

Rootstocks for Kentucky Fruit Trees

Dwight E. Wolfe, John G. Strang, and Shawn Wright, Horticulture

Most fruit trees that can be grown in Kentucky do not come true from seed. For example, a tree grown from a Golden Delicious apple seed will produce an apple tree, but the fruit will have different characteristics than Golden Delicious in color, taste, and shape. This is why fruit trees are reproduced by asexual propagation, such as budding and grafting. The desired cultivar, Golden Delicious in the example above, is budded or grafted onto a rootstock, a close genetic relative suitable for the graft. Rootstocks are selected to impart special traits—including dwarfing, disease resistance, and insect resistance.

This publication describes available rootstocks for apple, cherry, peach, pear, and plum trees suitable for Kentucky fruit tree growers.

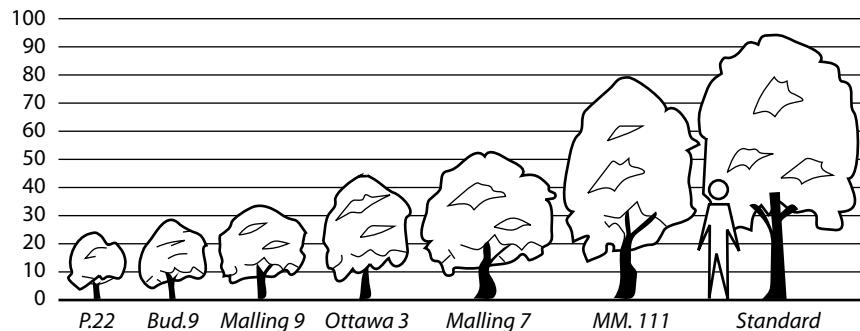
Terminology

The grafted tree consists of the *scion* (e.g., Golden Delicious apple) and the *rootstock* (e.g., B.9). In most nursery catalogs, it would be listed as Golden Delicious/B.9.

Standard trees are full-size trees. They usually have a seedling rootstock and are large. Some standard apple and pear trees may reach heights of 30 feet or more. Rootstocks can be grown from seeds (for example, Halford peach seedlings) or propagated asexually or clonally.

A prefix on apple rootstocks is used to designate the developer of that rootstock (e.g., "M" is used to designate rootstocks developed at East Malling Station in Kent, England; "MM" is used for rootstocks developed by John Innes Institute in Merton, England, and East Malling Station; "B" is used for rootstocks from the Budagovsky breeding program in Russia; "G" is used for rootstocks released and "CG" for rootstocks not yet released from Geneva-Cornell breeding program in

Figure 1. Comparative dwarfing by rootstocks for apples.



New York; "O" is used for rootstocks developed at the Ottawa Research Station in Canada; and "P" is used for rootstocks developed at the Research Institute of Pomology and Floriculture at Skieriewice, Poland).

Certified disease-free or *virus-free* indicates that the parent rootstock and offspring were subjected to intense inspection and testing and are, as the name implies, certified to be disease-free or virus-free. Initial efforts to remove viruses from the M series of rootstocks was not entirely successful, in that only some but not all of the viruses were removed. "A" is used with these rootstocks (e.g., M.7 A). EMLA refers to the East Malling/Long Ashton research station in England that now produces virus-free rootstocks of the East Malling series (EMLA 7 or M.7 EMLA, as opposed to just M.7 or M.7 A).

Tomato ringspot virus, abbreviated TRSV, is spread by dagger nematodes in the soil and causes apple union necrosis, which can result in a tree breaking off at its graft union. Trees on M.26 and MM.106 are susceptible; M.7 is tolerant. Apple replant disease, characterized by stunted growth, rosette leaves, and reduced fruit production, is caused by a complex of soil organisms that damage the tree's root system. The disease is usually but not always symptomatic of trees planted on sites where an old orchard has

been removed to make way for a new one.

Usually, the nursery grows the rootstock for one year before grafting or budding the scion to the rootstock. The trees are then grown for another year. However, June bud peach trees are trees grown from seed and budded in June of the planting year. They are then dug in the fall for sale and planting in the spring. Thus, the scion of a June bud tree is less than 1 year old and is a smaller tree.

Clonal Rootstocks for Apple

Clonal rootstocks are highly recommended for the commercial apple grower and the backyard hobbyist. These rootstocks control tree size and cause the scion cultivar to begin bearing earlier and produce more heavily than trees on seedlings rootstocks (Figure 1). Growers should be aware that a tree grows throughout its life and even a dwarf tree may get large if it is fertilized heavily, not pruned annually or not cropped consistently. If a dwarf tree is planted with the graft union below the soil line the scion cultivar will root and the tree will become a full-size standard tree.

The rootstocks below (Table 1) are in approximate order of increasing mature tree size relative to the standard-size seedling rootstock.

Table 1. Some Characteristics of Apple Rootstocks.

Rootstock	Percent of Standard	Support Needed¹	Burr-Knots	Root-Suckers	Collar Rot^{2,3}	Fire Blight	WAA	Yield Efficiency⁴	Comments
M.27	10-20	Y	few	few	MR	S	S	H	Susceptible to TRSV and winter injury. Best in well-drained soils where it is resistant to collar rot.
G.65	15-30	Y	few	some	R	R	MS	H	Not brittle; training support required; irrigation required; very winter hardy.
Bud.9 Treco	25-35	Y	few	some	VR	T	S	VH	Treco is the preferred B.9 clone for KY. Recommended only on well-drained sites. B.9 is very susceptible to apple replant disease.
P.2	25-35	Y	few	few	R	MS	S	H	More dwarfing than M.9; slightly less vigorous than M.26; cold hardy; resistant to crown gall; susceptible to TRSV.
G.41	30-40	Y	rare	few	R	R	R	VH	Size similar to M.9; productivity similar or > M.9. Very winter hardy and tolerant to apple replant disease.
M.9 T337	30-40	Y	some	few	R	S	VS	H	Certified virus-free by NAKB; attractive to mice; susceptible to nematodes; occasionally winter injured in KY.
M.9 EMLA	30-40	Y	some	few	R	S	VS	H	Virus-free version of original M.9; susceptible to nematodes; occasionally winter injured in KY.
M.9 Nic29	30-40	Y	some	some	R	S	VS	H	Preferred clone for KY.
G.11	35-45	Y	rare	few	R	R	MS	H	Size between M.9 and M.26, and slightly less vigorous than M.9 T337. Similar productivity to M.9. Not tolerant to apple replant disease.
G.16	35-45	Y	rare	few	R	R	S	VH	Not as brittle as M.9 with better anchorage; shows some signs of resistance to replant disease. Use only virus-free scion wood. Size and productivity similar to M.9.
O.3	40-50	Y/N	few	few	R	S	VS	MH	Has better anchorage than M.9. Susceptible to apple stem grooving virus and TRSV; winter hardy and yield efficient.
M.26 EMLA	40-50	Y	many	few	VS	VS	VS	H	Very winter hardy but also very susceptible to apple replant disease.
G.202	40-50	Y	rare	few	R	R	R	H	Produces a tree about the size of M.26 but not as productive as G.935. Moderate tolerance to apple replant disease.
G.935	50-60	Y	rare	few	R	R	S	H	Produces a tree slightly larger than M.26 and tolerant of apple replant disease.
G.30	50-70	Y/N	few	some	R	R	S	H	G.30 is M.7 size early, M.26 size late. Better anchorage than M.7 and tolerant to apple replant disease. Very winter hardy. Weak graft unions with weak cultivars during early years.
M.7 EMLA	60-70	Y/N	few	many	MR	S	S	MH	Staking the first 4 to 5 years is suggested. Trees are cold hardy and tolerant to apple replant disease.
MM.106	70-80	N	some	few	VS	MS	R	M	Very susceptible to TRSV. Susceptible to early winter freezes.
MM.111	80-90	N	many	few	R	T	R	L	The best semi-dwarf for heavy soils but not suitable for high-density orchards.

1 Y = yes, support is needed; N = no, support is not need; Y/N = may or may not need support depending upon site, etc.

2 *Phytophthora* spp.; also called Crown rot

3 I = immune; R = resistant; MR = moderately resistant; T = tolerant, S = susceptible, VS = very susceptible

4 Yield efficiency is a measure of productivity for a given size tree and is calculated as yield in lb/square inch of trunk cross-sectional area.

VH = very high, H = high, MH = moderately high, M = moderate, L = low.

Malling 27 (M.27): Released in 1991, size 15% of standard, rarely suckers. Must be supported and is not recommended for commercial production in Kentucky because the tree is too small. Cultivars on this stock are very early bearing and productive but have reduced fruit size. Resistant to collar rot if planted in well-drained soils, it is susceptible to fire blight and tomato ringspot virus. The rootstock

is slow to harden off in the fall and is more susceptible to winter injury.

P.22: From the breeding program in Poland, size 15 to 25% of standard. Trees on P.22 are less vigorous than trees on M.9. P.22 is resistant to collar rot and highly resistant to apple scab, powdery mildew, and crown gall. It is susceptible to woolly aphid and fire blight, but burr-knots and suckers are rare. Exceptionally winter

hardy, P.22 has been recommended for commercial trial to replace M.27 where appropriate but is considered to produce too small of a tree and not recommended for Kentucky.

G.65: Size 15-30% of standard, this rootstock was the first introduction from the breeding program of Dr. James N. Cummins and Dr. Herb Aldwinckle at Cornell University at Geneva, NY. G.65

is precocious, very productive, produces some root suckers but nearly no burr-knots. It is resistant to crown rot and very resistant to fire blight. (In the nursery, G.65 is resistant to scab and mildew, too). Trees on G.65 are sturdy, well-anchored, thrifty little trees but they do require irrigation. Macs on Geneva 65 survived severe winters in Quebec.

Budagovsky 9 (Bud.9, B.9 Treco, B.9 Europe): Size 25 to 35% of standard, is a highly dwarfing rootstock. Compared to M.9, B.9 is more winter hardy, more dwarfing, and more resistant to fire blight, collar rot, and woolly aphids. Like M.9, trees on B.9 require a permanent trellis or post support. Burr knots and suckers are rare. Graft union is smoother than that of M.9. B.9 promotes open scion growth and produces crops in two to three years with yield efficiency comparable to M.9. It is highly recommended as a dwarf rootstock in Kentucky on well-drained soils. The B.9 Treco clone is preferred for Kentucky.

P.2: Size 25 to 35% of standard, its cropping efficiency is similar to M.9, and it is resistant to collar rot and crown gall. It is slightly susceptible to fire blight and woolly apple aphid. Trees require a permanent trellis or post support.

G.3041 (G.41): Size 30 to 40% of standard, it is an Ottawa 3 x Robusta 5 cross that was selected for its resistance to crown rot, fire blight, and wooly apple aphid. It is a little more dwarfing than M.9, but highly yield efficient, very precocious, very cold hardy, replant-disease-tolerant, and does well in climates as warm as Mexico.

Malling 9 T337 (M.9 T337, M.9 NAKBT337): Size 30 to 40% of standard. Certified selection of M.9 tested by the General Netherlands Inspection Service for Woody Nursery Stock (NAKB) for viruses, it is usually referred to in nursery catalogs as M.9 T337. It commences fruiting early and is productive for its size. Trees on M.9 NAKBT337 are slightly less dwarfing than M.9 and should still be supported by a wire trellis or posts. The rootstock is susceptible to nematodes, woolly aphid, and fire blight but is resistant to Phytophthora root rot (crown or collar rot). Requires irrigation on sandy soils; responds well to mulching on most

soils but is unusually attractive to mice. It is suitable for high-density plantings. This is the preferred clone In Kentucky and would be as susceptible to winter injury as M.9 in extreme cold winters.

Malling 9 (M.9 EMLA): Size 30 to 40% of standard. Similar to the classical M.9 that was received from East Malling in 1931. It is a replacement clone that has undergone heat treatment to eliminate common latent virus. The rootstock is susceptible to nematodes, woolly aphid, and fire blight but is resistant to Phytophthora root rot (crown or collar rot). Shows winter injury occasionally in Kentucky.

Malling 9 Nic29 (M.9 Nic29): Size 30 to 40% of standard. A mutation of M.9 discovered and developed by Rene Nicolai at his nursery in Belgium. M.9 Nic29 is recommended for use with cultivars that are less vigorous such as Empire or Honeycrisp. M.9 Nic29 has slightly more vigor than other clones of Malling 9 yet is similar in other horticultural characteristics.

Geneva 11 (G.11): Size 35 to 45% of standard, it is less attractive to woolly apple aphid than is M.26 and moderately resistant to both fire blight and collar rot. Precocious with high yield efficiency, it seldom has burr-knots or suckers. It is comparable in M.9 in vigor.

Geneva 16 (G.16): Size 35 to 45% of standard, is highly sensitive to common latent viruses, and only virus-free scion wood may be used. It is tolerant to crown rot and has strong resistance to fire blight and scab, and some tolerance to apple replant disease. G.16 is not brittle and is well anchored. Suckers and burr-knots are rare. Some union breakage at the graft union has been observed in one of our plantings.

Ottawa 3 (O.3): Size 40 to 50% of standard, is very productive and early bearing. It is susceptible to fire blight, woolly aphids, and tomato ringspot virus but is resistant to collar rot. It is sensitive to extremely acidic soils but is free of suckers and burr-knots. Support has not been required in Kentucky, but this rootstock has fallen out of favor.

Malling 26 (M.26 EMLA): Size 40 to 50% of standard. Provides somewhat better

anchorage than M.9, but staking or other support is recommended for all but the most compact cultivars. Empire and similar cultivars fruit too early on M.26, and chemical fruit thinning should be used to prevent loss of leaders. Most cultivars have been quite productive on M.26, but those especially susceptible to fire blight (such as Gala and Jonathan) should be avoided. Susceptible to fire blight, woolly aphid, and crown rot, M.26 is the most tolerant of low winter temperatures of all the English rootstocks but requires a well-drained but not droughty soil. Under Kentucky conditions, problems with fire blight and collar rot have severely limited sites and cultivars with which it can be used.

Geneva 5202 (G.202) : Size 40 to 50% of standard; resistant to woolly apple aphids as well as crown rot and fire blight; produces a tree that is between M.26 and G.11 in size but not as productive as G.11. It is a good rootstock for weak scions such as Honeycrisp.

Geneva 5935 (G.935): Size 50 to 60% of standard, it produces a tree that is between M.26 and M.7 size with excellent production. It is resistant to crown rot and fire blight and is very cold hardy and tolerant to replant disease but susceptible to woolly apple aphid.

Geneva 30 (G.30): Size 50 to 70% of standard, it is more precocious and more productive than M.7, with yield efficiencies three to five times better than M.7, and less prone to suckers and burr-knots. It is resistant to crown rot and fire blight but tends to have thorns that must be cut off before planting. G.30 has weak graft unions with brittle cultivars during the early years and is not recommended for use with Gala, Golden Delicious, Honeycrisp, Jonagold, or Braeburn due to brittle graft unions. Tree support is highly recommended for trees with these cultivars on G.30.

Malling 7 (M.7, M.7A, M.7 EMLA): Size 60 to 70% of standard. Performs best on deep, well-drained soil and is somewhat drought tolerant. While most trees on M.7 are self-supporting, staking for the first four to five years is suggested. M.7 should be used as a rootstock for Delicious and Idared on only the most

favorable sites as it produces larger than desired trees. M.7 is prone to burr knots and suckers badly but is resistant to fire blight and crown rot. The virus-free clone of M.7 is M.7 EMLA; has exceptional winter hardiness.

Malling-Merton 106 (MM.106): Size 70 to 80% of standard, it is consistently a highly productive rootstock. Much better anchored and substantially more productive than trees on M.7, but it hardens off late in the fall and can be damaged by early freezes. Early bearing with few suckers, its susceptibility to collar rot and early winter freeze restricts its usefulness in Kentucky. Although it is resistant to woolly aphid, it should not be planted on sites that tend to have poorly drained soil. Trees of Red Delicious and some other cultivars on MM.106 are susceptible to union necrosis and decline, caused by tomato ringspot virus.

Malling-Merton 111 (MM.111): Produces trees 80 to 90% of standard that are moderately slow bearing with medium productivity. More drought tolerant, somewhat better anchored, and slightly more productive than other rootstocks, it is resistant to woolly aphid and has been an outstanding rootstock for Idared, spur-type Red Delicious, spur-type McIntosh, Jonathan and Rome Beauty. Best adapted clonal stock for survival in Kentucky, particularly on heavy soil. However, its large tree size is too large for most plantings.

Interstem B.9 or M.9/MM.111: Made by interposing a 6- to 10-inch stem piece of either B.9 or M.9 between the MM.111 rootstock and the scion cultivar. Dwarfing effect of the interstem is less than if either B.9 or M.9 is used directly as a rootstock and results in a tree that is about 50% of standard size. Staking can usually be avoided, but the tree should be planted with the soil level halfway up on the interstem. It is more tolerant of drought than either B.9 or M.9 alone and is collar rot resistant. It produces a tree that is intermediate in size to trees with either G.11 or M.7 as their rootstock.

Matching Rootstock Clones with Cultivars

It is recommended that B.9 or weaker clones of M.9 such as M.9 T337 be used with vigorous scion cultivars such as McIntosh, Mutsu, Jonagold, and Fuji or when planted in either high fertility or virgin soil. Alternatively, either M.9 Nic29 or O.3 should be used with weak cultivars such as Delicious, Jonamac, Empire, Idared, and Honeycrisp, or when planted in either low-to-medium fertility or replant soils.

Cherry Rootstocks

Mazzard: Standard rootstock for cherry, it is the preferred rootstock for both tart and sweet cherries in Kentucky.

Gissela 5 and Gissela 6: Gi.5 and Gi.6 produce trees about 45% and 65% of the size of trees on Mazzard rootstock, respectively. Trees will need to be supported and intensively managed through appropriate irrigation, pruning, and fertilization so as to prevent over-cropping. Gi.6 is recommended since Gi.5 has been shown to reduce sweet cherry fruit size and sugar content.

Peach Rootstocks

Bailey: Survived better than Lovell and Halford in Illinois trials and yielded similarly to these rootstocks.

Citation: This patented dwarfing rootstock for peaches and plums is a complex peach x plum hybrid bred by Floyd Zaiger of California. Peach trees on Citation are about half of standard size; Redhaven/Citation have not performed well in two different trials in Kentucky and are not recommended for Kentucky.

Guardian: A nematode resistant rootstock that is used extensively in the South but has not survived well in Kentucky.

Halford: Peach seedling rootstock that performs similarly to Lovell in Kentucky.

Harrow Blood: Has not performed well in Kentucky.

Lovell: Peach seedling rootstock that has been outstanding in most NC-140 trials and survives well in Kentucky. Trees of peach and nectarine are available on this traditional Prunus rootstock, but it is becoming difficult to find.

Mariana 2624: Will produce a semi-dwarf tree 10 to 15 feet tall. It does well on wet soils and tolerates a variety of soils. It is compatible as a rootstock for plums and peaches.

MP-29: Semi-dwarf plum peach hybrid rootstock with moderate vigor; resistant to peach tree short life and Armilaria root rot; new promising experimental rootstock still under evaluation.

Nemaguard: A Chinese rootstock that induces late blooming and is being tested in the Southeast. It is a Nematode-resistant rootstock that apparently is not winter hardy in Kentucky.

St. Julian GF 655-2: A clonal rootstock for peaches and plums that produces moderately vigorous, productive trees that do well on heavy, wet soils. Resistance to Phytophthora and bacterial canker is fair.

Tennessee Natural: Not recommended in Kentucky.

Pear Rootstocks

Pear rootstocks that control size in European pears generally do not dwarf Asian pears.

Pyrodwarf: A new rootstock which produces trees that are 50% of standard without reducing fruit size. It is a cross of Old Home and Bonnie Luise. Pyrodwarf is precocious, has moderate resistance to fire blight, and does not root sucker. It has not been evaluated in Kentucky and is recommended for trial.

Quince A: Size is 45 to 55% of standard size. A semi-dwarfing pear rootstock selected at the East Malling Station, England. Quince A is more vigorous but not as precocious as Quince C. Quince A is resistant to crown gall, mildew, nematodes, and pear decline but is very susceptible to fire blight and produces too many root

suckers. Province quince, from France, produces a tree 65% of standard. None of these are recommended for Kentucky.

OHxF 333: Size is 50 to 70% standard size. Semi-dwarfing pear rootstock from Oregon. In limited tests at Geneva, Bartlett trees on OHxF 333 rootstock are about half standard size, while Bosc trees on OHxF 333 rootstock are about two-thirds standard size. Resistant to fire blight, collar rot, woolly pear aphid, and pear decline. Trees are productive, precocious, and well-anchored. Some report that fruit size is reduced. It does not dwarf Asian pear. We think OHxF 333 is worthy of commercial planting.

OHxF 513: Size is 60 to 70% of standard size; a semi-vigorous pear rootstock, resistant to fire blight, crown rot, woolly pear aphids, and pear decline. OHxF 513 is reported to be a precocious and well-anchored pear rootstock.

OHxF 87: Size is 60 to 70% of standard size; a semi-vigorous pear rootstock, resistant to fire blight, crown rot, woolly pear aphids, and pear decline. OHxF 87 is reported to be a precocious and well-anchored pear rootstock.

OHxF 217: Size is 80% of standard size. Like all other OHxF pear rootstocks, OHxF 217 is resistant to fire blight, Phytophthora root rot and woolly aphid. Its vigor appears to be between OHxF 333 and standard pear seedling. It is suggested for trial.

OHxF 97: is vigorous, disease-resistant rootstock; sibling of OHxF 333. Bartlett and Bosc cultivars grafted on OHxF 97 have produced standard-size trees that are more productive and precocious than trees on seedling rootstock. OHxF 97 works well under ornamental pears and Asian pears.

Old Home: Hardy, fire-blight-resistant cultivar primarily used as a rootstock; produces full-size trees.

Pyrus betulifolia (seedling): Produces full-size trees. It is recommended for Asian pears as it increases fruit size.

Plum Rootstocks

St. Julian GF 655-2: A clonal rootstock for peaches and plums that produces moderately vigorous, productive trees that do well on heavy, wet soils and have fair resistance to Phytophthora and bacterial canker.

Myroblolan (Myro): A standard-size rootstock. Produces a well-anchored tree, grows well on a wide range of soil types, and is highly compatible with many cultivars. Suckers at the trunk base are common.

Marianna GF 8-1: Vigorous French rootstock somewhat more tolerant of poorly drained soils than Myroblolan. Winter hardiness is questionable. It is tolerant of calcareous soils but is sensitive to common nematodes. It is only suggested for limited trial.

Kentucky Rootstock Research

The University of Kentucky has an ongoing program on evaluating rootstocks for fruit trees. UK is a member of NC-140, a cooperative rootstock research group whose membership includes most fruit-producing areas in the United States, in addition to Mexico, Australia, and three provinces in Canada. Because rootstock evaluation is a long-term project, this group plans and executes cooperative research projects. Sharing of information and cooperative effort reduces the time needed to evaluate rootstock characteristics. Most Kentucky rootstock evaluation plantings are located at the UK Research and Education Center in Princeton. Results of these trials are published annually in the Fruit and Vegetable Research Report. The results for 2010 can be found at <http://www.ca.uky.edu/agc/pubs/pr/pr608/pr608.pdf>. The rootstock data is on pages 14-16. A number of these stocks are not yet commercially available and are presented for comparative performance to rootstocks described above.

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