WV EXTENSION

Rootstocks for Apples

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History of Today's Rootstocks

Apple trees are large trees and could reach 35 to 50 feet in height. Working with such large trees leads to potential problems, such as insect and disease spray coverage, pruning and harvesting. Growing trees on their own roots would create uneven stands due to great genetic diversity. Development of grafting and budding techniques made it possible to use rootstocks to address and overcome potential issues. In its infancy, gardeners used dwarf apple selections as rootstocks to control tree size. By the mid-1800s, there was so much variation in the plant material called by the common names that it was necessary to collect these materials, research them and confirm their identity.

In 1912, the research program started in East Malling Research Station in Kent, England, with the objective of collecting rootstocks "Paradise" and "Doucin" from around the world and confirming their identity. As a result of that study, the common name nomenclature that led to much confusion was abandoned, and a new one of assigning the Roman numerals from I to XXIV was established. A few years later, in 1917, the first apple rootstock breeding program started at the East Malling Research Station. In the 1920s, John Innes Institute at Merton, England, collaborated on apple rootstock breeding program. To distinguish the collaborative hybrids from the ones that came from East Malling Research program, they assigned them an Arabic number starting from 100 with a prefix MM, which stands for Malling-Merton. With some great rootstocks coming out of that collaborative effort in England by 1968, Dr. Jim Cummins started an American apple rootstock breeding program at Cornell University in New York. The objective was focused on resistance, specifically against fire blight (*Erwinia amylovora*), root and collar rots (*Phytophthora spp.*), and wooly apple aphids (*Eriosoma lanigerum, Hausmann*). Following is the list of some of the releases from this program that have been introduced into commercial production.

Choosing the Right Rootstock

There are certain factors influencing rootstock selection. The obvious ones would be the soil characteristics, climatic considerations, desirable tree size, orchard design, disease tolerance and suitability for use on replant sites. Lighter, mineral soils warm up quickly, inducing the early start of the season, and in fall, they cool off just as

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quickly. The growing season is short with the onset of very early frost events in fall and very late frost events in spring. Areas with heavier clay soils rich in organic matter are facilitating more vigorous growth, longer growing season and the same disease complex.

In general, more vigorous rootstocks are better suited for self-standing trees (do not require any support) and for lighter soils with a relatively high percentage of sand in it. Most used rootstocks in this category are MM.111, MM.106, M.7, M.26, Bud 118, G.935 and G.30. There are several new releases from the Geneva, New York, breeding program (G.210, G.222, G.890 and G.969) that fit into this group. For high density plantings, trees are available on the following rootstocks: M.9, M.9-types like Bud 9, Pajam 1(Lancep), NAKB T337, RN 29, G.11, G.41, G.16, G. 214 and Pajam 2 (Cepiland).

Budagovsky 118 or Bud.118 is a semi-dwarf rootstock bred in the Michurin College of Horticulture in Central Russia. The best attribute is that it is extremely winter hardy. It is a semi-dwarf rootstock with a size between MM.111 and MM.106 EMLA. It is precocious like MM.106 EMLA. It is highly productive with a good fruit size. It tolerates wide variety of soils. It has high tolerance to collar and root rot (*Phytophthora spp.*). Tolerance to fire blight (*Erwinia amylovora*) is yet to be determined.

Malling-Merton (MM) Series

MM series of rootstocks were released as a result of collaborative breeding program efforts between East Malling Research Station and John Innes Institute in Merton, England.

MM.111 produces a tree that is about 80% to 90% of a standard (seedling). It is widely compatible with apple cultivars. Tolerates wide range of soils; however, it does not tolerate poorly drained soils. It will suffer from root rots and collar rots (*Phytophthora spp.*). It does not require support. Produces self-standing trees. MM.111 is recommended for light soils that would inherently have more dwarfing effect on a tree and for the inter-stem trees. It is highly tolerant to Armillaria sp., also known as shoe-string root rot. It shows moderate susceptibility to fire blight (*Erwinia amylovora*). This rootstock is not very precocious. It takes six to seven years before it reaches full production capacity. It is moderately productive once established.

MM.106 produces slightly smaller tree than MM.111. It is still about 60% to 75% of a standard tree on a seedling. Trees on MM.106 are well anchored. It performs best on well-drained soils. It shows wide compatibility with different cultivars. It is precocious and highly productive. It does not produce suckers. MM.106 highly susceptible to collar and root rots (*Phytophthora spp.*) and does not tolerate "wet feet." It is highly tolerant to Armillaria spp., moderately tolerant to fire blight (*Erwinia amylovora*), and tolerant to woolly apple aphids (*Eriosoma lanigerum*). Cultivars grafted on this rootstock grow late in a season and go into dormancy very slowly, resulting in heightened susceptibility to cold injury. It does not require support. It is a self-standing tree. Suitable for medium-low density plantings (100 to 300 trees per acre).

M.7 (M.7 EMLA) is a release from East Malling Research Station. EMLA indicates that the rootstock was cleaned up from viruses. This is a semi-dwarf rootstock producing a tree that would be about 60% of a standard tree on a seedling rootstock. Virus-free material is about 20% to 30% more vigorous, or 80% to 90% of a standard, than that

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with the viruses. It is widely compatible with different cultivars. Tolerates wide range of soils but should not be planted in heavy clay due to susceptibility to collar and root rot (*Phytophthora spp.*). It is highly tolerant to Armillaria spp. It has good tolerance to fire blight (*Erwinia amylovora*). It is a shallow-rooted rootstock and needs support, particularly on heavy soils and windy sites. Will tip over without support. Suckers profusely. It is not precocious. It is moderately productive once established. Suitable for medium-low density plantings (200 to 350 trees per acre).

M.26 EMLA is a semi-dwarf rootstock resulting from hybridization between MM.116 (extremely vigorous rootstock) and M.9 (dwarfing rootstock). It gained in popularity quickly because of its size (only 40% to 50% of seedling), precocity and productivity. It shows partial incompatibility with some cultivars. Also, there is tendency for fruit to develop calcium deficiency on this rootstock. It is highly susceptible to fire blight (Erwinia amylovora) and collar rot (*Phytophthora spp.*). It is highly tolerant to *Armillaria*.

M.9 rootstock has been an industry standard when it comes to dwarfing rootstocks. It was released by the East Malling Research Station, England.

M.9 rootstock produces tree only about 30% to 35% of a standard. It has an extremely poor root system that does not provide good anchoring, thus it needs support. It requires well drained, deep soils. It is very precocious; it has excellent productivity. It is not for a spur-type cultivars. It is cold-tender. Burr knots may be a problem. It is highly tolerant to Armillaria sp. and collar and root rot (*Phytophthora spp.*), but extremely susceptible to fire blight (*Erwinia amylovora*).

M.9 EMLA rootstock has replaced the original M.9 rootstock after it was cleaned up from the viruses. It is 35% to 45% of a standard. Virus-free material is slightly larger than the original M.9 that contained viruses, and it is about 30% of a standard. It is precocious, more productive than original M.9; it has larger fruits that mature earlier. It is tolerant to Armillaria sp. and collar and root rot (*Phytophthora spp.*), but extremely susceptible to fire blight (*Erwinia amylovora*).

M.9-type Rootstocks

Mark rootstock was an open-pollinated seedling of M.9. It will produce trees slightly larger than on M.9 with other attributes like M.9. Tree-size is only 25% of a standard. Trees have better anchoring, bloom earlier, excellent productivity and no suckering. It is sensitive to droughty conditions.

NAKB 337 is clone of M.9 developed in Holland. It is one of the most sought-after rootstocks in Europe. It is slightly smaller tree than on M.9. It is very precocious and very productive – produces large, good-quality fruits. It shows sensitivity to powdery mildew, but it is extremely tolerant to collar rot (*Phytophthora spp.*).

Budagovsky 9 or Bud.9 is one from the series of rootstock produced in Michurin College of Horticulture in Central Russia. It is a result of a cross between M.8 and Crveni standard (Red standard). The main objective of they work was to develop rootstocks tolerant to extremely low winter temperatures. Bud.9 is highly tolerant to extremely low temperatures. It is very precocious and has high yielding capacity. In terms of size, it is like M.9 EMLA, about 35% to 45% of a standard. It requires support. It is compatible with most cultivars. It is susceptible to collar rot (*Phytophthora spp.*). It is moderately sensitive to powdery mildew (*Podosphaera leucotricha*) and fire blight (*Erwinia amylovora*).

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Ottawa 3 rootstock is progeny of crabapple Robin and M.9. It produces trees the size of M.26 (40% to 50% of a standard). It is precocious, very productive; however, the fruit size is small. The major limiting factor in its popularization is the fact that it is extremely difficult to propagate. This rootstock is sensitive to wooly apple aphid (Eriosoma lanigerum, fire blight (*Erwinia amylovora*), collar rot (*Phytophthora spp.*) and virus causing brownline decline.

Jork 9 rootstock is an open-pollinated seedling of M.9 developed in Jork Research Station in Germany. It is winter hardy, more easily propagated and equally productive as M.9. It produces large and good quality fruit.

Reně Nicolaï (RN or NIC) rootstocks were developed at the Reně Nicolaï Nursery in Belgium. They are product of bud mutation in M.9 stoolbeds. Three clones were identified and selected: NIC 8, NIC 19 and NIC 29. All three showed better performance than the original M.9 rootstock. All three are about the size of M.9 EMLA (40% to 45% of a standard). All have larger and better developed root system and have higher productivity. The more popular clones are NIC 29 and NIC 8 with NIC 29 being the most sought after. Both clones showed prolific suckering.

Pazan 1 (Lancep) and Pazan 2 (Cepiland) rootstocks are M.9 clones developed in France. Pazan 1, or Lancep, is less vigorous and has lower yielding capacity. Both clones produced significant numbers of suckers.

G-Series Rootstocks from Cornell University, Geneva, New York

The current Geneva rootstocks in production today are result of apple rootstock breeding program that has initiated at Cornell University in Geneva, New York, in 1968 under the leadership of Dr. Jim Cummins. The uniqueness of the program has been that it has been focused on disease resistance, specifically fire blight (*Erwinia amylovora*), root and collar rots (*Phytophthora spp.*) as well as wooly apple aphids (*Eriosoma lanigerum, Hausmann*). Following is the list of some of the releases from this program that have been introduced into the commercial production:

Geneva 65 or G.65 is the most dwarfing out of this group. It is 60% less vigorous than M.9. It is resistant to fire blight and Phytophthora spp., but it is sensitive to woolly apple aphids (*Eriosoma lanigerum, Hausmann*). It has very high yield efficiency, 10% smaller fruit than on M.9. It is a good fit in very high-density plantings of 1,600 to 2,400 trees per acre (4,000 to 6,000 trees per hectare) for large-fruited varieties, like Jonagold and Mutsu. Often, the large fruit size is preventing optimum peckout. This rootstock is difficult to propagate in stool beds, which has hindered its commercial production and availability. A few nurseries are offering it in limited quantities.

Geneva 16 is like vigorous clones of M.9 (RN 29, Pajam 2). It is highly tolerant to fire blight and highly tolerant to Phytophthora spp. and does not show tolerance to woolly apple aphids (*Eriosoma lanigerum*). It propagates easy. Produces a large tree in the nursery that continues with the vigorous growth in the first couple of years before it starts producing fruit. With the onset of cropping, the tree slows down reaching the size like M.9. Precocity, yield and cropping efficiency are slightly better than on M.9. It shows good winter hardiness though it might be more sensitive to early frost in early years due to its more vigorous initial growth. It appears that the rootstock is sensitive to latent viruses found in scion wood, thus use of virus free material is an imperative. If the virus-free material is used, G.16 is the best possible alternative rootstock to M.9

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in areas with high fire blight pressure. It is suitable for planting densities from 800 to 1,200 trees per acre (2,000 to 4,000 trees per hectare).

Geneva 41 is another dwarfing rootstock that has similar vigor to M.9 and G.16, about 40% to 45% of a standard. Disease and woolly apple aphid resistance is like in G.16. It is highly tolerant to fire blight, collar and root rot, wooly apple aphids and replant disease. It may be difficult to propagate since it does not produce many roots and may require higher planting density in stool beds or use of tissue-culture propagation. It is very precocious and productive surpassing M.9. It produces trees with wide branch angles, inducing early fruit production. Fruit size is excellent. It is like G.16 in all the attributes, and it does not have sensitivity to the latent viruses. Trees on G.41 require support, trellis or individual tree support. It is suitable for the same planting density as G.16.

Geneva 11 is more vigorous than G.16 and G.41 and similar in size to M.26, or 45% to 50% of a standard. Yield efficiency is like M.9, and fruit size is like M.26. Shows moderately high tolerance to fire blight (like M.7) and good resistance to Phytophthora root rot, but there is no resistance to woolly apple aphids. It is excellent replacement for M.26 in fire blight prone areas. Planting density should be from 600 to 1,000 trees per acre (1,500 to 2,500 trees per hectare).

Geneva 202 is a semi-dwarfing rootstock producing the tree similar in size to M.26. It has very good resistance to fire blight, Phytophthora and woolly apple aphids. It produces trees about 50% larger than M.9. Yield efficiency is slightly lower than in M.9. It is more productive than M.26. It is excellent alternative for M.26 in areas that woolly apple aphids present a problem. Planting densities are 600 to 1,000 trees per acre (1,500 to 2,500 trees per hectare).

Geneva 210 is a semi-dwarf rootstock producing a tree that is about the size of M.7, but it is more precocious and has higher production capacity. It is resistant to fire blight (*Erwinia amylovora*) and collar rot (*Phytophthora spp.*)

Geneva 214 is a dwarf rootstock that is between M.26 and M.9 in size. It is very winter hardy. It has excellent productivity. It is resistant to fire blight (*Erwinia amylovora*), collar rot (*Phytophthora spp.*) and woolly apple aphids (*Eriosoma lanigerum*). It has low suckering and burr knots potential.

Geneva 890 is a semi-dwarf rootstock highly tolerant to fire blight (*Erwinia amylovora*) and collar rot (*Phytophthora spp.*). Compared to a standard size tree (seedling), it is about 60% to 65% of its size or about the size of M.7. It is very precocious and highly productive.

Geneva 935 is another semi-dwarf rootstock that produces trees slightly larger than M.26. This is the most precocious semi-dwarf Geneva rootstock available. Crop efficiency and fruit size are like M.9. It is highly tolerant to fire blight (*Erwinia amylovora*) and collar and root rot (*Phytophthora spp.*), but sensitive to woolly apple aphids. It shows very good winter hardiness. Recommended planting density is 600 to 1,000 trees per acre (1,500 to 2,500 trees per hectare). G. 935 appears to be excellent replacement for M.26.

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Geneva 969 is a semi-dwarf rootstock producing trees in size like M.7. It is winter hardy. Good yielding potential. It is showing low suckering and burr knot potential. It is highly tolerant to fire blight (*Erwinia amylovora*), collar rot (*Phytophthora spp.*) and woolly apple aphids (*Eriosoma lanigerum*).

Geneva 30 is a semi-dwarf rootstock producing mature trees like M.26. In the early years, the growth is more vigorous resembling M.7. This rootstock is difficult to propagate due to the production of numerous side shoots (spines) on each shoot in propagation bed that require manual removal. It is highly tolerant to fire blight (*Erwinia amylovora*), collar and root rot (*Phytophthora spp.*), and replant disease. It is precocious and very productive. G.30 has weak graft union and requires support. Despite the problems, G.30 has found its place due to high productivity and wide adaptability to soil and climatic conditions. Recommended planting density is 400 to 600 trees per acre (1,000 to 1,500 trees per hectare).

References

Janick, Jules: (Gennaro Fazio1, Terence L. Robinson2 and Herb S. Aldwinckle3). 2015. Plant Breeding Reviews: Volume 39. Wiley Online Library 20 NOV 2015 http://onlinelibrary.wiley.com/doi/10.1002/9781119107743.ch08/summary

Robinson, T., G. Fazzio, H. Aldwinckle, S. Hoyng. 2004. Performance of the New Geneva Apple Rootstocks in Trials in the Unites States, New Zeland and Europe. IDFTA, The Compact Fruit Tree, Volume 37, Number 3, p. 91-94

M. Bulatović-Danilovich; R. Perry. 1996. Klonske podloge za jabuku tipa M.9 (M.9 Clonal Rootstocks). Jugoslovensko vocarstvo, 30/115-116:209-216

Rom, Roy and Carlson, Robert F. 1987. Rootstocks for Fruit Crops. John Wiley & Sons, Inc. ISBN 0-471-805513

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