COLLEGE OF AGRICULTURAL, CONSUMER AND ENVIRONMENTAL SCIENCES

Rootstocks for Size Control in Apple Trees

Revised by Shengrui Yao[1]

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INTRODUCTION

You may still see some old apple trees 20–30 feet apart in northern New Mexico, but for new plantings nationwide, high-density plantings with small trees are more and more popular. The planting density (trees/acre) depends on the grower's preference, existing orchard equipment, cultivars, rootstocks, and soil conditions, and can vary from central leader systems 10–12 × 15–20 feet to tall spindle systems 3–4 × 11–12 feet, or even higher with super spindle systems. Weak cultivars can be planted relatively closer or can be grafted onto a more vigorous rootstock in the same planting density.

Many advantages have been given for high-density plantings, such as reduced labor costs for pruning, spraying, and picking; improved fruit quality for a small canopy with good light penetration; and earlier yields compared to traditional low-density plantings. With more trees per acre, plus possible stakes and trellises, the planting costs are higher for high-density plantings, but these costs are recovered much more rapidly with earlier production compared to traditional plantings.

ROOTSTOCK DEVELOPMENT

To keep the consistent quality of apple cultivars, they have to be propagated clonally by grafting, like most tree fruit species. Each tree has two parts: rootstock and scion. The rootstock is used for its good anchorage, cold hardiness, size control, or stress tolerances. Rootstock research started in

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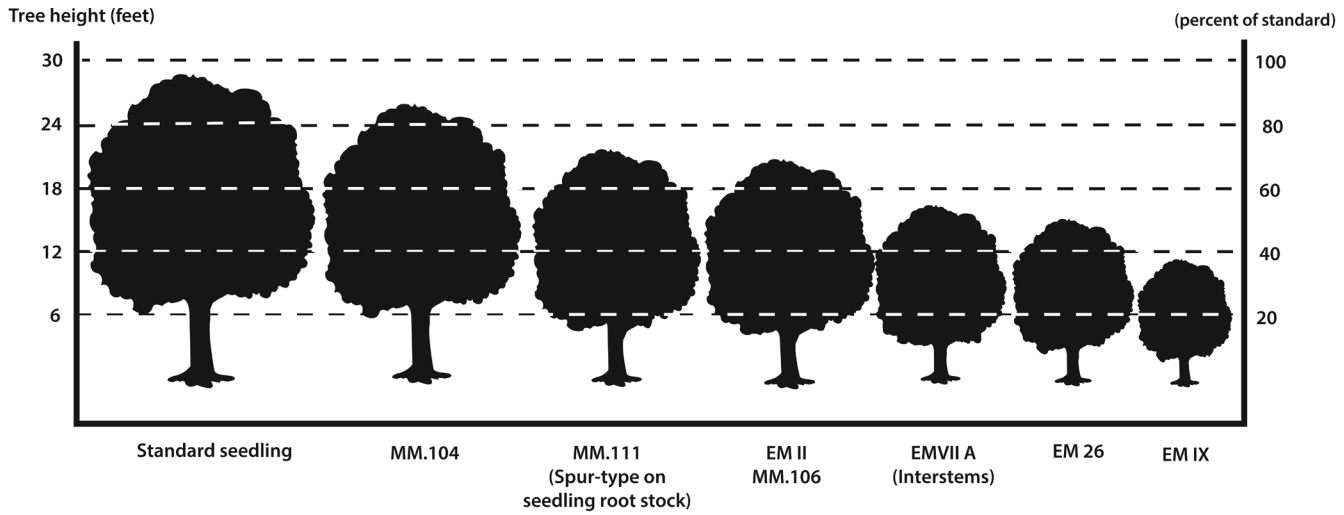

Figure 1. **Dwarfing effects of the M and MM series rootstocks. NOTE: Tree sizes indicated are approximate. Climate, soil environment, and cultural practices may alter the size and other characteristics in a given area.**

Europe in the 1800s. The traditional M series rootstocks were selected at the East Malling Research Station in Kent, England, and are generally termed East Malling (EM). (East Malling is usually shortened to Malling and often only an "M" is used.) MM series rootstocks resulted from a cooperative breeding program between the John Innis Horticultural Institute in Merton, England, and the Malling Station, and were selected for their resistance to woolly apple aphid. The EMLA series were virus-free rootstocks from East Malling and Long Ashton research stations in England.

Malling 1–16 were released between 1912–1914 and M.17–24 were released in 1924. Semi-dwarfing M.26 was released in 1959 and dwarfing M.27 in 1975. Until recently, M.9 was still the most widely planted apple rootstock worldwide, and Figure 1 illustrates the dwarfing effects of M and MM series rootstocks. There are many clones of M.9 sold in nurseries now and the dominant one is M.9 NAKB337 (M.9 T337), which is a virus-free clone from The Netherlands. Most M or MM series rootstocks have limited disease resistance. The Budagovsky series (Bud or B series) were developed in Russia for their cold hardiness. The P series are from Poland and are cold-hardy and resistant to collar rot.

The apple rootstock breeding program at Cornell University (Geneva [G] series rootstocks, CG series in testing stage) was initiated in 1968 by Dr. James Cummings. The original intention was breeding for rootstocks resistant to fire blight, collar rot, woolly apple aphid, and replant disorders in addition to size control. Now, the Cornell Geneva series apple rootstocks are getting more and more popular. They have released G.11, G.16, G.41, G.30, G.65, G.202, G.213, G.214, G.210, G.935, G.969, and G.890, and more are in development and pending release. Cornell University published the comparison chart of G series rootstocks with M series rootstocks (Figure 2).

Research reports indicate that some of these rootstocks, under certain conditions, are subject to various root rots. Other problems include non-tolerance of various soil types, scion/rootstock incompatibility, poor anchorage from weak root systems, suckering of some rootstocks, and lack of precocity in semi-vigorous stocks. The MM stocks are said to be resistant to woolly apple aphids, whereas the EM stocks are not. Since they were selected in a climate far different than ours (less extreme), they should not be expected to perform ideally under any soil and climate conditions.

Many of the important combinations of rootstocks and scions have been evaluated. The NC-140, a large multi-state research program, aimed to test the performance of newer rootstocks across the country. There was no NC-140 trial in New Mexico until 2015. Our first organic apple rootstock trial was set up in April 2015 with 11 different rootstocks: G.11, G.16, G.30, G.41, G.202, G.212, G.214, G.890, G.935, G.969, and M.9 T337 under a tall spindle training system. With our high-pH soil in New Mexico, we did notice varied leaf chlorosis among rootstocks; G.41, G.30, G.16, G.935, G.214, and G.222 were more sensitive, while G.11 and M.9 T337 were more tolerant than others. When choosing a rootstock based on the following descriptions, please also consider their tolerance to high-pH soils in New Mexico.

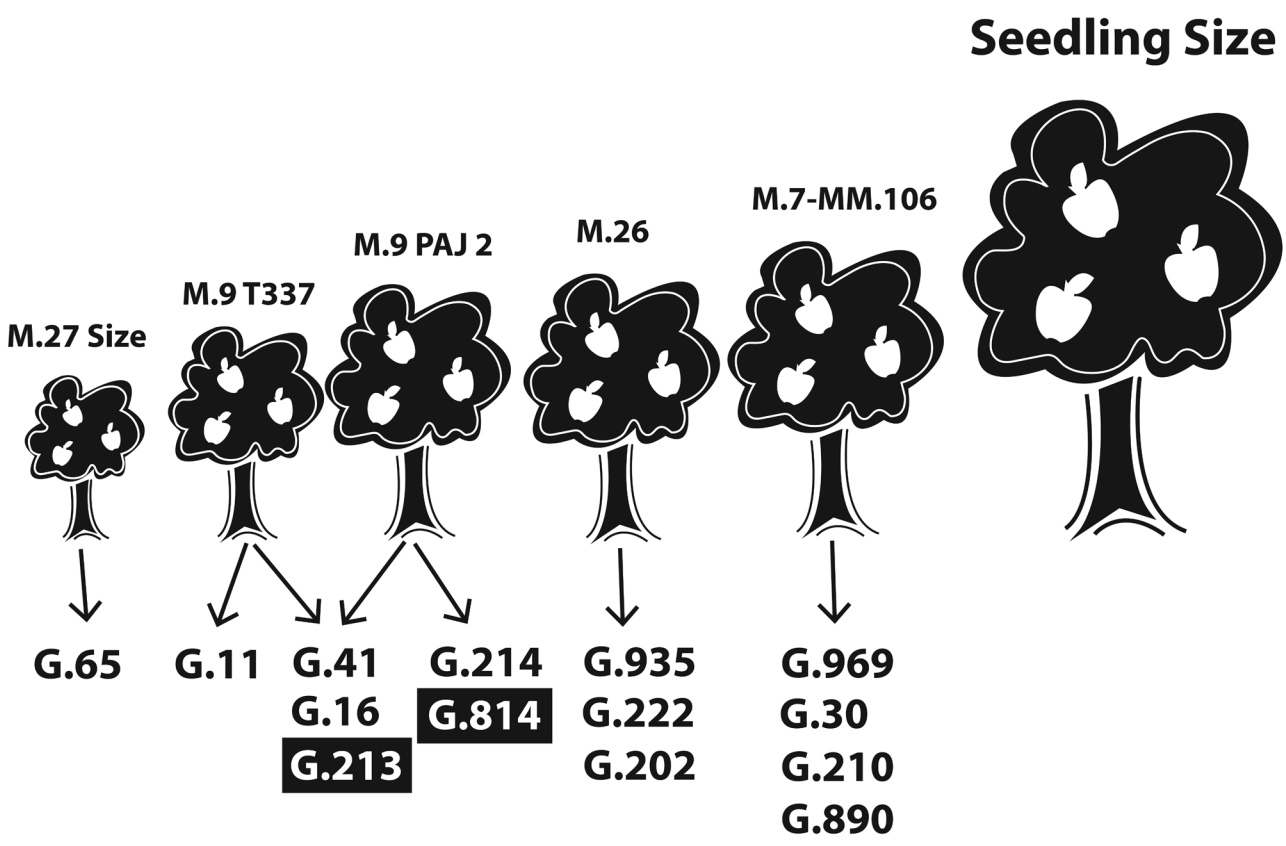

Figure 2. **Geneva (G) series apple rootstocks arranged by tree size; shading indicates a new release (adapted from https://ctl.cornell.edu/wp-content/uploads/plants/GENEVA-Apple-Rootstocks-Comparison-Chart.pdf).**

Spur-type trees, interstem grafts, and pruning can also be used to control tree size. Spur-type trees are usually 25% smaller in height and width and are more open than standard trees. A spur-type cultivar on seedling rootstock makes a tree approximately two-thirds the size of a non-spur cultivar on seedling rootstock. (Natural differences between cultivars should also be taken into account.) Limbs of spur-type trees have more fruiting spurs per foot of bearing wood. Therefore, this wood can be grafted onto dwarfing rootstocks or interstem grafts to give an even greater dwarfing effect. However, the interstem graft is not widely used in the nurseries.

AVAILABLE ROOTSTOCKS

Rootstocks are listed by tree size from small to large, and most information is based on NC-140 trials.

- **M.27:** Very dwarfing rootstock. Needs support to the central leader. Not very popular in nurseries.

- **Budagovsky 9 (B.9 or Bud9):** Released from the former Soviet Union. Trees are 25–35% smaller than M.9 EMLA depending on the cultivars. Cold-hardy and resistant to collar rot. Trees need to be supported.

- **M.9:** The most well-known dwarfing rootstock, 40% of standard size. The wood is brittle and must be supported by a stake or trellis. It needs deep, well-drained soil. Suckering is reduced by high budding and deep planting. A central leader must be maintained. M.9 is very early blooming and slightly hardier than EM.7A. M.9 NAKB337 is the dominant clone used in nurseries and a little less vigorous than M.9 EMLA, which is 25–30% more vigorous than M.9. M.9 Pajam 1 and Pajam 2 from France are 35–40% more vigorous than M.9 T337.

- **G.41:** Released from the New York State Agricultural Experiment Station in Geneva, NY. It is a fully dwarf rootstock, similar to M.9 T337 in size and winter hardiness. Resistant to fire blight, Phytophthora root rot, and replant disease. G.41 produces few root suckers and has a higher yield efficiency than M.9 T337.

- **M.26:** 50% of standard size. Should be staked, although it is self-supporting in good soils. It does not do well on slow-draining soils. It is very early and heavy bearing and causes some cultivars to

mature earlier. It is the most winter-hardy clonal rootstock. M.26 is susceptible to collar rot and fire blight and tends to produce burr knots. It should be planted lower than others, with the graft union 1–2 inches above the soil line. M.26 has graft union incompatibility with some cultivars like 'Rome', 'Stayman', 'Golden Delicious', etc.

- **G.210:** Semi-dwarfing rootstock with resistance to fire blight and crown rot. Similar in size to M.7 but more precocious and productive.
- **G.935:** Resistant to fire blight and crown rot. It is slightly larger than M.26, with similar production efficiency as M.9. Can be used as a replacement for M.26.
- **G.890:** Semi-dwarfing rootstock 50–60% the size of seedling rootstocks. Resistant to fire blight and crown rot. Similar in size to M.7 but more productive and precocious.
- **G.969:** Similar in size to M.7 at 45–55% the size of seedling rootstocks. Resistant to fire blight, crown rot, and woolly apple aphids with good cold hardiness. G.969 does not produce as many suckers or burr knots as M.7. Suitable as free-standing trees.
- **G.30:** An M.7-sized rootstock, with fewer suckers, fewer burr knots, and early production. In an NC-140 trial, it was noticed that 'Gala'/G.30 had compatibility issues. Individual staking is not enough for 'Gala'/G.30, but two extra wires at 36–40 inches and another one at 8–9 feet give additional support.
- **G.222:** 45–55% the size of seedling rootstocks. Needs support. Resistant to fire blight, Phytophthora root rot, and woolly apple aphid. Similar in size to M.7 but more precocious and productive.
- **M.7A:** An improved M.7 rootstock, 60% of standard size, that does well on most soils except heavy clay. It is free-standing, but certain cultivars lean. M.7A is early and heavy bearing, but not as good as M.26. This rootstock is notorious for its suckers, moderate winter hardiness, and susceptibility to collar rot.
- **MM.106:** 70% of standard size. Adapted to lighter soils. Better than M.7A, it has good anchorage in most soils. It is non-suckering, early and heavy bearing, and tolerant to high temperatures and drought. However, it is susceptible to collar rot, especially in poorly drained soils, and more susceptible to early winter freeze.
- **M.2:** 70% of standard size. Does best in moisture-retaining loam and tends to lean in a heavy clay soil. It has fair resistance to collar rot.
- **MM.111:** 75% of standard size. Drought-tolerant, widely adapted to moist soils, and well-anchored. Classified as medium in bearing age and total yield and moderately winter-hardy. Vigorous cultivars tend to be upright.
- **MM.104:** 90% of standard size. Requires well-drained soil. It has good anchorage and tends to produce a more spreading tree.

REFERENCE

Crassweller, R., and J. Schupp. 2018. Apple rootstocks: Capabilities and limitations [Online]. The Pennsylvania State University Cooperative Extension. https://extension.psu.edu/apple-rootstocks-capabilities-and-limitations

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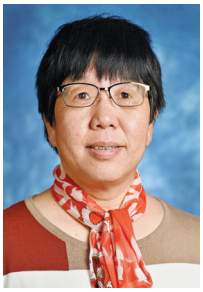

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