Performance of Gala Apple on 18 Dwarf Rootstocks after Five Years

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Report of IDFTA supported rootstock research.

The North American apple industry is in need of dwarfing rootstocks that are productive and that tolerate a wide range of insects, diseases, soil and environmental conditions. The regional project NC-140 was initiated in 1976 to evaluate promising rootstocks at many locations. This rapid exposure of new rootstocks to varying conditions has greatly reduced the time needed to identify the strengths and weaknesses of rootstocks. This report summarizes results from the first 5 years of a uniform rootstock trial involving 18 dwarfing rootstocks at 26 North American locations. A more detailed report was published in 2000 in the *Journal of the American Pomological Society* (54[2]: 92-107).

METHODS

TRECO Red Gala #42 trees were planted at 26 locations during the winter and spring of 1994 (Table 1). Trees were planted in a randomized complete block design at each location with 10 single-tree replicates per rootstock. A core of 14 rootstocks was planted at all 26 locations, but several locations did not receive trees on P.22, B.469, M.9 Fleuren 56, and/or V.3. Pollinator trees consisted of Liberty, Starkspur Supreme Delicious, and Fuji on M.26 EMLA. Each cooperator had a choice of two spacings: 5.7 x 14.75 ft (2.5 x 4.5 m) could be selected for low-vigor sites and 11.5 x 18 ft (3.5 x 5.5 m) for high-vigor sites. Trees were planted with the bud unions 2 inches (5 cm) above ground. Trees were supported to a height of at least 7 ft (2 m) and were trained as vertical axes.

Each year data were collected for trunk cross-sectional area (TCA), yield, number of fruit per tree, and number of root suckers per tree. In 1998 the height and spread of each tree was also recorded. In 1998, nine cooperators also recorded the percentage of the trunk circumference covered with burrknots for each tree.

RESULTS AND DISCUSSION

Interpretation of the results is complicated because rootstock performance varied greatly from one location to another. Means for each rootstock at each location were published in the *Journal of the American Pomological Society*. To facilitate comparison of rootstocks for this report, the data have been pooled across locations. One must compare means cautiously because some rootstocks were not planted at some locations. For example, if a rootstock was not planted at a location that generally had high yields, the mean yield for that rootstock may be lower than it would have been if it had been planted at all locations.

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TABLE 1

Locations for the 1994 NC-140 dwarf apple rootstock trial.

United States		Canada
Arkansas	New York—Geneva	British Columbia
Colorado	New York—Highland	New Brunswick
Georgia	Ohio	Ontario
Iowa	Oregon	
Illinois	Pennsylvania—Biglerville	
Indiana	Pennsylvania—Rock Springs	
Maine	South Carolina	
Massachusetts	Tennessee	
Michigan	Utah	
North Carolina	Virginia	
New Jersey	Washington	
	Wisconsin	

Tree Survival

No rootstock had 100% survival at all locations (Fig. 1). Rootstocks with less than 70% survival for at least three locations included M.26 EMLA, Mark, and P.22. When pooled over all locations, B.469 and V.3 were the only rootstocks with less than 86% survival, and V.1 had 98% survival. Most of the tree death resulted from fire blight or vole injury.

Tree Size

TCA correlates well with the weight of the aboveground portion of the tree and is often used as an indication of tree size (Fig. 2). TCA separated into three fairly distinct groups. The group with the smallest trunks (M.27 size class) included M.27 EMLA, B.491, P.16, and P.22. Rootstocks producing the largest trunks (M.26 size class) included V.1, M.26 EMLA, M.9 RN29, and M.9 Pajam 2. The other rootstocks were intermediate in vigor (M.9 size class). The overall ranking of the five M.9 clones planted at 23 locations was RN29 >Pajam 2 >M.9 EMLA >Pajam 1 >NAKBT337. M.9 Fleuren 56 was planted at only 13 locations, and it usually produced the smallest trunks of all the M.9 clones.

Based on tree height, there were three groups of vigor (data not shown). Rootstocks that produced the shortest trees included M.27, B.491, P.16, and Mark, whereas V.1, M.9 Pajam 2, M.26, and M.9 RN29 produced the tallest trees. Rootstocks producing trees with the smallest canopy spread included M.27, P.16, and B.491, whereas V.1, M.9 Pajam 2, M.26, and M.9 RN29 produced the largest canopies.

Burrknots

The percentage of trunk circumference covered with burrknots varied with location and rootstock (Fig. 3). Burrknot severity was influenced significantly by rootstock at 11 locations. At most locations Mark produced the most burrknots, but incidence was also high for M.26 EMLA. Rootstocks with the least burrknot development included V.1, O.3, B.9, P.2 and all the M.9 clones except NAKBT337. The height of the bud union above ground was also recorded for each tree, and the percentage of the circumference of the rootstock covered with burrknots was linearly related to the amount of rootstock above ground, but the relationship varied for different locations. These data need to be further analyzed to determine why burrknot development differed from one location to another.

Yield and Fruit Size

Cumulative yield per tree was greatly influenced by location (Fig. 4). Colorado, Georgia, New Brunswick, North Carolina, and Maine had low yields, where trees on most rootstocks averaged less than 33 lbs (15 kg) per tree. High yields, often exceeding 85 lbs (38 kg) per tree, were reported for Arkansas, Iowa, Illinois, Michigan, New York–Geneva, Oregon, Utah, Virginia, Washington, and Wisconsin. Rootstock did not significantly influence yield at most of the locations with low yields. In general, yield was positively related to tree size. For the more dwarfing rootstocks, P.16 generally had the highest yields followed by B.491 and M.27 EMLA. P.22 had yields similar to M.27 EMLA. For the high-vigor rootstocks, V.1 usually produced the highest yields, M.9 Pajam 2 had the lowest yields, and M.26 EMLA and M.9 RN29 were intermediate.

Average fruit weight (fruit size) was influenced by location (data not shown). Fruit weight was also influenced by crop load but the relationship was complex. The relationship between average fruit weight and crop load was influenced by some rootstocks at some locations. A complicated statistical analysis of these data will be needed to

FIGURE 1

Tree survival (%) for 5-year-old Gala apple trees on 18 dwarf rootstocks pooled over 26 locations. Means for V.1, M.9 Fleuren 56 and B.469 are based on only 8, 14 and 23 locations, respectively. Rootstocks listed from top to bottom in order of increasing tree size (TCA).

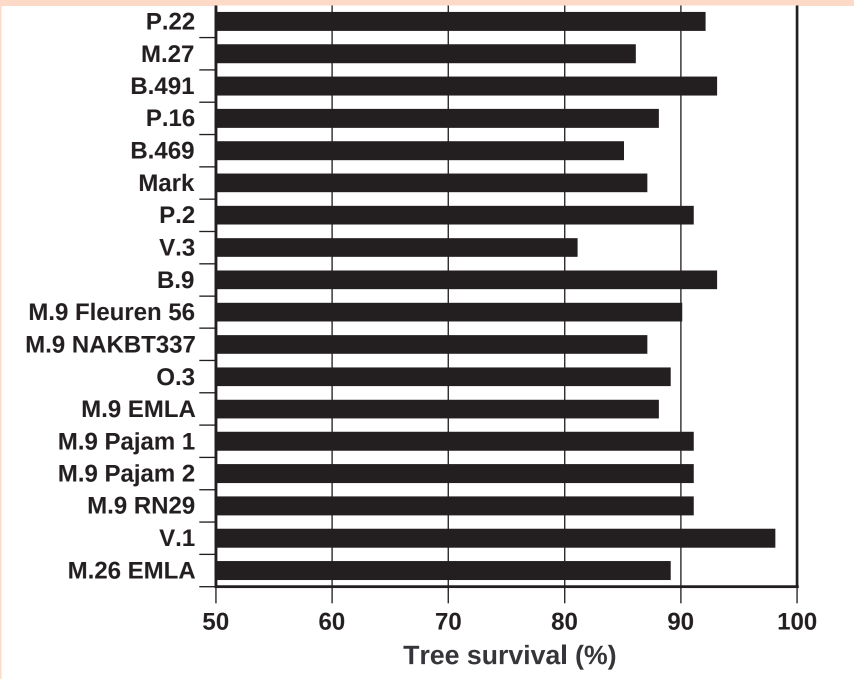


TABLE 2

Growth and productivity of Gala on six M.9 clones. Means were calculated from data reported for the 12 locations that had all six clones.

Rootstock, M.9 clone	Survival (%)	TCA (cm^2)	Root suckers/tree	Burrknots per tree	Yield (lbs/tree)	Yield efficiency (kg/cm^2 TCA)
Fleuren 56	94	21.7	6.2	2.8	69.9	1.47
NAKBT337	92	24.6	3.6	5.7	73.5	1.47
EMLA	93	27.1	1.9	3.6	84.7	1.40
Pajam 1	99	27.7	5.2	3.0	86.8	1.40
RN29	95	31.1	6.7	2.6	98.3	1.50
Pajam 2	93	31.3	6.4	1.9	97.3	1.40

separate out the effects of rootstock, location, and crop load on average fruit weight. When crop load is considered, no rootstock consistently influenced average fruit weight.

Yield Efficiency

Cumulative yield efficiency is the yield divided by the TCA (kg/cm^2). Yield efficiency is a measure of the relative amounts of carbohydrate the tree allocates to fruit vs. wood. Usually yield efficiency is highest for the more dwarfing rootstocks. Within a size class we would like to find rootstocks with high yield efficiencies. Yield efficiency was strongly influenced by location, and rootstock did not significantly affect yield efficiency at six locations (Fig. 5). Among the most dwarfing rootstocks, P.16 had the highest yield efficiency; the moderately dwarfing rootstocks with high yield efficiencies included O.3, Mark, and B.9. Among the most vigorous rootstocks M.26 EMLA tended to have the lowest yield efficiency.

FIGURE 2

Trunk cross-sectional area (TCA) of 5-year-old Gala apple trees on 18 dwarfing rootstocks pooled over 26 locations. Means for V.1, M.9 Fleuren 56 and B.469 are based on only 8, 14 and 23 locations, respectively.

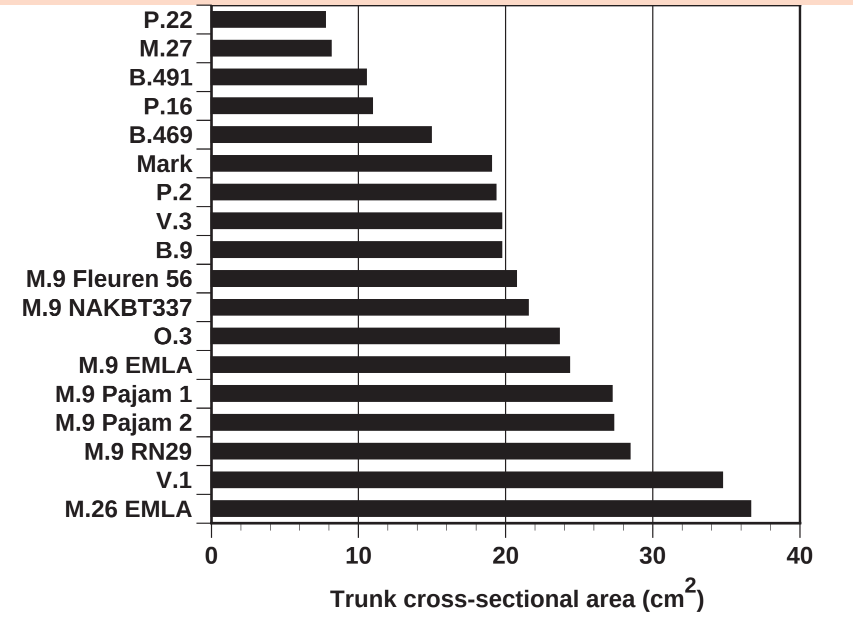
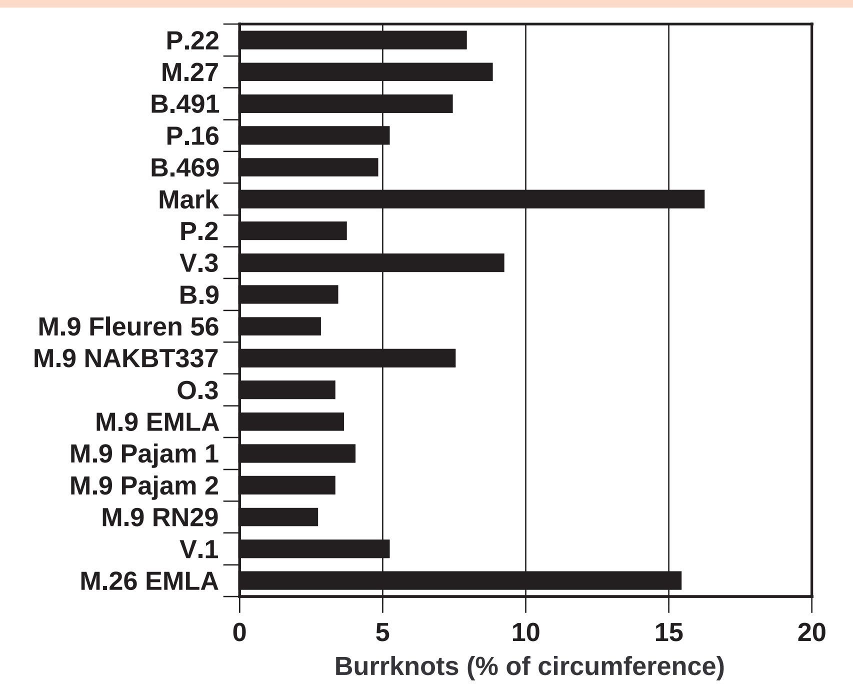


FIGURE 3

Burrknot severity (% of rootstock circumference) for 5-year-old Gala apple trees on 18 dwarfing rootstocks pooled over 26 locations. Means for V.1, M.9 Fleuren 56 and B.469 are based on only 8, 14 and 23 locations, respectively. Rootstocks listed from top to bottom in order of increasing tree size (TCA).



Comparing M.9 Clones

This is the first North American rootstock trial to compare several clones of M.9. Data for the six clones are presented in Table 2, in decreasing order of tree vigor. These data do not agree entirely with data in the figures, because data in Table 2 are based only on the 12 locations that had all six clones; data in the figures are means of all locations with a given rootstock. Data in the table are more appropriate for comparing M.9 clones. Tree survival was good for all clones and ranged from 92% to 99%. Tree vigor was quite different for the different clones. TCA was about 30% less for trees with NAKBT337 and Fleuren 56 than for Pajam 2 and RN29. M.9 EMLA and NAKBT337 had fewer root suckers than the other clones, but NAKBT337 had the most burrknots. Yield per tree seemed directly proportional to tree size, so yield efficiency was similar for all six clones.

CONCLUSIONS

These results should be interpreted cautiously because data are for only the first 5 years. It is impossible to make general statements about rootstocks because the performance of a given rootstock varied greatly from one location to another. At some locations, all rootstocks produced trees of similar size and productivity, so choice of rootstock is not very important. At other locations rootstock had a large influence on tree size and productivity, but the superior rootstocks varied for different locations. Several factors, such as soil type, climate, and tree management, might affect the results of rootstock trials. These results verify the need to test rootstocks at many locations. However, replicating a trial at 26 locations is expensive and a more efficient way of testing rootstocks is needed. An initial step would be for NC-140 to design experiments specifically to identify and quantify the factors affecting rootstock performance. This information can then be used to design more efficient trials.