

CULTIVARS AND ROOTSTOCKS IN VERMONT APPLE ORCHARDS



Cultivar and rootstock selection is critical for fruit growers, and can essentially be done only once for the life of a planting. Apple varieties are propagated vegetatively by grafting a known cultivar to a selected rootstock, both of which interact to produce the tree that will produce, or not, for the commercial grower. In recent year the selection of both rootstocks and cultivars has increased greatly.

CULTIVARS

Selecting and ordering the cultivars and the rootstocks you will be planting is a decision that should be given much consideration. Ideally, trees should be ordered two years in advance of planting, and up to eight or ten years before fruit production. There are approximately 10,000 apple cultivars in existence and 20 rootstocks commercially available. On what basis do you decide what to plant?

The following is a list of factors to consider when selecting a cultivar:

- Marketability of the cultivar. Is this cultivar well known? Or will you have to develop a market for this cultivar? How will you sell it? Does it fit a niche market?
- Adaptability to the region. Here in Vermont, the issues of winter hardiness and required frost-free growing season need to be considered very seriously.
- Uses. Determining your marketing avenues will help decide on what cultivars to plant.
- Maturity. Depending on the marketing plans you have for your apples, it might be advantageous to have cultivars ripening at different times.
- Disease Resistance. This is critical for anyone considering organic production. At this point only scab resistant varieties are recommended for organic systems due to the large inputs required to control scab organically.

RECOMMENDED CULTIVARS FOR VERMONT ORCHARDS

Below is a list of some recommended varieties for Vermont. Descriptions are modified from the [Penn State Tree Fruit Production Guide](#) to address Vermont conditions and experience.

Arlet

Also known as Swiss Gourmet, Arlet was developed in Switzerland as a cross between Golden Delicious and Idared. Apples are medium to large, round to conical, and brightly red striped with very aromatic pear-like flavor. Susceptible to apple scab, fruit gets greasy quickly if left too long on tree.

Cameo

Cameo was originally introduced as Carousel and was also tested as Wenatchee 66. It is a chance seedling of unknown parentage. The fruit is an attractive bright red striped over a yellow-green ground color. Fruits are round to slightly elongated and medium to large in size. The flesh is firm and creamy white. Flavor has been reported as sweet-tart and well received by consumers. Storage life is reported to be up to 1 year in CA storage. Fruit matures in mid-October, after Delicious and about the same time as Braeburn, so may not perform well in areas with shorter growing seasons. This apple tastes like a Delicious used to.

Cortland

Cortland was developed at Cornell from a cross of Ben Davis and McIntosh made in 1898. The fruit are roundish oblate, attractively red colored, with a heavy bloom. Trees tend to be vigorous, precocious and set heavy crops. Being a tip bearer, growth habit is similar to that of Rome Beauty. Cortland is a very popular apple in Vermont with a loyal customer following, and is used in pies and other baking.

Elstar

Sometimes also referred to as Lustre Elstar, this cultivar was developed in Holland as a cross between Golden Delicious and Ingrid Marie. Fruit is medium to large, round to conical, with red striping over a bright yellow background. Elstar matures in early to mid-September and has a medium storage life. In Europe it is marketed as a red blushed Golden Delicious. Fruit from plantings in central Pennsylvania appear nearly solid red. Fruit is heavily russeted across the shoulders.

Empire

Empire was developed at Cornell University as a cross of McIntosh x Red Delicious and released in 1966. Trees are extremely grower friendly with spreading branches and semi-spur growth habit. Empire is susceptible to apple scab. Fruit are naturally a bit small and heavy cropping; aggressive thinning is required to increase size. Empire has great storing qualities, especially when treated with 1-MCP, and provide a good late-season marketing opportunity for growers.

Fortune

Fortune was developed by Cornell University and was tested as NY429. Fruits from plantings in central Pennsylvania are large to very large with an attractive overall red color. The flesh is creamy white, and the tree may tend toward biennial bearing. A cross of Northern Spy and Empire, Fortune apples tend to be large to very large and store exceptionally well. A premier late-season apple.

Fuji

Fuji was developed in Japan as a cross between Ralls Janet and Delicious. Fruit is medium-sized, round to conical. Color has been reported to vary slightly from a solid red like that of Delicious, to light red stripes over a green background. Fuji has good market acceptance. Vermont growers should only grow early-ripening strains including Auvil, Daybreak, and September Wonder.

Gala

Gala was developed in New Zealand as a cross between Kidd's Orange Pippin and Golden Delicious. Fruit size is naturally small and heavy thinning and extra nitrogen fertilization are recommended. The original Gala is pale to golden yellow, with bright red-orange stripes. The fruit matures in early- to mid-September, and requires hot weather during ripening to develop best flavor. Storage life is rated at approximately 3 to 6 months. Gala requires multiple pickings for best quality. Multiple strains available.

Ginger Gold

Ginger Gold is a chance seedling found in a commercial orchard in Virginia. It is sold as an early maturing Golden type, harvested in mid-August to early September. Fruit finish is very smooth with little russetting. Storage potential is rated as very good. Trees are very precocious, annual, and productive. Trees are susceptible to scab, rusts, and powdery mildew.

Honeycrisp

Honeycrisp was developed at the University of Minnesota and tested as Minnesota #1711R. Fruits are large with a 50 to 90 percent solid to mottled scarlet red over green. Storage life in common storage has been as long as 6 to 7 months. Noted for outstanding crispness and juiciness, Honeycrisp has become a must-have variety for every Vermont orchard. Leaves of Honeycrisp frequently exhibit a green mottling during the summer. At present, we do not know if the discoloration is affecting production. The tree is not very vigorous and should not be planted on M.9 or B.9 unless they are spaced close together.

Jonagold

Jonagold was developed in New York as a cross between Golden Delicious and Jonathan. Although introduced in 1968, Jonagold has become more popular in Europe. Because of this demand, however, it is gaining favor in the United States. Jonagold is rated as one of the best-tasting apples. Fruit is large and conical, similar to Golden Delicious. Jonagold may have only medium storage potential. It is a vigorously growing triploid and therefore cannot be used as a pollen source. It is also intersterile with Golden Delicious. As with Gala, red sports are being released and there is similar concern about marketplace acceptance of non-coloring strains. May not ripen well in cooler Vermont sites.

Liberty

Liberty is a popular scab-resistant apple that performs well in Vermont. The tree contains the Vf gene, originally bred from the pea-sized crabapple *M. floribunda* which confers single-gene field immunity to apple scab. This resistance has broken down in some production areas where local scab races evolved virulence around this protection, therefore Liberty and other Vf gene-resistant apples should not be interplanted with scab susceptible varieties that are not treated for scab, and growers may wish to include modest fungicide sprays during peak ascospore release from tight cluster through fruit set. Liberty remains susceptible to other diseases and insects however, so a comprehensive and integrated pest management program should be followed. Tree form is good with spreading branches that have a tendency to form odd angles at annual growing points. Liberty is a very annual, very productive cultivar that must be aggressively thinned to maintain fruit size and quality. Storage life is short, with a narrow 7-10 day picking window for optimum maturity.

Macoun

Macoun resulted from a cross of McIntosh x Jersey Black made in 1923 at Cornell. Trees are very upright in growth with high spur density. Fruit require aggressive thinning to achieve good size. Macoun is considered an exceptional quality dessert apple, and treatment with 1-MCP has improved storage life.

McIntosh

McIntosh, the state Apple of Vermont, is the most predominant variety grown in the state, even after many years of decline. First brought to the state in 1868, 'Mac' is particularly suited to our cool climate. Trees are grower-friendly with wide spreading braches and moderate vigor. Particularly susceptible to apple, but fairly resistant to rusts and less prone to fire blight than many cultivars. Fruit is juicy, aromatic, and sweet-tart with easily bruised flesh. Fruit destined for storage must be picked at optimum maturity, prior to full ripeness.

Sansa

Sansa is attractive, crisp, aromatic, medium-sized, and sweet- favored. It may be stored for up to 2 months. One report says that Sansa is resistant to apple scab. The fruit matures about 2 weeks before Gala. Good-quality fruit for its season. The trees in the NE-183 planting at UVM had weak vegetative growth, and it is unknown if this is the natural condition of the cultivar.

Shizuka

Shizuka was developed in Japan from a cross between Golden Delicious and Indo. It has the same parentage as Orin and Mutsu. Fruit is very large with a green to yellow skin that occasionally shows a pink blush. Fruit is sweeter than Mutsu, but fruit quality is not as good. Fruit is harvested in October. Tree growth is very spreading. Shizuka is being promoted as a replacement for Mutsu because it does not appear to be susceptible to Blister spot and ripens one week earlier. It is a triploid, and therefore the pollen is not viable.

Silken

Silken is a cross between Honeygold and a numbered selection (8C-27-96) developed at the Summerland Research Centre in British Columbia. It is an early apple, ripening in August. The skin has a soft, yellow, almost translucent quality. Fruit is crisp and juicy. Trees are slow growing, but precocious. Limited commercial availability.

Snow Sweet

Snow Sweet is one of the latest releases from the University of Minnesota. It was developed from a cross between Sharon and Connell Red. The flesh is sweet with a hint of tartness and bright white that does not oxidize very easily. Tree growth habit is more willowy. Fruit ripen approximately 2 weeks after Honeycrisp.

Zestar

Zestar is a recent release from the Minnesota breeding program. It is an early season apple that ripens in late August. It was developed from a cross of State Fair x MN 1691. The apples are globose with an average diameter of 3 inches and are typified by a red striping. As a young tree the growth habit is upright. It is susceptible to fire blight and apple scab. Fruit quality is very good for its season.

Heirloom Varieties

There has been renewed interest in some heirloom varieties, defined as varieties that are not common in commercial production systems and which originated at least 100 years ago. Growers should be very cautious in making large plantings of these varieties until knowledge of their growth and production can be had on a particular site. Many heirloom varieties may have fallen out of commercial interest for good reason- not every apple is a good one just because someone's grandfather once grew it.

Useful Links:

[UMASS Variety Report](#): A diverse library of cultivars for New England orchards

[Apple Cultivars for Wisconsin](#) (PDF)

[The Time is Ripe for an Apple that Tastes Like Berries and One that Doesn't Brown](#) : 2008 Cornell CALS News article

[History of Golden Delicious](#)

[Cummins Nursery](#): Great Variety and Rootstock descriptions

[Scab Resistant Cultivars](#) and [Antique Varieties](#): New York Fruit Quarterly, Winter 2008

[Growing Apples for Cold Climates \(Idaho\)](#)



UVM HREC Apple Orchard (UVM)

ROOTSTOCKS

When selecting a rootstock to use for the cultivar you have chosen, consider what effect the rootstock is going to have on the aerial portion of the tree. The genetic control of the rootstock on the cultivar include:

- **Size.** The overall size of an apple tree will be greatly determined by the rootstock, but you must consider the cultivar that will be grafted onto the rootstock. You may not want to have a low vigor cultivar grafted onto a very dwarfing rootstock because the result may be a very 'runted' tree
- **Date of bloom and amount of bloom.** Some rootstocks may delay or hasten bloom.
- **Precocity.** Precocity or ability to bear fruit early is one of the advantages associated with some rootstocks, particularly the more dwarfing stocks.
- **Winter hardiness.** Winter hardiness of the rootstock is important to consider here in Vermont. Some rootstocks are slower at 'hardening' for winter and might be killed if an early frost occurs.
- **Resistance.** As you are able to choose disease resistant cultivars, so may you choose disease resistant rootstocks to such diseases as fire blight and collar rot.

The History of Rootstocks

Some of the following information is excerpted from the [Penn State Tree Fruit Production Guide](#). Further information on specific rootstocks can be found at the [Cornell University Apple Rootstock fact sheets](#) page.

Rootstocks to control tree size have been used in apple production for over 2,000 years. The clonal apple rootstocks that we use in the United States have traditionally originated in Europe.

In the mid-1800s horticulturists began referring to rootstocks by name. They were called Paradise (or French Paradise) or Doucin (or English Paradise), the former being more dwarfing than the latter. These plants, however, showed much variation in size control. In addition, many new stocks had been introduced inaccurately under these names; undoubtedly viruses and genetic mutations had occurred in the plant material. In the late 1800s one author described 14 different kinds of Paradise rootstocks. This diversity led researchers at England's East Malling Research Station to gather the selections to determine their trueness to name. The researchers concluded that indeed there were numerous misnamed and mixed collections of plant material.

Dr. R. Hatton decided that because of the confusion, he would drop the proper names and assign each stock a number. He assigned a Roman numeral to each of 24 selections but did not number them in any order with respect to tree size. Hence, M.9 with a larger number is a smaller tree than M.2.

Most of these, with the exception of M.9, M.7, M.2, M.8, and M.13, were never commercially important in the United States. In succeeding years some rootstocks were developed from controlled crosses, M.26 and M.27 being the most famous.

In 1917 a second research station, the John Innes Institute of Merton, England, joined with the East Malling station to begin a breeding program. Their efforts, oriented mainly toward developing rootstocks resistant to woolly apple aphids, produced the Malling-Merton series of rootstocks, of which MM.106 and MM.111 are still used widely today.

In the late 1960s, researchers began work to remove many of the viruses naturally present in the rootstocks in order to reduce incompatibility problems caused by the viruses. The first rootstock to be partially cleaned up was M.7; it was designated M.7a. Later still, more viruses were removed from all of the Malling and Malling-Merton series of rootstocks. These were then designated EMLA for the East Malling and Long Ashton research stations in England. While the viruses have been removed, some of the rootstocks' size control has been lost. Therefore, the old "dirty" M.9 will produce a smaller tree than the "clean" M.9EMLA. Currently in the industry nearly all apple rootstocks are virus free.

The next few years will bring several new rootstocks, many developed in Europe. Those likely to be available first are the Budagovsky series. Designated as either Bud or B, they were developed in the central plains of the Soviet Union for their cold-hardiness. The next rootstocks to be released will probably be from Poland and are called the "P-series." Like the Russian series they are expected to have some cold-hardiness. The P-series was developed from crosses between M.9 and common Antonovka. Reportedly, these stocks have good resistance to collar rot.

The newest rootstocks, however, are being developed here in the United States. One group comes from Cornell University's breeding program, which has bred rootstocks for resistance to fire blight. Some of these rootstocks are also resistant to other problems such as apple scab, collar rot, and woolly apple aphids, and exhibit a reduction in burr knot formation.

A large multistate research program known as the NC-140 Research Project is primarily responsible for conducting most evaluations of these new rootstocks. Penn State has been a member of this project since its inception.

Growers should be aware of each rootstock's known capabilities and limitations. Many of the newer rootstocks will probably be available to the commercial industry before they have been thoroughly evaluated with different cultivars.

SPECIFIC ROOTSTOCKS

The following are brief descriptions of and comments on apple rootstocks. Rootstocks are listed in order from smallest to largest. (Much of the information was gleaned from research reports of the NC-140 committee from around the country).

Malling 27 (M.27)

Malling 27 (M.27) is a very dwarfing rootstock. Unless the central leader is supported, the tree will be very small. Little is known about disease or insect susceptibility. To date, most commercial nurseries are using this rootstock only as an intermediate stem piece on MM.106 or MM.111. If handled and spaced properly, it can be a very productive stock for a vertical axe system.

Budagovsky 469 (B.469)

Budagovsky 469 (B.469) induces dwarfing similar to that of M.27 and is very winter hardy. Its only use would be for an interstem. Test plantings of Ginger Gold with this rootstock at University Park have not been viable. In New York State trials B.469 has shown very good compatibility between the scion, without the typical overgrowth. Not widely available.

Geneva 65 (G.65)

Geneva 65 (G.65) was developed by Dr. Jim Cummins at Cornell University. Tree size once thought to be about that of M.9 is now considered to be closer to M.27. The rootstock is difficult to propagate in nursery stool beds. It is susceptible to tomato ring spot virus and apple stem grooving virus. It is resistant to fire blight and collar rot.

Budagovsky 9 (B.9 or Bud9)

Budagovsky 9 (B.9 or Bud9) is a dwarfing rootstock bred in the Soviet Union from the cross of M.8 x Red Standard (Krasnij Standart). Like the other stocks in this series, the leaves are a distinctive red. Trees on this stock are 25 to 35 percent smaller than M.9EMLA depending upon the cultivar. In a 10-year trial at University Park, PA, York Imperial, Rome Beauty, and Empire on B.9 were approximately 25 percent smaller than the same cultivar on M.9EMLA; while Jonagold, Golden Delicious, and McIntosh were approximately 35 percent smaller. B.9 appears to be resistant to collar rot and is very cold-hardy. It has performed very well in colder sites, but its low vigor may prelude its use in some systems. Trees will need to be supported.

Malling 9 (M.9)

The traditional and best-known dwarfing rootstock. It should be planted on a well-drained site. Trees on this rootstock always require leader support. The rootstock is very susceptible to fire blight and can develop burr knots. Numerous clones of M.9 are now being sold by nurseries, including M.9 NAKB 337, the current dominant strain used. It is a virus-free clone from Holland and appears to be 5 to 10 percent less vigorous than M.9EMLA. M.9EMLA is a virus-free clone from the East Malling/Long Ashton research stations. It is approximately 25 to 30 percent more vigorous than M.9. They are 35 to 40 percent more vigorous than M.9 NAKB 337. One other clone is M.9 RN 29, selected by Rene Nicolai in Belgium. In plantings at University Park, PA with Gala, it is approximately 30 percent larger than M.9 NAKB 337.

Geneva 41 (G.41)

Geneva 41 was released in 2005 as a rootstock that produces trees the size of M.9. The rootstock was developed from a cross between M.27 and Robusta 5 made in 1975. It was selected for resistance to *Phytophthora* and fire blight. G.41 has great potential as a replacement for M.9 in areas and with cultivars prone to fire blight, and has performed as well or better than M.9 in NC-140 research trials.

MARK

Formerly named MAC 9, developed in Michigan. It is an open-pollinated seedling of M.9. Trials in Pennsylvania indicate that this rootstock is not freestanding and is slightly larger than M.9. The central leader tends to lean. In recent years this rootstock has fallen into disfavor due to an abnormal growth proliferation at the soil line. Trees with this growth proliferation cease to grow and become spur bound; therefore, it is not recommended to be planted unless supplemental irrigation is provided. Very drought sensitive.

Geneva 16 (G.16)

This is a recent rootstock released from Cornell University's breeding program. Like others in the series, it is resistant to fire blight. It is tolerant of collar rot and immune to apple scab. It is susceptible to woolly apple aphid and powdery mildew. Size is reported to be between that of M.9 and M.26. It does appear, however, to induce wider branch angles in the scion cultivar. Geneva 16 is very sensitive to latent viruses in apple and should only be propagated with virus free scion wood on top.

Malling 26 (M.26)

Malling 26 is a more vigorous rootstock than M.9. It can be used to produce either a dwarf or a semidwarf tree, depending on scion variety, production system, and soil type. It is susceptible to collar rot and fire blight and should not be planted in a wet site. Certain varieties, such as Rome, Stayman, Golden Delicious, and many triploids, when grafted onto this rootstock may exhibit signs of graft union incompatibility. When incompatibility occurs, the trees may break off at the union in high winds. Because exposed portions of the rootstock have a strong tendency to produce burr knots, the union between the scion variety and the rootstock should be set no more than 1 to 2 inches above the final soil level.

Geneva 935 (G.935)

Geneva 935 is a 1976 cross of Ottawa 3 and Robusta 5. Size is reported to be slightly larger than M.26, but the rootstock has resistance to fire blight and crown rot. It is not resistant to wooly apple aphid. Resistant to crown rot and fire blight. Productivity has been excellent in VT NC-140 trials, G.935 has outyielded M.26 consistently.

Geneva 11 (G.11)

The second release of the Cornell breeding program; only limited plantings exist in Vermont. Reported to be similar in size to M.26 but more productive. Has the advantage of being resistant to fire blight and crown rot as well as only rarely producing suckers or burr knots. Availability limited but increasing. Tissue-cultured trees are larger than trees propagated by stool beds.

Geneva 202 (G.202)

Geneva 202 is a semi dwarfing rootstock that produces a tree slightly larger than M.26. It was developed from a cross of M.27 and Robusta 5. It is fire blight and Phytophthora resistant as well as having resistance to wooly apple aphids. The rootstock has been mainly tested in New York and New Zealand. In New Zealand they are looking at this rootstock as a possible replacement for M.26 since it is more productive than M.26. In a 9-year study with the scion cultivar of Liberty, G.202 was about 50 percent smaller than M.7 but had much greater production efficiency.

Geneva 30 (G.30)

The advantages of this M.7-size rootstock are early production, fewer burr knots, and less suckering. NC-140 trials do indicate that trees on this rootstock come into bearing earlier and produce more fruit than M.7. Unfortunately, in the last two years questions have arisen about the graft compatibility of this rootstock with Gala. In tests around the country in the NC-140 trials, there have been occasions where Gala/G.30 have snapped off at the bud union during high winds. Therefore, it is recommended that if Gala is propagated on G.30, the trees be supported by two wires, one at approximately 36 to 40 inches above the ground and a second wire at 8 to 9 feet. Individual stakes or poles have not been sufficient because they allow excessive twisting of the trees in the wind.

Malling 7 (M.7)

This rootstock produces a semidwarf tree that is freestanding in deep well drained soils. In rocky, steep, or shallow soils, it tends to lean. High budding and deeper planting may help remedy this problem. The rootstock may sucker profusely and is susceptible to collar rot. M.7a is a clone of the original M.7. but which has had some of the inherent viruses removed.

Budagovsky 490 (B.490)

This rootstock produces a tree the size of MM.106 and has the same favorable characteristic of inducing early bearing. Burr knots rarely occur. The rootstock has some resistance to collar rot and is reportedly moderately resistant to fire blight. Nurseries find this stock easy to propagate by hardwood cuttings and are grooming it to replace MM.106.

Malling-Merton 106 (MM.106)

A rootstock, slightly larger than M.7, that produces freestanding, early-bearing trees. Trees on MM.106 are susceptible to collar rot when planted in wet soils and are not recommended for poorly drained sites. Delicious on MM.106 is susceptible to apple union necrosis.

Malling-Merton 111 (MM.111)

A well-anchored rootstock, resistant to woolly apple aphids, and tolerant of drier soil conditions. It is the most cold-hardy rootstock readily available. Trees on MM.111 are semistandard to standard in size. Planting depth of this rootstock is critical. The union should be no higher than 1 to 2 inches above the final soil line.

Budagovsky 118 (B.118)

A more vigorous clone out of the Minsk breeding program. It is more vigorous than the other rootstocks in the series but still imparts the high degree of winter-hardiness. It propagates easily in stool beds and does not sucker. It has moderate resistance to fire blight but is susceptible to *Phytophthora*. Because of the vigor of the rootstock it is only recommended for spur strains of apple or in weak soil or replant situations.

SELECTING A NURSERY

The investment you will be making when buying your trees needs to have very careful consideration. The tree quality you buy will have an effect on the life- long productivity of the orchard. Choose a nursery carefully. Ask other growers for suggestions on where to buy your trees.

Things to keep in mind when buying trees:

- Bargain or low priced trees are more costly in the long run because they may be of poor quality.
- Ask the nursery if they have enough trees to meet your demands. You are better delaying your planting for a year than ending up with a mixed block where the spacing might not be correct or trees are not compatible (i.e., cross pollination, blooming time, pest management).
- Ask about any guarantees about survivability, quality, and trueness to type.
- Order early. This will give you a better chance of getting what you want.
- The ideal tree size is 1/2 to 5/8 inch diameter. These trees are usually 4 to 6 feet tall. Avoid larger trees unless you are planting a high density orchard where feathered trees (trees with branches) are better.
- If you need the nursery to custom bud or graft to a particular cultivar, you need to contact the nursery in June or July two years before you wish to plant.
- Information about a nursery from other growers can be invaluable. Ask growers about their experiences with the nursery.
- Tell the nursery when you want the trees to be delivered, and ask them to let you know when they are being shipped so you will be prepared. Here in Vermont, planting is done in the spring when ground has thawed and the danger of hard freezes has past. Early planting in April is better than late planting.

UVM Fruit Program | 63 Carrigan Drive | Burlington, VT 05405

802-656-0972 | terence.bradshaw@uvm.edu

uvm.edu/extension/commercial



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