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Field Performance of *Malus Sargentii* as a Rootstock for Four Commercial Apple Varieties.[1]

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Abstract

Sargent crab (*Malus sargentii* Rehd.), an apomictic crabapple, performed well as a rootstock for four virus-free commercial varieties: 'McIntosh,' 'Cortland,' 'Delicious,' and 'Golden Delicious,' in a trial planted in 1970 and evaluated over 13 years. The trees were free-standing and survival was 100% with no evidence of incompatibility. A weakness noted was the production of numerous root suckers. The effect of Sargent crab on fruit yield efficiency varied with variety. 'Delicious' on Sargent crab reached a size about 60% of similar trees on standard seedling rootstock and yield efficiency was approximately 50% greater on Sargent crab.

Introduction

The advantages of using genetically uniform, clonal rootstocks for apple production has justified the cost of labor-intensive procedures necessary to propagate these rootstocks. Standard seedling rootstocks are inexpensive to propagate, but are more variable and generally lack the effects on vigor control, precocity induction, fruit productivity, and other desirable characteristics for which clonal rootstocks have been selected (21). There are, however, a number of polyploid crabapple species which produce a high proportion of apomictic seed (facultative apomixis) through the development of an unreduced egg cell (14). Open-pollination, of apomicitc crabapples have been reported to produce progenies of 90% or more maternal-type seedlings (14). Zimmerman (22) reported high germination percentages from seed of apomictic *Malus* species. Thus, crabapples with a high frequency of apomixis can be clonally propagated efficiently by seed. Since apomixis is not absolute, it is also possible to obtain a low percentage of sexual crosses. This allows breeders to create hybrid populations and to select clones with superior rootstock characteristics (15, 16, 17). The hybrids obtained also tend to be highly apomictic (14). An added advantage of apomixis is that seed transmission of virus has not been observed in apple (16, 20). The characteristics and potential uses of apomictic crabapples were recently reviewed (10).

Malus sargentii Rehd. (common name Sargent crab) and hybrids of this apomictic crabapple have been reported to be particularly promising as potential rootstocks for commercial apple varieties (15, 16, 17). *M. sargentii* produces 90 to 100% maternal-type seedlings (14), has low vegetative vigor (1, 2, 4, 13, 17), is reported to be cold hardy when used as a rootstock (7), and has resistance to apple scab, fire blight, powdery mildew, and cedar apple rust (6, 9, 18, 19). Seedlings of *M. sargentii* were also resistant to collar rot, caused by *Phytophthora cactorum* (J.N. Cummins, personal communication).

Initial trials evaluating *M. sargentii* and other crabapples as potential rootstocks reported a high degree of incompatibility with commercial varieties (3, 8, 12). Much of the incompatibility observed was subsequently found to be caused by latent viruses carried in the variety grafted onto the crab rootstocks (5, 11, 16). *M. sargentii*

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and most of its hybrids were found to be among the most virus-sensitive crabapples (15). However, it has been reported that when virus-free material is used, compatibility of *M. sargentii* hybrids with commercial varieties was 86 to 100%, higher than for hybrids of other apomictic crabapple rootstocks (16). The purpose of the study reported here was to determine how *M. sargentii* would perform as a rootstock for virus-free commercial apple varieties in a northern climate.

Materials and Methods

Malus sargentii was evaluated as a rootstock for four virus-free varieties as part of an apple variety trial at the Maine Agricultural Experiment Station field facility for tree fruit research (Highmoor Farm, Monmouth, ME). The varieties evaluated on *M. sargentii* were 'McIntosh' (G-29), 'Cortland' (SE-27), 'Richared Delicious,' and 'Golden Delicious' (Lutz). Prior to propagation at Highmoor, budwood of these varieties was first tested and found to be free of stem pitting, rubbery wood, and other latent viruses using the virus indicators Virginia crab, Lord Labourne, and *Malus platycarpa*. The *M. sargentii* rootstocks were grown from seed obtained from a commercial seed source. Five to 30 trees of each combination on *M. sargentii* were planted in in 1970. Performance of 'Richared Delicious' on *M. sargentii* was compared with two 'Earlibrite Delicious' trees on standard seedling rootstock, also planted in this orchard in 1970. The trees on seedling rootstock were purchased from a commercial nursery and were not virus indexed, but it is likely that they contained the latent viruses common in commercial varieties. The soil in this orchard is heavy and shallow and consequently the trees were periodically subjected to wet, poorly drained conditions.

The trees were planted without randomization, with those on *M. sargentii* spaced at 2.4 by 6.1 m (8 by 20 feet) and 'Delicious' trees on standard seedling spaced at 4.9 by 6.1 m (16 by 20 feet). The trees were trained to a central leader and standard procedures of orchard management were followed. Fruit yield was recorded annually and trunk diameter was measured at 15 cm above the ground in 1982. Most of the trees were removed in 1984.

Results and Discussion

There was no evidence of incompatibility, with 100% survival and healthy appearance of all trees over the course of the study. The *M. sargentii* root systems were well anchored and did not need support, however, they did produce numerous root suckers. No apparent winter damage was observed in the *M. sargentii* or seedling rootstock trees, despite cold damage to other trees nearby. The trees were exposed to severe temperatures without snow cover until mid-February during the winter of 1970-71. The winter of 1980-81 was also severe, with low temperatures and lack of snow cover during December and January. These observations are in agreement with the relative winter hardiness of *M. sargentii* rootstocks reported by Lapins (7).

In 1982, trunk cross-sectional-area of the varieties on *M. sargentii* ranked in order from smallest to largest as: 'Golden Delicious', 'Cortland,' 'McIntosh', and 'Richared Delicious' (Table 1). Average annual yield and yield efficiency on *M. sargentii* varied with variety in exactly the opposite order (Table 1). The inverse trend of yield with tree size was highly linear, with a correlation coefficient of -0.97 based on the four variety means. Similarly, the linear correlation of tree size with yield efficiency was -0.99. Increase in productivity with decrease in tree size indicates that small tree size was not due to latent incompatibility or virus infection. Schmidt (17 and unpublished) also found a similar relation-

Table 1. Performance of four commercial apple varieties on *Malus sargentii* rootstock.

Year	Scion Variety: 'McIntosh' (C-29)	'Cortland' (SE-27)	'Richared Delicious'	'Golden Delicious' (Lutz)
NUMBER OF TREES PLANTED				
1970	22	10	5	30
YIELD PER TREE (kg)				
1979	24.3 ± 10.5	57.7 ± 11.4	37.0 ± 14.2	69.1 ± 13.1
1980	29.4 ± 10.3	— ± —	19.7 ± 8.0	48.1 ± 10.9
1981	24.6 ± 9.3	23.9 ± 6.9	8.8 ± 4.9	14.9 ± 8.7
1982	65.6 ± 20.7	50.2 ± 10.2	22.4 ± 3.4	86.4 ± 11.1
1983	38.2 ± 13.8	57.2 ± 10.2	52.2 ± 11.0	— ± —
Mean:	36.4 ± 17.2	47.3 ± 15.9	28.0 ± 16.8	54.6 ± 30.8
TRUNK CROSS—SECTIONAL—AREA AT 15 cm HEIGHT (cm^2)				
1982	127	119	130	109
YIELD EFFICIENCY (AVERAGE ANNUAL YIELD PER 1982 TRUNK AREA, g cm^{-2})				
	287	397	216	503

ship between yield and tree size for four European apple varieties on *M. sargentii* hybrid rootstocks.

Comparisons of 'Richared Delicious' on *M. sargentii* with performance of 'Earlibrite Delicious' on seedling rootstock are only approximate since strains and virus contents differed, tree number and spacing was variable, and the trial was not randomized. However, with these qualifications in mind, the performance of *M. sargentii* and standard seedling are compared as rootstocks for 'Delicious' in Table 2. *M.sargentii* resulted in a reduction of tree size of about 40% (that is, a tree about 60% of full size) and a marked increase in yield efficiency of about 50%.

The effects of *M. sargentii* on the varieties reported here are observational and not conclusive. However, these results suggest several conclusions. First, our data confirms reports by others that compatibility of *M. sargentii* with commercial cultivars is very high when virus-free scion varieties are used. Second, *M. sargentii* can be expected to produce a free-standing, semidwarf tree with markedly increased yield efficiency over trees on standard seedling rootstocks. Third, the *M. sargentii* rootstock appears to be tolerant to poorly drained soils and relatively hardy to low winter temperatures in the absence of snow cover. Further work is needed to critically evaluate the effects of *M. sargentii* on vigor and yield efficiency of commercially important varieties, relative to the performance of these varieties on standard seedling and commonly used clonal rootstocks.

Table 2. Effect of *Malus sargentii* on growth; and yield of 'Delicious', relative to standard seedling rootstock.

Parameter	'Richared Delicious'/ *M. sargentii*	'Earlibrite Delicious'/ standard seedling	Relative performance (% difference from seedling)
Trunk cross-sectional-area in 1982 (cm^2)	130	228	-43%
Average yield over 1979-1983 (kg)	28	32	-13%
Yield efficiency (g cm^2)	216	141	+53%

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