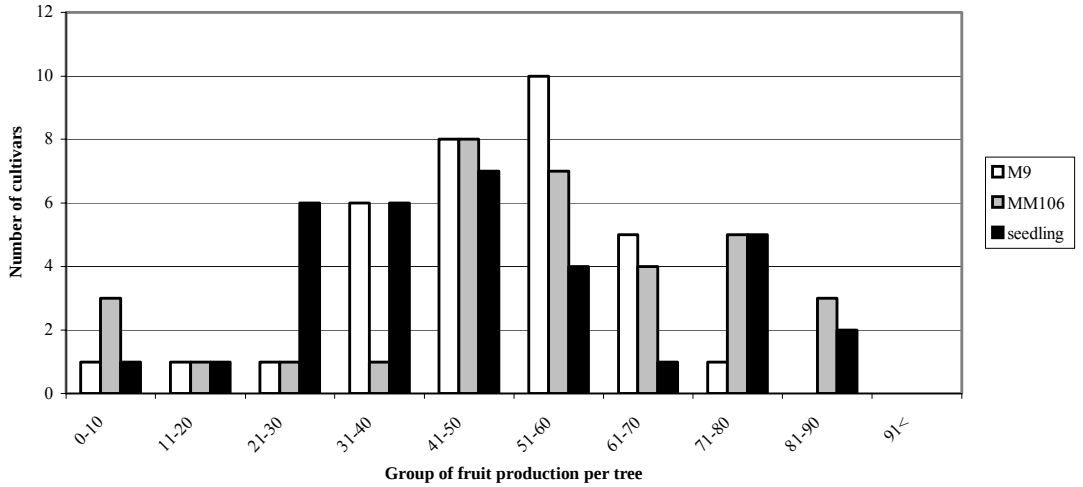

Table 4

Effect of rootstock on apple tree production
(Nagykutas, Hungary, 2002-2003)

Order	2002		2003	
	Number of cultivar	Percent of cultivar	Number of cultivar	Percent of cultivar
M9<MM106<seedling	10	31	6	19
seedling<M9<MM106	7	21	8	24
MM106<M9<seedling	4	12	3	9
seedling<MM106<M9	4	12	8	24
M9<seedling<MM106	3	9	5	15
MM106<seedling<M9	2	6	1	3
M9=MM106<seedling	1	3	0	0
M9=seedling<MM106	1	3	0	0
MM106=seedling<M9	1	3	2	6
Total	33	100	33	100

CONCLUSIONS

Almost all cultivars bloomed at the same date; however, there were large yearly differences. Rootstock seems to have a considerable effect on the date of petal fall and it was much later on dwarf rootstock than on the other two. Flower and fruit densities are higher on dwarf rootstock than on semidwarf or seedling rootstocks. However, fruit yield per tree is lower on dwarf rootstock than on the other ones.

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