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Performance of Five Ornamental Crabapples (*Malus* sp) on Seven Size-Controlling Rootstocks

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Commercial apple growers have a long history of using a wide range of size-controlling apple rootstocks to tailor tree size to meet desirable tree spacing and training systems. Many of these rootstocks also encourage earlier and more profuse flowering and fruiting and may also offer disease resistance.

To satisfy the variable needs due to space limitation and garden design, it would appear desirable to tailor-make crabapples to meet these needs. Ideally, crabapples selected for disease resistance and desirable ornamental characteristics could be made available in a range of tree sizes by selecting the appropriate rootstocks. Since these trees would be designed to fill special needs, they should be a value-added product.

To determine the feasibility of this approach, an experiment was established to evaluate the performance of five ornamental crabapples that were important commercially on seven apple rootstocks selected to produce a range of tree sizes from very small to full size.

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Materials and Methods

In the spring of 1998, apple rootstock liners were ordered from commercial suppliers as follows: M.27EMLA, M.9EMLA, M.26EMLA, M.7EMLA, MM.111EMLA from TRECO, Woodburn, Oregon; domestic seedling, Bailey Nurseries, Inc., St. Paul, Minnesota; Antanovka 306 from Lawyer Nursery, Inc., Plaines, Montana. The rootstock liners were set in the nursery area of Secrest Arboretum at a spacing of one foot in the row and six feet between rows. Any shoots developing on the bottom 10 inches were removed during the summer, and weeds were controlled by hand as needed.

Scion wood of the flowering crabapples listed here was secured from the commercial nurseries that propagated these cultivars — 'Adirondack,' 'Golden Raindrops,' 'Louisa,' 'Prairifire,' and 'Molten Lava.' Thirty trees of each rootstock were T-budded with each crabapple on August 27, 1998. Both rootstock and scion wood were slipping with good budding condition. All trees were cut above the inserted buds in early spring of 1999.

A significant number of buds failed, and these rootstocks were cut to a single shoot and budded a second time in August of 1999. Bud take and average shoot length were recorded for each combination. In the fall of 2000, a U Blade Barerooter was

borrowed from D. L. Crawford Nursery to dig the trees, which were placed in underground storage over the winter.

The following spring (2001), the eight best trees of each combination were selected and planted at a spacing of 10′ x 20′ in eight north-south rows at Horticulture Unit I of The Ohio State University's Ohio Agricultural Research and Development Center in Wooster. Treatments were arranged as a split plot with crabapple cultivar as the whole plot and rootstock as the split plot with eight single-tree replications.

Trees on M.27 and M.9 were staked with a metal T-post and tied, with all others being free-standing. Trees were pruned as little as possible, only removing branches below 2.4 inches and any broken branches. Herbicide was used to control vegetation in a four-foot band in the tree row and row middles mowed as needed.

This planting was adjacent to a pear planting with considerable fireblight, and in 2001 and subsequent years, infection occurred, and the degree of the trees infected was counted. Following the growing season of 2003, tree height and spread were measured, and the percentage of the tree with fruit estimated.

Results and Discussion

Bud take in the nursery of the cultivar rootstock combinations differed widely, with no buds surviving of 'Adirondack'/M.26 and 'Louisa'/M.27 (Table 1). The same people budded the trees. In adjacent rows of some of the same rootstocks budded to commercial apple cultivars, bud take exceeded 85% of all combinations.

Across all rootstocks, the best bud take occurred in 'Prairifire,' with nearly 85% take, and poorest with 'Louisa,' with only 33%. Across all cutivars, the best bud take occurred with Antanovka 306 with 85% and poorest with M.27 with only 31%. If a take of 66% (20 out of 30) is selected as the lower limit of acceptable, there were 14 combinations below this level.

Although we cannot definitely ascertain the cause of the poor bud take of some combinations, the following can be eliminated: personnel doing the budding; quality of the rootstocks; and quality of the scion wood, since some combinations of all cutivars and rootstocks had acceptable bud take.

Crabapples are often indicators for latent viruses, and it is possible that certain combinations had a hypersensitive reaction, causing the buds to abort. The dismal bud take of some combinations with all cultivars except 'Prairifire' would suggest that commercial producers of crabapples should avoid many rootstocks until a test of compatibility is accomplished. It is interesting that all these rootstocks are considered compatible with commercial apple cultivars.

Due to tree quality or lack of adequate bud take, the following combinations were not included in the field plantings: 'Adirondack' on M.7 or M.26 and 'Louisa' on M.27 and MM.111. Survival in the field also varied considerably due to the cultivar rootstock combination. Each cultivar had 100% survival on one or more rootstocks, and all rootstocks except Antanovka 306 had one or more cultivars with complete survival. Some of this loss, particularly with 'Golden Raindrops,' was due to infection with fireblight, but other losses were likely a combination of incompatibility identified in bud take in the nursery.

Generally, shoot length and trunk cross-sectional area differences had similar extremes caused by the cultivars and

Table 1. Survival of Nursery Bud Take and After Three Years in the Field of Five Flowering Crabapples *(Malus)* on Seven Rootstocks.

Rootstock	Nursery Survival (of 30 budded)					
	'Adirondack'	'Golden Raindrops'	'Louisa'	'Prairifire'	'Molten Lava'	Total
M.27	20	9	0	7	21	57
M.9	12	25	22	22	27	108
M.26	0	12	22	28	28	90
M.7	11	26	6	29	26	98
MM.111	27	29	3	21	27	107
Antanovka 306	21	27	25	28	27	128
Domestic Seedling	16	13	3	16	22	70
Total	107	141	81	151	178	
Field Survival (of 8 trees planted)						Total % of Planted
M.27	8	4	–	7	5	75
M.9	5	5	8	6	7	77
M.26	–	5	8	5	5	72
M.7	–	8	8	6	8	94
MM.111	8	7	–	8	7	94
Antanovka 306	7	6	6	5	7	77
Domestic Seedling	7	6	4	8	6	77
Total as % of Planted	87	73	85	80	80	

rootstocks selected in this study (Table 2). 'Golden Raindrops' and 'Prairifire' were the largest cultivars, and 'Adirondack' the smallest cultivar, both when initially planted and after three years in the field.

The rootstocks are listed in order of increasing tree size based on performance of commercial apple cultivars in previous trials. Generally, the same order occurred in growth in the nursery and after three years in the field. The significant interaction between cultivar and rootstock for planting height occurred because 'Louisa' on M.9 was much taller than expected and 'Molten Lava' on MM.111 was much shorter than expected (data not presented).

Trunk cross-sectional area (TCA) for commercial apples has been shown to be the most highly related nondestructive measurement to total tree dry weight. The significant interaction in the 2001 TCA was due to a smaller than expected value for 'Adirondack' on domestic seedling and a

Table 2. Performance of Five Flowering Crabapples on Seven Rootstocks With Potential to Influence Tree Size.

Cultivar	Planting Height (m) 2000	Trunk area (cm^2) 2000	Bloom % tree covered		Fireblight (2001)		Suckers/ tree	Fruiting % Tree covered	Tree size (m)	
			2001	2003	% Tree infected	Number strikes			Height	Spread
Adirondack	1.22dz	1.67d	20.9b	88.7a	3.6b	1.55b	1.07	71.3a	1.67b	0.7c
Golden Raindrops	1.97a	2.59b	49.9b	54.5b	20.5a	4.12a	0.89	15.3c	2.04a	1.5b
Louisa	1.21d	2.91ab	59.1a	84.8a	2.4b	0.94b	0.55	17.7c	1.24d	2.0a
Prairifire	1.66b	2.14c	58.5a	98.8a	6.6b	2.20b	1.16	71.9a	2.03a	1.6b
Molten Lava	1.50c	2.96a	65.9a	96.3a	7.6b	1.11b	.50	48.2b	1.50c	2.2a
Rootstock										
M.27	1.20e	1.20d	32.4bc	86.7	16.2a	2.22abc	0.54	65.0a	1.13e	.80d
M.9	1.50cd	2.21c	73.6a	82.6	14.8a	3.76a	0.19	44.0bc	1.63cd	1.50bc
M.26	1.41d	2.41bc	69.4a	86.1	12.9ab	3.00ab	0.13	38.0c	1.50d	1.91a
M.7	1.59bc	2.66ab	59.8ab	86.7	10.7abc	2.62abc	1.06	36.6c	1.77bc	1.88a
MM.111	1.69ab	2.71ab	40.3bc	78.6	3.66bc	1.41bc	0.90	49.0b	1.83bc	1.50c
Antanovka 306	1.78a	2.91a	40.2bc	79.5	1.9c	0.86c	1.09	40.8bc	1.86b	1.77ab
Domestic Seedling	1.67b	3.00a	42.4c	83.0	3.1bc	0.88c	2.22	45.0bc	2.11a	1.88a
F Significance										
Cultivar	**	**	**	*	**	**	–	**	**	**
Rootstocks	**	**	**	NS	**	**	–	*	**	**
RS x Cv	**	**	**	NS	NS	NS	–	NS	*	**

Mean separation by Duncan's multiple range test, $P \leq 0.05$.
NS, *, ** = Nonsignificant or significant at $P < 0.05$ or 0.01, respectively.

larger value on M.9 and smaller value on M.7 for 'Molten Lava' than expected (data not presented).

As a general rule, the more dwarfing rootstocks cause earlier flowering and fruiting of commercial apple cultivars. One of the concerns of this study was that this increased precocity might cause the crabapples that were also selected for profuse flowering to go biennial in bloom. 'Adirondack' and 'Golden Raindrops' had less bloom in 2001 than the other cultivars, and generally trees on M.9 and M.26 had more bloom than on the rootstocks producing the largest trees and on the smallest trees on M.27 (Table 2).

The significant interaction in 2001 bloom was caused by trees of 'Golden Raindrops' having almost no bloom on Antanovka 306, and 'Prairifire' having very light bloom on this rootstock, with bloom of 'Louisa' on seedling being much greater than expected. In 2003, there was no interaction between rootstock and cultivar for amount of bloom, and all trees had heavy blooms. Thus, to date, no evidence of a biennial bloom pattern has developed.

Although not recognized when this experiment was planned, 'Golden Raindrops' was very susceptible to fireblight, and infection occurred with only small amounts in the other cultivars

(Table 2). Rootstocks M.9 and M.26 are very susceptible to fireblight, and they tended to have more infection than some of the trees on larger rootstocks. No interaction occurred between rootstock and crabapple cultivar in fireblight infection. Some trees of 'Golden Raindrops' died on susceptible rootstocks. Because of the heavy inoculum pressure from the adjacent pear planting, some fireblight was recorded in this planting each year.

Rootsuckering is undesirable in both commercial apple and crabapple plantings. Suckering in this planting was very light, but the largest amount occurred on trees on domestic seedling, which is an industry standard rootstock for crabapples.

The amount of tree covered in fruit was estimated in 2003 with 'Adironback' and 'Prairifire' displaying the most fruit, followed by 'Molten Lava,' with rather light fruiting on 'Golden Raindrops' and 'Louisa.' The effect of rootstock on fruiting was less than the effect of cultivar with heavy fruiting on the very dwarf trees on M.27, followed by trees on MM.111, and little difference among the other rootstocks.

Tree size was influenced by both cultivar and rootstock at the end of the 2003 growing season, and the interaction was significant (Tables 2 and 3). Generally, trees on 'Adirondack' and 'Prairifire' followed the expected tree size induced by the rootstocks. Trees of 'Golden Raindrops' were much larger on M.9 and M.7 than expected. Trees of 'Louisa' on M.7 were smaller than expected. 'Molten Lava' trees on M.9 were larger and trees on MM.111 smaller than expected.

In summary, it appears that rootstocks used in the commercial apple industry to adjust tree size can offer similar possibilities for ornamental crabapples. The effect is most evident with upright spreading cultivars such as 'Prairifire,' and, in hindsight, cultivars such as 'Adirondack,' 'Molten Lava,' and 'Louisa' that modify tree size by growth habit should have been excluded from the study. The biggest concern that was unanswered in this work was the significant loss in bud take of some combinations. It did not appear predictable by either cultivar or

Table 3. Interaction of Flowering Crabapples and Rootstocks on Initial Bloom and Tree Height and Spread After Four Years in the Field.

	Bloom (% tree covered) 2001					Tree height (m) 2003					Tree spread (m) 2003				
Rootstock	Adi-ron-dack	Golden Rain-drops	Louisa	Prairi-fire	Molten Lava	Adi-ron-dack	Golden Rain-drops	Louisa	Prairi-fire	Molt-en Lava	Adi-ron-dack	Golden Rain-drops	Louisa	Prairi-fire	Molt-en Lava
M.27	13.8	45.1		42.7	32.0	1.07	1.17		1.45	0.82	0.48	1.17		1.37	1.64
M.9	21.7	69.8	67.5	47.2	75.8	1.78	2.06	1.75	1.81	1.40	0.62	1.35	2.05	0.143	1.98
M.26		65.4	82.7	69.7	59.5		1.80	1.17	1.94	1.25		1.60	2.05	1.70	2.20
M.7		51.0	32.5	71.7	83.1		2.27	0.95	2.25	1.73		1.75	1.97	1.76	2.37
MM.111	24.6	13.7		63.1	62.7	1.81	1.96		2.00	1.45	0.75	1.21		1.61	2.00
Anta-novka 306	26.7	2.7	36.0	75.2	63.2	1.98	1.85	1.48	2.40	1.77	0.92	1.51	2.23	1.85	2.40
Domestic Seedling	17.8	20.6	96.0	38.7	84.1	1.81	2.76	1.40	2.41	1.81	0.75	2.06	2.17	1.88	2.00
	LSD 0.05 = 31.4					LSD 0.05 = 0.35					LSD 0.05 = 0.38				

rootstock. Thus, if crabapple producers were to capitalize on the value added by adjusting tree size by rootstock, a trial for bud take would be needed for each combination. This was an unexpected finding, since these rootstocks appear compatible with a wide range of commercial apple cultivars.