Performance of Four Semi-Dwarf Apple Rootstocks After Five Years at 24 Locations

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During the past three decades the North American apple industry gradually has been increasing the number of trees planted per acre. This transition has required size-controlling rootstocks. Although recent rootstock testing emphasizes dwarfing rootstocks, there is still a place for semi-dwarfing rootstocks. Some growers question the profitability of intensive orchards, with high establishment costs, for processing varieties. Semi-dwarfing rootstocks may also be desirable for weak-growing or spur-type varieties, especially on nonvigorous or replant sites.

There are currently three widely used semi-dwarf rootstocks, but all three have serious faults. MM.111 produces trees that are nearly as large as seedling rootstocks, it produces burrknots and it is nonprecocious. M.7 produces an abundance of root suckers and is relatively nonprecocious. Trees of many varieties on M.7 tend to lean, especially on windy sites. M.7 also may lack adequate cold tolerance in northern climates. MM.106 is usually the most dwarfing and most productive of the semi-dwarf rootstocks, but its use is restricted due to unacceptably high tree mortality caused by collar rot (*Phytophthora* spp.) and brown line. MM.106 performs best on well-drained soils. A series of precocious semi-dwarf rootstocks is needed, providing a range of vigor and tolerance to biotic and abiotic stresses.

In this study four semi-dwarf rootstocks were evaluated at 23 locations representing a wide range of growing conditions. Reported here are the results after five growing seasons.

. . . the relative performance of any rootstock depends on the location.

TABLE 1

Location and cooperators in the 1994 semi-dwarf rootstock trial.

Location	Cooperator	Planting location
(AR) Arkansas	Curt R. Rom	Fayetteville
(BC) British Columbia	Cheryl Hampson	Summerland, Canada
(GA) Georgia	Stephen Myers, Joseph Garner	Blairsville
(IA) Iowa	Paul A. Domoto	Ames
(IL) Illinois	Mosbah M. Kushad	Urbana
(IN) Indiana	Peter Hirst	West Lafayette
(KY) Kentucky	Gerald R. Brown	Princeton
(ME) Maine	James R. Schupp	Monmouth
(MI) Michigan	Ronald L. Perry	Clarkesville
(NB) New Brunswick	Jean-Pierre Privé	Bouctouche, Canada
(NJ) New Jersey	Winfred P. Cowgill, Jr.	Pittstown
(NC) North Carolina	Michael Parker, Richard Unrath	Fletcher
(NYG) New York	Terence Robinson	Geneva
(NYH) New York	Edward Stover, Terence Robinson	Highland
(OH) Ohio	David C. Ferree	Wooster
(ONT) Ontario	John Cline	Simcoe, Canada
(OR) Oregon	Eugene Mielke	Hood River
(PA) Pennsylvania	George M. Greene	Biglerville
(SC) South Carolina	Gregory L. Reighard	Clemson
(TN) Tennessee	Charles A. Mullins	Crossville
(UT) Utah	J. Lamar Anderson	Farmington
(VA) Virginia	Richard P. Marini	Blacksburg
(WA) Washington	Bruce H. Barritt	Wenatchee
(WI) Wisconsin	Teryl Roper	Sturgeon Bay

MATERIALS AND METHODS

Trees were planted at 24 sites during the spring of 1994. Cooperators and locations are listed in Table 1. Trees were planted in a randomized complete block design at each site. Most sites had 10 trees of each of four rootstocks, but several sites did not receive trees on P.1. Each cooperator planted 10 pollinizer trees on M.26 EMLA, but the cultivars were not the same at all sites. Each cooperator had a choice of two spacings: 13.1 x 19.7 ft (4 x 6 m) could be selected for low-vigor sites and 16.4 x 22.9 ft (5 x 7 m) for high-vigor sites. Trees were planted with the bud union 2 inches (5 cm) above the soil surface. Trees were supported to a height of about 7 ft (21 m) and were trained to a vertical axis system. Pest, fertility and water management followed local recommendations.

Trunk circumference or diameter of each tree was measured each fall and trunk cross-sectional area (TCA) was calculated. Some sites harvested fruit in 1995, and all sites harvested fruit in 1996. The total number of fruit per tree and yield (lbs/tree) were recorded each year and used to calculate average fruit weight (FW). Root suckers were counted and removed each fall.

RESULTS AND DISCUSSION

For most of the variables that were measured, there was a strong interaction between site and rootstock. This means that relative rootstock performance differed from one site to another. Interactions are difficult to interpret so means averaged over all sites are presented (Table 2). It is important to remember that the performance of a rootstock may have been quite different at some sites.

Tree Survival

Pooled over all sites, trees on G.30 and M.26 had the poorest survival. No tree mortality occurred at 8 sites, whereas 10 sites lost at least 30% of the trees on one or more rootstocks. At least 70% of the trees on P.1 and V.2 survived at all sites. Eleven sites reported no tree losses for G.30 and M.26. However, at least 50% mortality was reported for G.30 at three sites and 50% mortality was reported for M.26 at four sites. Although the cause of tree death is not known for most sites, in general the greatest tree loss for G.30 and M.26 was from breakage at the bud union during windstorms. As a result of these observations, the NC-140 technical committee recommends that two wires, to prevent tree twisting in the wind, should be used to support trees on G.30 and M.26 trained to the vertical axis.

Tree Size

Averaged over all sites, trunks were about 20% larger for P.1 than for the other rootstocks (Table 2). TCA was not significantly influenced by rootstocks at three sites. At most but not all sites, trees on P.1 had the largest TCA and trees on G.30 had the smallest TCA. Tree height was not dramatically influenced by rootstock and ranged from about 8 ft to about 14 ft and was influenced by rootstock at 10 of the 17 sites. Tree spread ranged from about 5 ft to 12.5 ft, and canopy diameter was influenced by rootstock at 8 sites. At most sites, trees on M.26 had the smallest spread (data not shown).

Yield and Yield Efficiency

When averaged over all locations, trees on G.30 had the highest yield and yield efficiencies, followed by V.2, M.26 and P.1. We have not evaluated V.2 and G.30 in other NC-140 trials but, in two trials planted in 1990, P.1 was the least productive rootstock in the trials. Yield varied greatly from one location to another. Locations with high yields included Arkansas, Iowa, South Carolina, Virginia and Kentucky, whereas those locations with low yields included Georgia, Pennsylvania and New Brunswick. Cumulative yield was not significantly influenced by rootstock at Arkansas, Georgia, Indiana, Ontario, South Carolina or Virginia.

A Word of Caution

These data are for only the first five years of a 10-year trial, so data should be viewed as preliminary. For ease of interpretation means presented in this paper were pooled over all locations. One should remember that there was a strong location by rootstock interaction for most variables measured in this trial. This means that the relative performance of any rootstock depends on the location. For example, when cumulative yield is averaged over all locations, yield for P.1 was only about 60% that of G.30. However, yield was not statistically affected by rootstock at 7 of the 19 locations that were included in the statistical analyses. In fact, V.2 outyielded G.30 at Georgia, New Jersey, Ohio, Ontario, Utah and Virginia. These types of observations support the concept of regional rootstock evaluations. Only by exposing candidate rootstocks to a wide range of conditions can we rapidly identify their strengths and weaknesses.

TABLE 2

The influence of four semi-dwarf rootstocks on tree survival, trunk cross-sectional area (TCA), tree height, cumulative yield and cumulative yield efficiency of surviving Gala apple trees after 5 years.

Rootstock	Survival (%)	TCA (cm^2)	Tree height (ft)	Cumulative yield (lbs./tree)	Cumulative yield efficiency (kg/cm^2)
P.1	95	50.6	13.1	66.4	0.67
V.2	95	39.5	12.4	92.1	1.10
G.30	82	35.0	12.2	107.6	1.29
M.26	84	39.1	11.9	74.1	0.91