ROOTSTOCKS

Probably just as important as variety selection is the selection of rootstock for height, soil, moisture and suckering to name a few. This eBook covers general information for rootstocks and specific information for individual rootstocks. Twenty-two apple, 11 pear, 3 Asian pear, 6 cherry and 10 stone fruit rootstocks are described.

GENERAL INFORMATION ABOUT ROOTSTOCKS

There are four primary factors controlling tree size: rootstock, *vigor* of *cultivar*,* soil fertility, and climate. Generally rootstock is the primary factor in tree height. Rootstocks have been selected to control the size of the tree. Then vigor of the *variety* grafted on the rootstock will cause a variance in tree height. This is followed by soil fertility and climate. This is why a size range is given for any rootstock that you select.

The lower portion of a fruit tree is called the *rootstock*. This is the portion of the tree that has been grafted over to a specific variety or cultivar. Different rootstocks provide opportunities for everyone to enjoy the thrill of growing your own fruit. If you have limited growing space you could choose a super-dwarf rootstock that limits the height of your tree to as little as 5 feet! There are possibilities and sizes to match almost any need. Lastly, pruning has a great impact on size. When the tree has reached the height that you want, the easiest, most effective way to keep fruit trees at that height is through summer pruning.

BEWARE OF MINI-DWARF, DWARF, SEMI–DWARF, AND STANDARD LABELS

These terms that may (usually) be seen on labels for fruit trees have little meaning for the average consumer. For example, semi–dwarf is a tree that is smaller than standard. That's nice! Just how tall is a standard tree? (See below). You may also see on the label, "50% of standard size." If the nursery does not or will not name the rootstock for you, my suggestion is DO NOT DO BUSINESS WITH THEM! The nursery should be able to tell you the specific name of the rootstock. It is only with that name that you will have a rough estimate of tree size. You may be shocked that the "semi–dwarf" that you purchased grows to 20-24 feet tall. No matter the name of the rootstock, you will also be told that you can prune the tree to keep it the height that you want. This is a valid statement, but why fight genetics. In the long run, genetics will win.

SUGGESTIONS ON CHOOSING ROOTSTOCKS

In many cases, 10-20 different rootstocks will produce the same size of tree. Then, how do you make a choice that you will not regret? To take the confusion out of choosing your rootstock, you need to make some decisions in advance. You need to determine tree size, winter hardiness, soil type present, staked or free-standing tree, irrigation or no irrigation, sucker vs non-suckering, burrknots vs no burrknots and disease

resistance wanted in your rootstock. Knowing these characteristics of the rootstock in advance will make your selection wiser and easier.

* italicized terms are defined in the glossary except for scientific names which are always italicized.

JUST HOW LARGE IS A "STANDARD" TREE ANYWAY?

When reading the descriptions of dwarf and dwarfing rootstocks, you will come across statements like this: "produces a tree 50-60% of standard." Nice statement, but do you know how large a standard tree is? Most of us do not know. So, 50-60% of what tree height? The following information will partially answer the question. Partially, because variety, soil fertility, early cropping and climate all play a role in determining tree height.

HEIGHT AND WIDTH OF SELECTED STANDARD UNPRUNED TREES IN FEET

	HEIGHT	WIDTH
Almond	35	30
Apple	40	40
Apricot	30	30
Asian Pears	20	15
Cherry (Sweet)	45	40
Cherry (Sour)	15	10
Chestnut	50	40
Cornelian Cherry	25	25
Fig	35	50
Hazelnut	20	20
Medlar	20	10
Mulberry	35	35
Nectarine	25	25
Paw Paw	25	20
Peach	25	25
Pear	40	25
Persimmon, American	30	25
Persimmon, Asian	20	20
Plum, Japanese	15	20
Plum, European	25	15
Quince	20	20
Walnut, Black	150	100
Walnut, English	60	60

INTRODUCTION TO APPLE ROOTSTOCKS

Standard apple trees are 40 feet tall with a 40-foot diameter.

All apple rootstocks are either seedling or clonal. Seedling rootstocks will produce a standard sized tree with variable characteristics due to sexual reproduction. Whereas, clonal rootstocks are asexually reproduced, hence the characteristics are the same. In selecting rootstocks, consider the vigor to the scion (what is grafted on to the rootstock), soil fertility, cold hardiness, burrknots, root suckers, and disease and pest resistance.

Historically many rootstocks have been selected from the wild and breed for particular traits. The following is a brief explanation of the meaning of some of the symbols and numbers in naming apple rootstocks. Be advised that you will only have a vague estimate of your tree size by selecting rootstocks that are named, Super-dwarf, Dwarf, Semi–dwarf, Semi-vigorous or Vigorous. These terms are vague making them close to meaningless. About all that is communicated by these terms is that Super-dwarf is smaller than Dwarf and Dwarf is smaller than Semi–dwarf and Semi-dwarf is smaller than Semi-vigorous.

Malling Series

Beginning in 1912, the East Malling Research Station in England selected, classified and named a series of vegetative (asexually) propagated apple rootstocks that ranged from very dwarfing to very invigorating in their effect on the *scion* cultivar. The dwarfing influence of these various rootstocks does not extend to the fruit, however, fruit size, especially on young dwarfed trees, is often larger than on standard sized trees. The more dwarfing the rootstock the earlier the tree bears fruit and the larger the fruit. The letter M is used to designate rootstocks from the Malling series, g., M.9.

Malling–Merton Series (MM)

The John Innes Horticultural Institution in England and the East Malling research Station began working jointly in 1928 on breeding a new series of apple rootstocks to provide resistance to woolly apple aphids and to give a range in tree *vigor*. The letter MM is used to designate rootstock from the Malling–Merton series, e.g., MM.111.

Budagovski Series (B or Bud)

Dr. Budagovski, was the most successful apple rootstock breeder in old Soviet Union (Russia), at the college of Horticulture in Michurinsk where temperatures drop to -55˚F. These rootstocks are very cold hardy that is it will survive harsh cold environments. Knowing where the rootstock was developed will give you some indication to its cold hardiness The Budagovski series of rootstocks are identified with a B, e.g., B.491.

Poland Series (P)

Dr. S. W. Zagaja at Skierniewice, Poland, made original crosses in 1954. The Poland breeding program was started with three hardy apple cultivars (‘Antonovka’, ‘Longfield’ and ‘Glogerowka’) crossed with M.9 and M.4 and about 3,000-hybrid

seedlings were grown. Several promising selections were found among the Antonovka progenies and were subjected to various tests. The Poland series of rootstocks are identified with a P, e.g., P.22.

EMLA

Virtually all of the rootstock in use was infected with various viruses. The enzyme-linked immunosorbant assay (ELISA) test has proven useful in virus disease detection. Any rootstock that passes the ELISA test is then designated, EMLA, and is virus free. Virus free rootstock will produce a tree 10 to 15% larger than when infected with a virus.

BURRKNOTS

Burrknots are above ground root *primordia* that form under shaded conditions (either from trunk wrap or excessive suckering). This "warty" growth may result in abnormal tree growth. They are also sensitive to winter injury, and a potential point of entry for fireblight bacteria.

To counter the burrknot problem, plant the susceptible rootstock with as little rootstock as possible above ground. However, do not allow the graft union to be below ground, because it will root and you will lose the dwarfing effect of the rootstock. That is you will have a standard sized tree.

SUCKERING

Shoots originating from the soil line at the base of the trunk or from roots are called root suckers. These are difficult to control chemically, with herbicides or manually, by pruning. There point of origin can also become disease sites for rootstock infection.

PLANTING REMINDER

All woody plants should be planted in a hole large enough to spread out the roots and at a planting depth about 1 inch deeper than they were grown in the nursery. An exception would be an apple rootstock that forms burrknots (see above). All should be watered in even if the soil is wet.

DEPTH OF PLANTING

Because of burrknots the proper depth at which to plant apple trees remains a very important issue. With the exception of high density supported systems (slender spindle, vertical axis, etc.), the bud union should be positioned 2 inches (5 cm) above the final soil level. The length of rootstock shank above the soil surface determines the vigor of the scion. This is a greater factor with dwarf than more vigorous rootstocks. To plant deeper may lead to the scion growing roots and the dwarfing influence of the rootstock being lost. To have the union excessively above the ground will reduce the size of the tree and introduces the possibility of burrknots or aerial roots developing. This disruption in the bark can be invaded by the dogwood borer and can lead to tree losses. For consistency of tree size and to reduce unnecessary trunk injury, special care is required to properly position the bud union.

APPLE ROOTSTOCKS

Following is a list within categories **in order of increasing tree size from top to bottom**. Note: There is a small difference in tree size between closely ranked rootstock and will vary depending on vigor of variety, soil and climate conditions.

MINI-DWARF APPLE ROOTSTOCKS: 4 to 8 feet; (<10-20% standard)

M.27 (EMLA 27)

Size 4 to 8 feet; M.27, released in 1971. If EMLA M.27, virus free, then the tree will be slightly larger (<10-20% of standard)
Pedigree: M.13 x M.9, in 1929
Precocity: Very precocious
Productivity: High, under ideal conditions
Scion Fruit Quality: Generally fine
Anchorage: Very poor, permanent support required
Fireblight: Highly susceptible, others say highly resistant?
Crown & Root Rots: Considered resistant
Powdery mildew: Moderately susceptible
Hardiness (midwinter): Questionable, slow to harden off
Suckering average per year over 10-year period: 9
Burrknots: Light

Observations, suspicions, and history:
• M.27 is a good choice for container culture.
• Also good for high-density plantings by experienced growers on sites with high fertility and vigor when using large fruited vigorous scion varieties.
• Not recommended for low vigor cultivars (See HOS Publication). Other uses are not recommended due to extremely low vigor of the rootstock. Irrigation and support is a must with EMLA M.27 or M.27.
• Will tolerate heavy (clay) and moist soil.
• Will produce a tree about half the size of M.9
• Bearing age 2 years.
• Planting distance, suggested, 4-5 ft (1.2-1.5m) apart, 6 ft (1.8m) between rows.

P.22 (Poland 22)

Size: 4 to 8 feet, slightly larger than P.16 and slightly smaller than M.9 EMLA (<10-20% of standard)

Pedigree: M.9 x 'Common Antonovka,' developed by S. W. Zagaja at Skierniewice, Poland
Precocity: Very precocious, similar to M.9
Productivity: Very productive, more yield efficient than M.9
Anchorage: Fair, support required for first five years

Fireblight: Susceptible, further testing required; resistant in England
Crown & Root Rots: Resistant
Woolly Apple Aphid: Susceptible
Powdery mildew: Moderately resistant
Hardiness (midwinter): Among the most cold tolerant rootstock genotypes
Suckering: Light to none
Burrknots: Light

Observations, suspicions, and history:
• P.22 is suitable for container growing.
• Similar to the discrepancies with P.2, P.22 has proven inconsistent across sites for the level of vigor control.
• P.22 does best on medium (loam), moist and fertile soils.
• P.22 produced 10 to 12 foot trees in Norway, but appears similar to M.27 in U.S. trials.
• P.22 is a good cold tolerant option for growers with vigorous scion cultivars, rich soils, and intensive management.
• Over cropping of young trees must be avoided, and trickle irrigation is highly recommended to avoid drought stress.
• P.22 is a direct and strong competitor for the market niche presently dominated by M.27.
• Tree size on P.22 is uniform within individual sites.
• Irrigation and staking is required.
• Bearing age 2-3 years.
• Planting distance, suggested, 4-5 ft (1.2-1.5m) apart, 6 ft (1.8m) between rows.

P.16 (Poland 16, Lizzy)

Size 4 to 8 feet (<10-20% of standard)

Pedigree: 'Longleaf' x M.9, developed by Dr. S. W. Zagaja at Skierniewice, Poland
Precocity: Very precocious, similar to M.27
Productivity: Very productive, more yield efficient than M.9
Scion Fruit Size: Large
Anchorage: Poor, permanent support required
Fireblight: Susceptible, further testing required
Crown & Root Rots: Resistant
Woolly Apple Aphid: Susceptible
Hardiness (midwinter): Moderate to excellent hardiness, further testing required
Suckering: Moderate to none
Burrknots: Light

Observations, suspicions, and history:
• P.16 is suitable for container growing.
• P.16 is a rootstock intermediate between M.27 and M.9 in vigor that may have improved cold hardiness and very high yield efficiency.

• P.16 is being planted extensively in Western Europe and is a strong competitor to M.9 and M.27.
• As will all dwarfing rootstocks, irrigation and support is a requirement when establishing high-density orchards.
• P.16 may be less vigorous than P.22 in some Pacific Northwest sites.
• P.16 may be less tolerant of light soils and water stress than some other rootstocks.
• P.16 has characteristic undergrowth of the scion relative to the rootstock trunk diameter.
• Planting distance, suggested, 4-5 ft (1.2-1.5m) apart, 6 ft (1.8m) between rows.

The Poland breeding program was started in 1954 with three hardy apple cultivars ('Antonovka,' 'Longfield' and 'Glogerovka') crossed with M.9 and M.4 and about 3,000-hybrid seedling were grown. Several promising selections were found among the Antonovka progenies and were subjected to various tests.

B.491 (Budagovski 491)

Size: 5 to 7 feet B.491 (Bud 491) (12-18% of standard)

Pedigree: Developed by Dr. Budagovski in Michurinsk, in the former USSR
Precocity: Very precocious, similar to M.27, fruit in 2-3 years
Productivity: Rated as medium to excellent for the size class
Scion Fruit Quality: Good coloring on one trial, may transfer more calcium (Ca^{2+}) to leaves and fruits than other genotypes, important for bitter pit control
Anchorage: Requires permanent strong support
Fireblight: Susceptible
Crown & Root Rots: Susceptible, further testing; required
Woolly Apple Aphid: Susceptible
Powdery mildew: Susceptible
Hardiness (midwinter): Reportedly extremely winter hardy
Suckering: Light
Burrknots: Light/medium

Observations, suspicions, and history:
• B.491 is suitable for container plantings.
• B.491 may become a competitor to M.9 and M.27 in the future.
• B.491 is intermediate in size between the two.
• There remain many questions about the likely future of this rootstock in North America.
• B.491 should be planted on a limited scale for on-farm and backyard testing by growers when planting M.27.
• B.491 may be appropriate for use in high-density plantings on fertile soils with vigorous scion varieties, particularly in areas where M.27 has insufficient winter hardiness.
• Possible improvements in fruit quality due to higher calcium loading of fruits should be explored more fully.
• B.491 must be irrigated and staked.
• Bearing age 2-3 years
• Planting distance, suggested, 4-5 ft (1.2-1.5m) apart, 6 ft (1.8m) between rows.

G.65 (Geneva 65, Little Beauty)

Size 6 to 10 feet (15 to 25% of standard)

Pedigree 1974 cross of M.27 x Beauty Crabapple
Precocity: Excellent
Productivity: Very good
Scion Fruit Size: Reduced fruit size
Anchorage: Support required
Fireblight: Excellent resistance
Crown & Root Rots: Screened as a seedling, currently testing
Woolly Apple Aphid: Moderately susceptible
Powdery mildew: Good resistance
Hardiness (midwinter): Currently testing
Suckering: Moderate to heavy
Burrknots: Light

Observations, suspicions, and history:
• US distribution hampered by misidentifications, mislabeled and G.65 has not recovered from the error.
• Virus free scion budwood required.
• G.65 is very difficult to propagate, which may result in significantly increased tree costs should it ever encounter strong demand from growers.
• G.65 is a good choice for on-farm and backyard trials to compare with P.22, P.16, B.491, and M.27.
• Suitable for containers.
• Must be irrigated and staked.
• Planting distance, suggested, 5-8 ft (1.5-2.4m) apart, 8 ft (2.4m) between rows.

B.146 (Bud. 146, Budagovski 146)

Size: 8 to 12 feet (20 to 30% of standard)

Precocity: Very precocious, similar to M.27
Productivity: Highly productive like M.9
Scion Fruit Size: Typically large fruited, comparable to M.9
Anchorage: Requires strong support, B.146 has particularly brittle roots
Fireblight: Susceptible, further testing required
Crown & Root Rots: Undetermined, further testing required
Woolly Apple Aphid: Susceptible
Hardiness: (midwinter) Reportedly extremely winter hardy
Suckering: Moderate/variable - perhaps strain specific
Burrknots: Moderate/variable - perhaps strain specific

Observations, suspicions, and history:
• B.146 is suitable for container plantings.
• B.146 may become a competitor to M.9 and M.27 in the future, an intermediate in size between the two.
• Many questions remain about the likely future of this rootstock in North America.
• B.146 should be planted on a limited scale for on-farm and backyard testing by growers when planting M.27.
• B.146 may be appropriate for use in high-density plantings on fertile soils with vigorous scion varieties, particularly in areas where M.27 has insufficient winter hardiness.
• B.146 must be irrigated and staked.
• Planting distance, suggested, 8-10 ft (2.4-3m) apart, 12 ft (3.6m) between rows.

M.9
Standard apple trees are 40 feet tall and 40 feet wide.

IMPORTANT M.9 INFORMATION!

There are many strains of M.9. One 10 year study compared six different strains of "M.9," **M.9 EMLA, M.9 Fleuren 56, M.9 Pajam 1, M.9 Pajam 2, M.9 RN29 and M.9 NAKBT337**.

M.9s ranked according to size from **smallest to largest: M.9 Fleuren, M.9 NAKBT337, M.9 EMLA, Pajam 1, RN29** and **Pajam 2**. Trees on Fleuren 56 were nearly 70% smaller than those on Pajam 2. This experimental evidence makes it imperative that you know which "M.9" you are purchasing to help predict tree size.

Size: 9 (M.9 Fleuren) to 14 feet (Pajam 2) (22 to 35% of standard)

Pedigree: Chance seedling, an English selection of a group of French genotypes known collectively as "Jaune de Matz" in 1879.
Precocity: Very precocious
Productivity: High, under the correct conditions
Scion Fruit Size: Typically large fruited
Anchorage: Poor, support required due to brittle roots and a high fruitwood ratio
Fireblight: Extremely susceptible
Crown & Root Rots: Considered resistant
Woolly Apple Aphid: Susceptible
Powdery mildew: Moderately susceptible
Hardiness (midwinter): Questionable - may be less hardy where soil drainage is poor. Has remained productive in British Columbia and Norway following severe winters.

Suckering: Average per year over 10-year period

M.9 Rootstock	# of Suckers/year
M. 9 EMLA	14
M.9 NAKBT337	22
M.9 RN 29	26
M.9 Pajam 1	28
M.9 Fleuren 56	37
M.9 Pajam 2	42

Burrknots: Light to heavy, depending on subclone and propagation methods

Observations, suspicions, and history:
• M.9 is suitable for container culture.
• M.9 is often a good choice for use in high-density plantings by experienced growers.
• M.9 requires a higher level of management than many larger types of rootstocks, but it has a well-established history of high productivity and precocity.
• M.9 and all subclones and close relatives are particularly susceptible to fireblight, a problem exacerbated by heavy suckering.
• All growers should use extreme caution when planting M.9 with highly susceptible fireblight scion varieties such as 'Ginger Gold,' 'Pink Lady,' 'Gala,' 'Fuji,' and some other varieties that are presently popular.
• Burrknots increase with increased budding height, and M.9 NAKBT337 and Pajam 1 have the most burrknots, therefore, plant the graft union lower than normal and burrknots
• M.9 has a shallow root system that is relatively weak, and it is also more susceptible to water stress than many other rootstocks.
• Irrigation and staking is always recommended for M.9 orchards.
• Not suited to dry, light soils; uncontrolled flowering can lead to runting-out of the tree
• Where conditions favor vigorous tree growth, early fruiting may be essential to control tree size
• Will not do well under poor drainage conditions but it is tolerant of collar-rot and does well on heavier soils where drainage is adequate
• Bearing age 2-3 years
• Planting distance, suggested, 8-10 ft (2.4-3m) apart, 12 ft (3.6m) between rows

DWARF APPLE ROOTSTOCKS: 10 to 22 feet; 30-55% of standard)

P.2 (Poland 2)

Size: 8 to 12 feet, may vary on the tall side (20 to 30% of standard)

Pedigree: M.9 x Common Antonovka, developed by Dr. S. W. Zagaja at Skierniewice, Poland: original crosses made in 1954
Precocity: Very precocious, similar to M.9
Productivity: Very productive, similar to M.9
Anchorage: Support recommended for several years
Fireblight: Susceptible
Crown & Root Rots: Variable screening results, further testing required
Woolly Apple Aphid: Susceptible
Powdery mildew: Moderately resistant
Hardiness (midwinter): Originally released as a colder tolerant competitor to M.9, later tests have been inconclusive. P.2 is probably among the most cold tolerant rootstock genotypes, but perhaps not in late winter/early spring.
Suckering: Light
Burrknots: Light

Observations, suspicions, and history:
• There is a conflict between European and American trial results in P.2 - American trials have placed P.2 consistently as a more dwarfing rootstock than M.9, while European trials have generally found P.2 to be significantly larger than M.9.
• In the Pacific Northwest, P.2 is considered to be competitive with MARK, B.146, and B.491.
• P.2 is a promising cold hardy genotype.
• P.2 is recommended for orchard testing by growers in regions where fireblight is less severe, like the Willamette Valley.
• Bearing age 3 years.
• Planting distance, suggested, 8-10 ft (2.4-3m) apart, 12 ft (3.6m) between rows.

B.9 (Bud.9; Budagovski 9, Red-leafed Paradise 9, and Paradizka Krasnolistnaya 9)

Size: 8 to 12 feet (20 to 30% of standard)

Pedigree: M.8 x Red Standard, developed by Dr. Budagovski in Michurinsk, in the former USSR
Precocity: Very precocious, similar to M.9
Productivity: High, under the correct conditions, similar to M.9
Scion Fruit Size: Good, typically large fruited, similar to M.9
Anchorage: Poor, requires support like M.9
Fireblight: Not adequately tested, but it may be more tolerant to field infections of fireblight than M.9
Crown & Root Rots: Claimed to be resistant, more resistant than M.9 in some trials

Woolly Apple: Susceptible
Powdery mildew: Susceptible
Hardiness (midwinter): Reportedly extremely winter hardy, but some reports say M.26 is more cold hardy (perhaps particularly for late winter cold snaps)
Suckering: Few/light
Burrknots: Few/light, usually not a problem
Virus hypersensitivities: Tolerant of common latent viruses

Observations, suspicions, and history:
• B.9 is a good choice for container culture.
• B.9 is probably a good choice for use in high-density plantings, especially in areas where extremely low midwinter temperatures are possible.
• Recommended as an *interstem* in colder regions.
• The late fall and early spring cold hardiness of B.9 has not been sufficiently tested.
• In some trials B.9 has shown better resistance to the rootstock phase of fireblight than M.9 (not to worry in the Willamette Valley, OR, not enough heat units, unless global warming becomes more severe), in other trials they have had similar reactions.
• B.9 is a strong competitor to M.9, and appears to be gaining in popularity in North America.
• Bearing age 2-3 years.
• Planting distance, suggested, 8-10 ft (2.4-3m) apart, 12 ft (3.6m) between rows.

O.3 (Ottawa 3)

Size: 9 to 13 feet (22 to 32% of standard)

Pedigree: M.9 X Robin (hardy crabapple)
Precocity: Precocious, slightly less than M.9
Productivity: Very productive, similar to M.26
Scion Fruit Size: Good, comparable to M.26
Scion Fruit: Good, high coloring
Anchorage: Support recommended, but anchorage better than M.9, similar to M.26
Fireblight: Susceptible
Crown & Root Rots: Variable susceptibility, conflicting reports
Woolly Apple Aphid: Susceptible
Powdery mildew: Susceptible
Hardiness (midwinter): Originally released as a colder tolerant competitor to M.26, later tests have been inconclusive. O.3 is probably among the most cold tolerant rootstock genotypes, but perhaps not in late winter/early spring.
Suckering: Light to none
Burrknots: Light to none

Observations, suspicions, and history:
• Suitable for container culture.
• O.3 is a promising cold hardy rootstock for growers interested in a rootstock generally considered intermediate between M.9 and M.26 in vigor.

• On light textured soils O.3 may perform better than trees on more size-controlling rootstocks.
• Because O.3 is difficult to propagate in the *stoolbed* there are few nurseries willing to supply it.
• Virus indexed scion wood is strongly recommended whenever propagating O.3 nursery trees.
• Must be irrigated and staked.
• Planting distance, suggested, 8-10 ft (2.4-3m) apart, 12 ft (3.6m) between rows.

G.16 (Geneva 16)

Size: 10 to 14 feet (25 to 35% of standard)

Pedigree: Ottawa 3 x *Malus floribunda*, 1981, Cornell University/Geneva Apple Rootstock Breeding Program
Precocity: Very precocious, similar to or better than M.9
Productivity: High in initial test orchard
Scion Fruit Size: Fruit size has been adequate
Scion Fruit Quality: No problems noted
Anchorage: Moderate, perhaps better than M.9, support required
Fireblight: Highly resistant
Crown & Root Rots: Screened, but not yet confirmed to be resistant
Woolly Apple Aphid: Susceptible
Hardiness (midwinter): Currently testing
Suckering: Light, less than M.9
Burrknots: Rare
Virus hypersensitivities: Hypersensitive to at least one latent virus Note: Only virus free budwood should be used with this rootstock

Observations, suspicions, and history:
• G.16 appears to be a very highly productive *dwarfing rootstock* with excellent fireblight resistance that may challenge M.9.
• Very limited orchard trials suggest caution should be exercised until more experience lends confidence to this rootstock.
• Planting distance, suggested, 10-12 ft (3-3.7m) apart, 12 ft (3.6m) between rows.

M.26, EMLA 26 (virus-free, will be slightly larger)

Size: 18 to 22 feet (Recently, M.26 has been labeled “dwarf.”) (45 to 55% of standard)

Pedigree: M.16 x M.9, 1929, part of the Malling M series from East Malling Research Station, UK
Precocity: Precocious, slightly less than M.9
Productivity: High
Scion Fruit Size: Good
Scion Fruit Quality: Generally fine, good coloring

Anchorage: Good to fair, support recommended at least for early growth and beyond, will lean with many cultivars, M.26 will become self-supporting after about 5 to 8 years but tree support is still recommended for early economical cropping
Fireblight: Extremely susceptible
Crown & Root Rots: Variably susceptible, conflicting reports, some say moderately resistant
Woolly Apple Aphid: Susceptible
Powdery mildew: Moderately resistant
Hardiness (midwinter): Most hardy of Malling series rootstocks
Suckering average per year over 10-year period: 2
Burrknots: Moderate to heavy, deep planting, keeping the union just above the soil surface, reduces burr-knot formation, increasing tree stability and discourages suckering

Strains: EMLA; virus-free clone. Some "smooth" subclones exist that exhibit less size control

Observations, suspicions, and history:
• Partial incompatibility with some cultivars, including 'Blaxtayman' and 'Holiday,' may occur. • Somewhat drought susceptible, but also sensitive to *Phytophthora* species induced root rots, so irrigation and good drainage are essential
• Will not perform satisfactorily on poorly-drained sites
• M.26 is a good choice for density plantings in poorer soils and/or for less vigorous scion varieties in areas where fireblight can be managed.
• When grafted to spur type scions, EMLA 26 should be planted on higher fertility soils.
• M.26 is a risky choice for use with fireblight susceptible scion cultivars in any region.
• In some locations M.26 produces a smaller tree than M.9.
• Staking is strongly suggested, some say staking is not required, but most trees will "lean over" with heavy crop and wet soil.
• Some compatibility problems have been identified with some cultivars.
• Uncontrolled early fruiting slows development of good anchorage, induces loss of vigor, produces fruiting-out and loss of the central leader and encourages the onset of a spur-bound condition.
• Bearing age 2-3 years.
• Planting distance, suggested, 10-12 ft (3-3.7m) apart, 12 ft (3.6m) between rows.

Supporter™ 4, var Pi-80 Select (Pollinizer 80, Pi-80)

Size: 18 to 22 feet (45 to 55% of standard)

Pedigree: M.9 x M.4
Precocity: Precocious
Productivity: Competitive with M.26, more yield efficient than M.26 in some German trials
Scion Fruit Size: Said to be better than M.26
Anchorage: Support usually recommended for young orchards, reported to be better anchored than M.26

Fireblight: Extremely susceptible
Powdery mildew: Susceptible
Hardiness (midwinter): Moderate to excellent hardiness, further testing required
Suckering: Light
Burrknots: Light
Strains Supporter™ 4, var Pi-80 Select is reportedly a better-rooted strain of the original Pi-80, which is not present in North America

Observations, suspicions, and history:
• Supporter™ 4, var Pi-80 Select may become a strong competitor with M.26.
• Reports vary, but Supporter™ 4, var Pi-80 Select is usually reported to impart slightly more vigor on the scion than M.26.
• Orchard trials have shown Supporter™ 4, var Pi-80 Select to be as productive as M.26 or better, but it is easier to propagate in the stoolbed.
• Extensive testing and now planting in Europe has generated strong interest in this rootstock.
• Supporter™ 4, var Pi-80 Select is extremely hypersensitive to fireblight, similar to M.26.
• Planting distance, suggested, 10-12f t (3-3.7m) apart, 12 ft (3.6m) between rows.

SEMI-DWARF APPLE ROOTSTOCKS: 22-26 feet; 55-65% of standard)

G.30, Geneva 30

Size: 22 to 26 feet (45 to 65% of standard)

Pedigree: Robusta 5 x M.9, in 1974
Precocity: Very precocious, similar to M.26, very early and better than M.7A
Productivity: High in NC-140 and grower trials
Scion Fruit Size: Fruit size has been adequate
Scion Fruit: Quality, no problems noted
Anchorage: Poor, support required, others report support not required?
Fireblight: Highly resistant
Crown & Root Rots: Resistant
Woolly Apple Aphid: Susceptible
Powdery mildew: Data not available
Hardiness (midwinter): Currently testing, probably good
Suckering: Moderate, less than M.7
Burrknots: Rare
Virus hypersensitivities: Data not available

Observations, suspicions, and history:
• G.30 is a very productive "semi–dwarf" rootstock with excellent fireblight resistance. However, it has brittle wood and requires strong trellis support.
• Similar to M.7 but superior in almost all-important characteristics.
• One notable problem with G.30 is that it forms a weak graft union with brittle cultivars such as 'Gala.'
• Planting distance, suggested, 12-14 ft (3.7-4.3m) apart, 12 ft (3.7m) between rows.

M.7, M.7A, EMLA 7

Size: 12 to 20 feet (30 to 50% of standard) (EMLA 7, virus-free, will be slightly larger)

Pedigree: Descended from 'Doucin Reinette' ("Sweet little queen") first described in 1688.
Precocity: Somewhat precocious
Productivity: Moderate to low under most conditions but can be high
Scion Fruit Size: Fruit size is often small with M.7
Scion Fruit Quality: Generally fine, bearing in 4 years
Anchorage: Good, typically free-standing when mature, could use support with some cultivars, subject to blow down if tap root impeded by shallow soil or bedrock
Fireblight: Resistant
Crown & Root Rots: Considered resistant but very susceptible to crown gall in Oregon and Washington
Woolly Apple Aphid: Susceptible
Powdery mildew: Moderately resistant

Hardiness (midwinter): Highly questionable - probably less hardy than M.9
Suckering: Heavy
Burrknots: Light, more on M.7A
Virus hypersensitivities: Tolerant
Strains: M.7A - virus reduced clone. M.7 EMLA - virus free clone has slightly increased vigor.

Observations, suspicions, and history:
• M.7 can be a good choice, particularly in marginal apple production areas, due to the high tolerance it exhibits to fireblight and root diseases.
• M.7 is especially useful with spur-type scion cultivars and on very poor sites.
• Staking is required for 5 years.
• Use of M.7 is declining in North America because it has only moderate productivity for most applications and suckers heavily.
• Performs best on a good soil in a location protected from the wind
• EMLA 7 performs better on deep fertile loam soils of a moderate to heavy texture under a wide range of conditions. It does not perform well on light sandy soils or under low fertility and has no drought tolerance.
• Bearing age 3-4 years.
• Planting distance, suggested, 12-14 ft (3.7-4.3m) apart, 12 ft (3.7m) between rows.

SEMI-VIGOROUS APPLE ROOTSTOCK: 26-34 feet; 65-85% of standard

MM.106, Malling Merton 106, EMLA MM.106

Size: 26 to 30 feet (EMLA MM.106, virus-free, will give a slightly larger tree) (65 to 75% of standard)

Pedigree: 'Northern Spy' x M.1
Precocity: Somewhat precocious, crops early for larger tree
Productivity: High, very good for the size
Scion Fruit Size: Not as large as M.9
Scion Fruit Quality: Not as good as M.9
Anchorage: Good, typically free-standing when mature
Fireblight: Susceptible
Crown & Root Rots: Highly susceptible
Woolly Apple Aphid: Resistant
Powdery mildew: Data not available
Hardiness (midwinter): Highly questionable, needs further testing, very susceptible, early, hardy late winter
Suckering: Light
Burrknots: Light
Virus hypersensitivities: Hypersensitive to Tomato Ringspot Virus

Observations, suspicions, and history:
• MM.106 can be a good choice, and is more productive than M.7 on most well drained sites.
• Commercial interest in MM.106 is declining because it is larger than necessary for most applications.
• MM.106 is a good choice for spur type scion varieties on poor, light soils.
• More sensitive to soil moisture than most, do not plant on poorly drained soils because MM 106 is susceptible to collar rot (*Phytophthora cactorum).*
• MM.106 is a popular interstem tree with M.9 grafted to it. The interstem tree will produce a tree up to 20 feet tall.
• Bearing age 3-4 years.
• Planting distance, suggested, 12-14f t (3.7-4.3m) apart, 15 ft (4.5m) between rows.

B.490 (Bud.490, Budagovski 490)

Size: 28 to 34 feet (70 to 85% of standard)

Pedigree: B.9 x B.13-14, developed by Dr. Budagovski in Michurinsk, in what was USSR
Precocity: Somewhat precocious, similar to MM.106
Productivity: High, very good for the size, similar to MM.106, but reports of both high and low productivity
Scion Fruit Size: Not as large as M.9, smaller than MM.106 in some trials

Scion Fruit Quality: Data not available
Anchorage: Good, generally free standing
Fireblight: Susceptible, further testing required, others say tolerant
Crown & Root Rots: Susceptible, further testing required, others say moderately resistant
Woolly Apple Aphid: Susceptible
Powdery mildew: Susceptible
Hardiness (midwinter): Reportedly extremely winter hardy, but some reports say M.26 is more hardy (perhaps particularly for late winter cold snaps)
Suckering: Free from suckering
Burrknots: Moderate to severe

Observations, suspicions, and history:
• B.490 may become a competitor to MM.106 and M34 in the future.
• Bearing age 3-4 years.
• Planting distance, suggested, 16-18 ft (4.9-5.5m) apart, 16 ft (4.9m) between rows.

MM.111, EMLA MM.111

Size: 30 to 34 feet (EMLA MM.111 will be slightly larger than MM.111) (75 to 85% of standard)

Pedigree: 'Northern Spy' x Merton's. 793
Precocity: More precocious than seedling (i.e. poor)
Productivity: Moderate under most conditions
Anchorage: Good, typically free-standing
Fireblight: Moderate resistance
Crown & Root Rots: Moderate resistance
Woolly Apple Aphid: Resistant
Powdery mildew: Susceptible
Hardiness (midwinter): Moderate
Suckering: Light
Burrknots: Heavy
Strains: EMLA MM.111 - virus free clone has slightly increased vigor

Observations, suspicions, and history:
• MM.111 is appropriate for use with spur type scion varieties, on poor dry sandy soils, and on heavy soils where MM.106 would fail.
• One of most drought resistant apple rootstock known.
• Because MM.111 produces large trees, utility of MM.111 in North America is limited to extreme situations and home gardens.
• MM.111 is very tolerant of a wide range of soil conditions, and is the most drought tolerant clonal produced apple rootstock.
• MM.111 is used as rootstock with an M.9 interstem to produce dwarf freestanding trees that are drought tolerant.
• Tolerant of both heavy and light soils.
• Planting distance, suggested, 15 ft (4.5m) apart, 20 ft (6m) between rows.

P.18 (Poland 18)

Size: 30 to 34 feet (75 to 85% of standard)

Pedigree: M.4 x Common Antonovka
Precocity: Poor
Productivity: Low to moderate, similar to seedling
Scion Fruit Size: Data not available
Scion Fruit Quality: Data not available
Anchorage: Support generally not required
Fireblight: Reportedly somewhat resistant, further testing required
Crown & Root Rot: Resistant, further testing required
Woolly Apple Aphid: Susceptible
Powdery mildew: Somewhat resistant
Hardiness (midwinter): Moderate to excellent hardiness, further testing required
Bud Break: Early
Suckering: Light
Burrknots: Light

Observations, suspicions, and history:
• P.18 is a vigorous rootstock noted for its horizontal rooting habit that may be useful in poorly drained sites.
• The primary advantage of P.18 provides over seedling rootstocks in uniformity in size.
• P.18 might also be useful for very specific applications with dwarfing interstems.
• P.18 may prove commercially useful on a limited basis for use with spur type scions on poor sites.
• Bearing age 3-4 years.
• Planting distance, suggested, 15 ft (4.5m) apart, 20 ft (6m) between rows.

The Poland breeding program was stared in 1954 with three hardy apple cultivars (‘Antonovka,’ ‘Longfield’ and ‘Glogerovka’) crossed with M.9 and M.4 and about 3,000-hybrid seedlings were grown. Several promising selections were found among the Antonovka progenies and were subjected to various tests.

B.118 (Bud.118, Budagovski 118)

Size 32 to 34 feet (75 to 85% of standard)

Pedigree: Moscow Pear x M.9 or M.8, developed by Dr. Budagovski in Michurinsk, in what was USSR
Precocity: More precocious than seedling (i.e., poor)
Productivity: Moderate under most conditions, better than B.490 in Washington trials
Scion Fruit Size: Small in some trials
Scion Fruit Quality: Data not available

Anchorage: Good, typically free-standing
Fireblight: Moderately resistant
Crown & Root Rots: Susceptible, but resistant to collar rot
Woolly Apple Aphid: Data not available
Powdery mildew: Susceptible
Hardiness (midwinter): Reportedly excellent
Suckering: Data not available
Burrknots: Data not available

Observations, suspicions, and history:
• B.118 is appropriate for commercial use with spur type scion varieties on weak sites in areas subject to extreme midwinter low temperatures.
• May be used as a rootstock for spur types in poor soil conditions.
• Well adapted to various soil types, particularly valuable on dry, sandy soils.
• Planting distance, suggested, 15 ft (4.5m) apart, 20 ft (6m) between rows..

VIGOROUS APPLE ROOTSTOCK: 34-40: >85% of standard

Novole

Size: to 40 feet (100% of standard)
Pedigree: A selection of *Malus prunifolia*
Precocity: Poor, similar to seedling
Productivity: Poor, similar to seedling, but more uniform
Anchorage: Good, usually free standing
Fireblight: Resistant
Crown & Root Rots: Data not available
Woolly Apple Aphid: Data not available
Hardiness (midwinter): Data not available
Suckering: Heavy

Strains: Novole appears to have several strains, or perhaps a mixture of genotypes, all are derived from *Malus prunifolia* and all are full sized trees.

Observations, suspicions, and history:
• Novole literally means voles (can kill trees by *girdling*) will avoid this rootstock and the trees rarely suffer damage from winter-feeding.
• Novole may be a good choice for some low input production systems.
• Bearing age 3-6 years.
• Planting distance, suggested, 20 ft (6m) apart, 20 ft (6m) between rows.

Seedling

Size: to 40 feet. (100% of standard) Some size control (26 to 34 feet, 65-85%;) can be obtained with spur-type strains

Pedigree: Variable
Precocity: Poor, variable
Productivity: Poor, variable
Scion Fruit Size: Variable
Scion Fruit Quality: Variable
Anchorage: Good free standing
Fireblight: Variable
Crown & Root Rots: Variable
Woolly Apple Aphid: Variable - 'Northern Spy' progeny are often resistant
Powdery mildew: Variable
Hardiness (midwinter) Variable
Suckering: Heavy, variable
Burrknots: Light, variable
Strains: Seeds of 'Northern Spy' and Spur type 'Red Delicious' are often chosen as seedling rootstocks

Observations, suspicions, and history:
• Seedling rootstocks are not extensively used commercially in North America at this time because they produce very large trees that are economically inefficient.
• Seedling trees are phenotypically and genetically variable, and their performance cannot be predicted.
• Bearing age 10+ years.
• Planting distance, suggested, 20 ft (6m) apart, 20 ft (6m) between rows.

PEAR ROOTSTOCKS

INTRODUCTION TO PEAR ROOTSTOCK

Standard (seedling) pear trees are 40 feet tall and 25 feet in diameter. Use this guide to help you determine the height of trees on selected rootstock. The nursery will say that "OH x F 333 is 50-70% of standard size." Presently there are no known "dwarf" pear rootstocks, only "dwarfing" pear rootstocks, which means less than 40 feet tall.

Pears have a tendency to grow straight up and spreading. Note: the 25-foot diameter of a standard tree. Limbs growing straight up are less fruitful than those at a 60˚ angle. This means that you will need to spread the pear limbs to a 60˚ angle when they are young and trainable.

OLD HOME FARMINGDALE SERIES

The Old Home Farmingdale series (OH x F) of rootstocks originated from crosses made more than 70 years ago by Fred C. Reimer at Oregon State. Reimer was seeking primarily rootstocks resistant to fireblight; both 'Old Home' and 'Farmingdale" parents are highly resistant. Reimer's work was continued by nurseryman Lyle Brooks and by researchers at Oregon State. All OHxF's are propagated asexually, with considerable difficulty.

Pear rootstocks are listed alphabetically, **not according to size**.

OH X F 40 (Old Home Farmingdale 40), USPP #5412

Size: About 24 to 28 feet (60 to 70% of standard)

Pedigree: 'Old Home' x "Farmingdale'
Precocity: Very productive
Anchorage: Well anchored
Woolly Pear Aphids: Resistant
Crown & Root Rots: Resistant
Fireblight: Resistant
Pear decline: Resistant
Suckering: Data not available

Comments:
• Planting distance, 14-18 ft (4.3-5.5m) apart, 20 ft (56.1m) between rows.

OH X F 87 (Old Home Farmingdale 87), USPP #6362

Size: About 24 to 28 feet (60 to 70% of standard)

Pedigree ‘Old Home’ x “Farmingdale’
Precocity: Very productive
Anchorage: Well anchored
Woolly Pear Aphids: Resistant
Fireblight: Resistant
Crown & Root Rots: Resistant
Pear decline: Resistant
Suckering: Data not available

Comments:
• Proven to be the most precocious of rootstocks tested at the Mid-Columbia Agricultural Research and Extension Center at Hood River, Oregon.
• Impart some early spurring and growth control with the ‘D’Anjou’ variety.
• Planting distance, 14-18 ft (4.3-5.5m) apart, 20 ft (56.1m) between rows.

OH X F 97 (Old Home Farmingdale 97)

Size: to 40 feet (100% of standard)

Pedigree: ‘Old Home’ x “Farmingdale’ at Oregon State
Precocity: Very productive, early fruiting
Anchorage: Well anchored
Fireblight: Data not available
Pear decline: Data not available
Suckering: Data not available

Comments:
• Selected to replace common pear seedling.
• Responds well to limb bending.
• Appears to be especially good for weaker growing Asian pears, such as ‘Hosui.’
• Planting distance, suggested, 25 ft (7.6m) apart, 25 ft (7.6m) between rows.

OH x F 333 (Old Home Farmingdale 333)

Size: 20 to 28 feet (50 to 70% of standard)

Pedigree: ‘Old Home’ x “Farmingdale’ at Oregon State
Precocity: Productive
Anchorage: Well anchored
Fireblight: Resistant
Pear decline: Resistant
Hardiness: Cold tolerant to Zone 4
Suckering: None

Comments:
• Selected to replace Province Quince as it is much more hardy.

• Does well on a variety of soils.
• Compatible to all known European pear cultivars with limited compatibility with Asian pears.
• Planting distance, 14-18 ft (4.3-5.5m) apart, 20 ft (56.1m) between rows.

OH x F 513 (Old Home Farmingdale 513)

Size: About 24 to 28 feet (60 to 70% of standard)

Pedigree: 'Old Home' x "Farmingdale' at Oregon State
Precocity: Very productive
Anchorage: Well anchored
Woolly Pear Aphids: Resistant
Fireblight: Resistant
Crown & Root Rots: Resistant
Pear decline: Resistant
Suckering: None
Hardiness: To Zone 4

Comments:
• Recommended as the best by the Medford Pear Experiment Station.
• Planting distance, 14-18 ft (4.3-5.5m) apart, 20 ft (56.1m) between rows.

Pyrus communis

Size: 40 feet by 25 feet, 100% standard, this is the classic standard tree

Pedigree: Seedling of *Pyrus communis*
Preciosity: Very productive, slow to start cropping
Anchorage: Well anchored
Fireblight: Variable
Pear decline: Variable
Suckering: Variable

Comments:
• Very vigorous but can be variable due to its seedling genetics.
• Planting distance, suggested, 25 ft (7.6m) apart, 25 ft (7.6m) between rows.

Pyrodwarf® (US Patent #11,041)

Size: to 20 feet (about 50% smaller than OHxF 97) (50% of standard)

Pedigree: New *Pyrus communis*, 'Old Home' x 'Bonne Luise' cross-made in Geisenheim, Germany, in 1980
Precocity: Very precocious, starts bearing in the 2nd leaf
Fireblight: Moderate resistance

Suckering: None
Hardiness: Good winter cold hardiness

Comments:
• There is no significant reduction of fruit size and the trees reach full bearing in 5 years.
• Planting distance, suggested, 9-12 ft (2.7-4.6m) apart, 12 ft (3.6m) between rows

Pyro™2-33 (CV.RHENUS 3 PEAR ROOTSTOCK, US Plant Patent #12,771)

Size: to 40 feet (100% of standard)

Pedigree: New *Pyrus communis*, 'Old Home' x 'Bonne Luise' cross-made by Dr. Helmut Jacob at Research Station Geisenheim, Germany, in 1980
Precocity: Starts bearing in the 2nd leaf and starts heavy pear production 2 years earlier than OHxF clones
• Planting distance, suggested, 25 ft (7.6m) apart, 25 ft (7.6m) between rows.

Quince A, EMLA Quince A

Size: 20-24 feet (50 to 60% of standard) EMLA Quince A will be slightly larger

Pedigree: EMLA Quince A is another virus certified pear rootstock to come out of East Malling Long Ashton, UK
Precocity: Not as precocious as Quince C
Productivity: High, under the correct conditions
Scion Fruit Size: Typically large fruited
Anchorage: Poor
Fireblight: Susceptible
Crown & Root Rots: Considered resistant to crown gall and collar rot
Woolly Apple Aphid: Susceptible
Powdery mildew: Moderately susceptible
Hardiness: Hardy to –15˚F.
Suckering: Yes, increases fireblight susceptibility.

Comments:
• Poor graft compatibility is usually overcome by using a compatible interstem, 'Beurre Hardy,' for cultivars such as 'Beurre Bosc.' See partial list of compatible and non-compatible cultivars, p. 29.
• Resistant to pear decline.
• Tolerates heavy clay soils.
• Needs support.
• Good for espalier.
• Planting distance, 14-18 ft (4.3-5.5m) apart, 20 ft (56.1m) between rows.

Quince C, EMLA Quince C

Size: 18 to 20 feet (45 to 50% of standard) EMLA Quince C will be slightly larger

Pedigree: Seedling Quince
Precocity: Testing in England has shown EMLA Quince C to be more dwarfing and precocious than Quince A
Nematodes: Resistant
Fireblight: Susceptible
Pear decline: Resistant
Mildew: Resistant
Crown gall: Resistant
Root aphids: Resistant
Hardiness: More winter hardy than Provence Quince BA 29-C, hardy to -10˚F

Comments:
• Tolerates wet soil.
• Poor graft incompatibility is usually overcome by using a compatible interstem, 'Beurre Hardy,' for cultivars such as 'Beurre Bosc.' See partial list of compatible and non-compatible cultivars, p. 29.
• Cultivars such as 'Comice' and 'Taylor's Gold' are fully compatible with quince rootstocks.
• Planting distance, suggested, 9-12 ft (2.7-4.6m) apart, 12 ft (3.6m) between rows.

Quince, Provence (Le Page Series C or Quince C)
Quince, Provence (BA 29-C)

Size: 20 to 26 feet (50 to 65% of standard)

Pedigree: Both rootstocks are selections from the same species, *Cydonia oblonga*, which were produced by the Institute National De LaEcherche Agronomique, (NRA) in France.
Precocity: Productive
Anchorage: Well anchored
Fireblight: Susceptible
Pear decline: Resistant
Crown gall: Resistant
Root aphids: Resistant
Winter Hardiness: More winter hardy than EMLA Quince C.

Comments:
• Quince BA 29-C is virus free.
• Poor compatibility, see partial list of compatible and non-compatible cultivars, p. 29.
• Some pear compatibility problems with the Quince Provence rootstock. Use an interstem ('Comice" is frequently used) between the scion cultivar and the rootstock to overcome incompatibility.
• Planting distance, suggested, 10-14 ft (3.1-4.3m) apart, 15 ft (4.6m) between rows.

Graft Compatible with Quince

Quince rootstock compatibility traits are from germplasm release notices, published reports, or observations made at NCGR-Corvallis.

‘Abbe Fetel (‘Abate Fetel’)
‘Anjou’
‘Anjou – Naumes’
‘Aurora’
‘Bartlett - French Compatible’
‘Bartlett – Swiss’
‘Beierschmitt’
‘Belle Guerandaise’
‘Beurre Alexandre Lucas’
‘Beurre Capiaumont’
‘Beurre Diel (3x)
‘Beurre Dubuisson’
‘Beurre Easter’
‘Beurre Giffard’
‘Beurre Hardy’
‘Beurre Superfin’
‘Beurre d'Amanlis’ (3x)
‘Beurre d'Amanlis Panachee’
‘Bloodgood’
‘Butirra Precoce Morettini’
‘California’
‘Clara Frijs’ (‘Comtesse Clara Frijs’)
‘Colette’
‘Conference’
‘Dabney’
‘Dawn’
‘Devoe’
‘Docteur Desportes’
‘Doyenne Gris’
‘Doyenne d'Hiver’ (‘Beurre Easter’)
‘Doyenne du Comice’
‘Doyenne du Comice’ - 4x
‘Doyenne du Comice - Crimson Gem’
‘Doyenne du Comice - Crimson Gem #2’
‘Doyenne du Comice - Regal Red’
‘Doyenne du Comice – Spur’
‘Duchesse Bronzee’
‘Duchesse d'Angouleme’
‘Duchesse d'Angouleme Bronzee’
‘Early Seckel’
‘Emile d'Heyst’
‘Figue d'Alencon’

‘Flemish Beauty’
‘Fondante de Moulins Lille’
‘General Le Clerc’
‘Glou Morceau’
‘Gorham’
‘Grand Champion’
‘Harrow Delight’
‘Harvest Queen’
‘Highland’
‘Howell – Sport’
‘Jeanne d'Arc’
‘Josephine de Malines’
‘Kieffer’
‘Laxton's Superb’
‘Louis Pasteur’
‘Louise Bonne d'Avranches (L.B. de Jersey)
‘Louise Bonne d'Avranches Panachee’
‘Magness’
‘Maxine’
‘Old Home’ Rootstock
‘Olivier de Serres’
‘Onward’
‘Passe Crassane’
‘Passe Crassane’ (Virus Indicator)
‘Passe Crassane Rouge’
‘Pierre Corneille’
‘Rogue Red’
‘Saint Andre’
‘Santa Claus’
‘Sierra’
‘Sucree de Mountlucan’
‘Tongre’ (=Durondeau)
‘Tyson’
‘Urbaniste’
‘Vicar of Winkfield’
*Warren
‘White Doyenne’

LIST OF NON-COMPATIBLE CULTIVARS: DO NOT GRAFT THE FOLLOWING CULTIVARS DIRECTLY TO QUINCE ROOTSTOCK, use an interstem.

‘Bartlett’
‘Bosc’
‘Clapps Favorite’
‘El Dorado’
‘Farmingdale’
‘Forelle’
‘Packham’s Triumph’
‘Seckel
‘Triump’
‘Winter Nelis’

ASIAN PEAR ROOTSTOCKS

Asian pear standard size tree to 20 feet

Rootstocks. All Asian pear varieties will grow on *Pyrus* ***betulifolia (****betulaefolia)*, *P. calleryan*a, *P. serotina*, *P. ussuriensis* and *P. communi*s ('Bartlett,' 'Old Home' x' Farmingdale,' 'Williams,' or 'Winter Nelis' seedling) rootstocks. Usually *P.* ***betulifolia (****betulaefolia)* is preferred for its vigor, large fruit and tolerance of wet soils. Its cold-hardiness varies with seed source. All rootstocks are satisfactory in California and the warmer winter areas of Oregon, but in Washington special cold-hardy *P.* ***betulifolia (****betulaefolia)* strains are needed. Most Japanese pear varieties are dwarfed about 50% on *P. communis* rootstock so California growers and nurseries prefer *P.* ***betulifolia (****betulaefolia)* because they like vigorous trees that size fruit easily. Chinese Asian pear varieties like, the 'Ya Li' variety, are compatible and grow well on either *P. communis* or *P.* ***betulifolia (****betulaefolia)* rootstock. In Japan, Asian pears are all propagated on *P. serotina* or *P.* ***betulifolia (****betulaefolia)*. *P.* ***betulifolia (****betulaefolia)* is used to prevent hard-end, a problem in some areas where *P. serotina* is used as a rootstock for Japanese pears. *P. serotina* or *P. ussuriensis* are cold-hardy to -40° F and could be used as an Asian pear rootstock for all West Coast fruit districts if a good seed source was available to nurseries. *P. calleryana* makes a good Asian pear rootstock in California but lacks winter hardiness for most areas outside of California.

Listed alphabetically**, not in order of size**

Betulifolia (*Pyrus betulifolia)* (also spelled *Betulaefolia)*

Size: 130% of standard for European pears. Slightly dwarfing rootstock for Asian pears (15-18 feet) (75 to 90% of standard)

Pedigree: Seedling, therefore lacks uniformity
Precocity: Very productive
Anchorage: Well anchored
Pear psylla: Resistant
Root aphid: Resistant
Fireblight: Resistant
Crown & Root Rots: Resistant
Pear decline: Resistant
Suckering: Data not available
Winter Hardiness: Winter damage if temperature consistently below -10˚F.

Comments:
• Tolerates excessive moisture and a range of soil types if the soils are moderately fertile.
• Established plants are drought tolerant.

• *Pyrus betulifolia* is most widely used because it is long-lived, versatile, vigorous, and it tends to produce abundant crops and large fruits. However, it is less tolerant of alkaline soils and extreme cold.
• Bears fruit 6-12 years.
• Planting distance, Asian pears, suggested, 8-10 ft (2.4-3m) apart, European pears, suggested 32 ft (9.8m) apart.

Pyrus calleryana **(Callery Pear)**

Size: Asian pears, to 18 feet (90% of standard) European pears to 36 feet (90% of standard)

Pedigree: Seedling, therefore lacks uniformity
Precocity: Very productive
Anchorage: Well anchored
Fireblight: Resistant
Root aphid: Resistant
Nematodes: Resistant to most
Pear decline: Somewhat susceptible, others resistant
Hardiness: Lacks winter hardiness, good for California type climates

Comments:
• Tolerates wet soils.
• Planting distance, Asian pears, suggested, 8-10 ft (2.4-3m) apart, European pears, suggested 22 ft (6.7m) apart.

Pyrus communis

Size: Asian pears to 18 feet 90% of standard)

Pedigree: Seedling of either 'Bartlett,' 'Old Home' x 'Farmingdale,' 'Williams,' or 'Winter Nelis'
Precocity: Good, but slow to come into production
Anchorage: Good
Fireblight: Resistant, if 'Old Home' is in the parent
Root aphid: Resistant
Nematodes: Resistant to most
Pear decline: Somewhat susceptible, others resistant
Hardiness: Cold hardy, Zone 4

Comments:
• Tolerant of clay soils and lime induced chlorosis.
• Not recommended for Asian pear varieties.
• Planting distance, suggested, 8-10f t (2.4-3m) apart
Also see OH x F 97 above.

CHEERY ROOTSTOCKS

Standard sweet cherry is 45 feet, sour cherry, 15 feet, plum, peach, and nectarine, 25 feet; apricot, 30 feet; and almond, 35 feet.

CHERRY ROOTSTOCKS
Listed alphabetically, **not according to size**.

Colt, Colt EMLA (US patent #4059)
Compatible with sweet and sour cherries and most ornamental varieties

Size: Sweet cherries, 31 to 36 feet (70 to 80% of standard); sour cherries, 10 to 12 feet in height (66 to 80% of standard)

Pedigree: *Prunus avium* x *P. pseudocerasus*, East Malling Station, England, 1958
Precocity: Very high, good quality
Anchorageage: Excellent
Hardiness: Cold hardy, -10˚F.
Bacterial canker: Resistant
Crown gall: Resistant, others susceptible
Cherry replant disease: Resistant

Comments:
- Trees are well branched.
- Tolerates wet heavy soils better than Mahaleb.
- Cherries on 'Colt' are field resistant to cherry stem pitting.
- Drought sensitive.
- Planting distance, suggested, sweet cherries, 20 ft (6.1m) apart, 20 ft (6.1m) between rows; sour cherries, suggested, 7-10 ft (2.1-3m) apart, 10 ft (3m) between rows.

Gisela SELECTIONS:

Many years ago in Giessen, West Germany, Dr. Wernes Gruppe and the University of Giessen made thousands of crosses looking for a true dwarf cherry rootstock. After many years of worldwide testing several are being grown and grafted for use. The rootstock is patented and made available only to selected nurseries.

The Gisela selections are so precocious that pruning techniques need to be developed to limit fruit crop. Some pruning techniques recommended for Gisela 5® are:
1. Strong annual "renewal" pruning to induce new vegetative growth and thus improve the balance between production on 2- to 3- year old wood, relative to that on spurs;
2. Flower thinning or post flower pruning of heavily fruiting shoots to moderate crop load;
3. Matching strongly productive cultivars with less productive rootstocks or strongly productive rootstocks with less productive cultivars.

Gisela® 5 (US Plant Patent #9622)

Size: approximately 20-22 feet (<50% of standard)

Pedigree: *cerasus* x *canescena*
Precocity: High bloom intensity and high yield efficiency, very precocious
Anchorage: Fair, may need supporting
Hardiness: Cold hardy, as good or better than Mazzard
Prunus necrotic ringspot virus: Tolerant
Prune dwarf virus: Tolerant
Suckering: Little to none

Comments:
• Tree shape is open and spreading.
• Appears to be well adapted to heavy (clay) soil and medium tolerance to water logging
• Staking required for the first 5 years.
• Bearing age, 3 years
• Very sensitive to systemic herbicides such as Glyphosate the use of which should be avoided around young trees
• Best known and most planted Giesla rootstock in Germany
• Planting distance, suggested, 10 ft (3m) apart, 12 ft (3.6m) between rows.

Gisela® 6 (US patent #8954)

Size: to 35 feet in height (<80% of standard)
Precocity: Very precocious, early blooming, very good yield efficiency
Anchorage: Well anchored
Suckering: Limited
Hardiness: Cold hardy, as good or better than Mazzard
Prunus necrotic ringspot virus: Tolerant
Prune dwarf virus: Tolerant
Suckering: None to very few
Pocket gophers: Moderately susceptible

Comments:
• Adaptable to a wide range of soils including high tolerance to heavy (clay) water logged soils, also adapted to light soils without irrigation
• Appears to be grafting compatible to all varieties.
• Fruit size is good even with heavy cropping.
• Planting distance, suggested, 20 ft (6.1m) apart, 20 ft (6.1m) between rows.

Gisela® 12 (US patent #9631)

Size 25 to 30 feet in height (55 to 67% of standard)

Precocity: Very high
Anchorage: Good, but support is recommended
Hardiness: Cold hardy, as good or better than Mazzard
Prunus necrotic ringspot virus: Tolerant
Prune dwarf virus: Tolerant
Suckering: None to very few

Comments:
• Tree shape is open, spreading and stocky
• Appears to have wide soil adaptability and does well on heavy (clay) soils
• One of strongest growing Giesla clones
• Planting distance, suggested, 10 ft (3m) apart, 12 ft (3.6m) between rows.

Krymsk 5™ (VSL 2)

Size: 10 plus feet, similar in size to Gisela 5® (>22% of standard)

Pedigree: hybrid of *Prunus fruiticosa* x lannesina
Precocious: Yes
Suckering: None
Compatibility: Compatible to all cherries, sweet and sour.

Comments:
• This rootstock is patented and may not be reproduced without permission of the patent holder. • Developed by Russian breeder Gennady Eremin at the Krymsk Valvilov Institute.
• Planting distance, suggested, 10 ft (3m) apart, 12 ft (3.6m) between rows.

Krymsk 5, 6, 7, and 8. All of these cherry rootstocks are compatible with both sweet and sour cherries, reduce tree sizes, are very precocious with high yields, and are resistant to wet soils. Further testing is occurring and may become available in 2007.

Mahaleb (*Prunus mahaleb*, St. Lucie or perfumed cherry)

Size: to 45 feet (100% of standard)

Pedigree: Seedling cherry, used by French in 1768
Anchorage: Good
Suckering: Moderate to heavy
Hardiness: To Zone 4.
Peachtree borer: Modularity susceptible
Bacterial canker: Moderately susceptible
Phytophthora root & crown rot: Highly susceptible
Crown gall: Moderately resistant
Armillaria root rot: Susceptible

Vericillium wilt: Susceptible
Root knot nematode: Resistant
Root lesion nematode: Susceptible
Prunus necrotic ringspot virus: Tolerant
Prune dwarf virus: Tolerant
Pocket gophers and voles: Highly susceptible

Comments:
• More drought tolerant than Mazzard.
• Intolerant of wet, heavy (clay) soils.
• Bears fruit 3-5 years.
• *Prunus mahaleb* known as Mahaleb, St. Lucie or perfumed cherry was the first alternative rootstock to Mazzard, used by French horticulturists in 1768. In the early 1800s the British found than Mahaleb dwarfed sweet cherries but Mahaleb could not adapt to British soils. Therein lies the controversy over which is best, Mazzard or Mahaleb. The controversy between the two, which began in Western Europe and continuities worldwide into the present day, is stimulated by differences in soil adaptability.
• Planting distance, suggested, 20-25 ft 6.1-7.6m) apart, 20-25 ft (6.1-7.6m) between rows.

Mazzard

Size: to 45 feet (100% of standard)

Pedigree: *Prunus avium* (Mazzard), seedling cherry
Precocity: Slow to bear, then precocious
Anchorage: Good
Suckering: Medium to heavy
Hardiness: Cold hardy
Peachtree borer: Less susceptible than Mahaleb
Bacterial canker: Susceptible
Phytophthora root & crown rot: Moderately resistant
Crown gall: Susceptible
Armillaria root rot: Moderately resistant
Vericillium wilt: Susceptible
Root knot nematode: Resistant
Root lesion nematode: Susceptible
Prunus necrotic ringspot virus: Tolerant
Prune dwarf virus: Tolerant
Pocket gophers and voles: Moderately resistant

Comments:
• Typically used for sweet cherries, but can also be used for sour cherries.
• Can be planted in wetter, poorly drained soils where Mahaleb cannot grow.

• The primary rootstocks of use in the world are seedlings or clonal selections *Prunus avium* known as Mazzard. Bears fruit 5-6 years.
• The Greeks and Romans since circa 330-400 B.C. have used Mazzard.
• Planting distance, suggested, 20-25 ft 6.1-7.6m) apart, 20-25 ft (6.1-7.6m) between rows.

STONE FRUIT ROOTSTOCKS: PEACHES, NECTARINES, PLUMS, APRICOTS, and ALMONDS

NOTE: Many of the stone fruits can be grafted on to the same rootstock, so that one named rootstock could also be compatible for peaches, nectarines, apricots, almonds and plums.

Standard sizes: plum, peaches & nectarines, 25 feet, plums, 25 feet, apricots, 30 feet, and almonds, 35 feet

Listed alphabetically, **not according to siz**e.

Citation (Patent # 5112)
Compatible with peaches, nectarine, apricots, and plums

Size: peaches and nectarines, 12 to 16 feet (48 to 64% of standard), apricots to 22 feet (74% of standard), plums to 19 feet (76% of standard)

Pedigree: Peach-plum hybrid rootstock (interspecific), developed by Floyd Zieger
Precocity: Very productive
Anchorage: Well anchored
Nematode: Resistant
Crown gall: Susceptible
Bacterial canker: Susceptible
Oak root fungus: Susceptible
Hardiness: Cold hardy to Zone 4, induces early dormancy
Suckering: None.

Comments:
• Induces early bearing (3-4 years), and advances maturity and increases size and sugar content of fruit.
• Tolerant of wet soil conditions.
• Trees on peach x almond hybrid rootstocks, including interspecifics, are very sensitive to dehydration, keep roots damp at all times.
• While planting, keep roots damp and irrigate after planting or the rootstock will die.

A "new" series of stone fruit rootstocks, Krymsk from Russia, is being tested and released in the US in the next few years. Characteristic data for the US is limited.

Krymsk 1 (VVA#1 cultivar, Russia)
Compatible with peaches, plums, nectarines, and apricots.

Size: To 15 feet, plums and peaches (to 60 % of standard), apricots to 18 feet (to 60% of standard), and almonds to 21 feet (to 60% of standard)

Pedigree: fruticosa x lannesiana
Hardiness: Cold hardy

Comments:
• Ten days of fruit maturity advancement.
• May be available in 2007.

Krymsk 2.
Compatible with: peaches, plums, apricots, and almonds

Size: To 15 feet, plums and peaches (to 60 % of standard), apricots to 18 feet (to 60 % of standard), and almonds to 21 feet (to 60 % of standard)
Pedigree: Fruticosa x lannesiana
Precocity: Productive
Scion Fruit Size: Normal, not reduced
Hardiness: Cold climates.

Comments:
• Tolerant to dry soil conditions.
• May become available in 2007.

Krymsk 86 Kuban cultivat, Russia.
Compatible with peaches and almonds

Pedigree: fruticosa x lannesiana
Anchorage: Excellent
Lesion & Rootknot nematode: Resistant
Hardiness: Cold hardy

Comments:
• New and not much known about this rootstock.
• Tolerates wet soils.
• May become available in 2007.

Lovell (Lovell Seedling)
Compatible to all *Prunus* species

Size: 15 feet

Pedigree: Peach Seedling
Precocity: Very productive
Anchorage: Well anchored
Bacterial canker: Resistant, others somewhat susceptible
Crown & Root Rots: Tolerant
Nematodes: Susceptible in sandy soils

Hardiness: Cold hardy
Suckering: Data not available

Comments:
• Will tolerate a wide variety of soils, including wet soils.
• Bears fruit in 2-3 years.

Mariana 26-24
Compatible with apricots, plums, most almonds.

Size: "Slightly dwarfing" for apricots and plums, apricots, less than 30 feet, plums less than 25 feet

Pedigree:
Precocity: Very productive
Anchorage: Poor. shallow root system
Nematode: Some Resistance
Crown gall: Susceptible
Crown rot: Resistant.
Bacterial canker: Susceptible, can out grow disease.
Honey fungus: Resistant.
Oak root fungus: Resistant
Prune brown-line: Resistant
Root knot nematode: Very resistant.
Tomato ring spot virus: Resistant.
Hardiness: Cold hardy to Zone 4, induces early dormancy
Suckering: Several, less than seedling rootstock

Comments:
• Shallow root system, much more tolerant of wet soils than Lovell or Nemaguard.
• Tolerant to drought, fair tolerance to wet soils.
• Mature trees comparatively small.

Myrobalan 29C
Compatible with apricots, plums, most almonds.

Size: Near standard, apricots, 30 feet, plums, 25 feet, almonds 35 feet (100% of standard)

Pedigree: *Prunus cerasifera*
Precocity: Very productive
Anchorage: Poorly anchored, shallow rooted, could lean
Peachtree borer: Susceptible
Bacterial canker: Less susceptible than Mariana 26-24
Phytophthora root & crown rot: Resistant
Crown gall: Highly resistant
Crown rot: Resistant

Armillaria root rot: Susceptible
Verticillium wilt: Moderately susceptible
Ring Nematode: Susceptible
Root knot nematode: Resistant
Root lesion nematode: Moderately resistant
Pocket gophers and voles: Susceptible
Hardiness: Cold hardy to Zone 4, induces early dormancy
Suckering: Less than seedling rootstock, medium to heavy

Comments:
• Compatibility very good.
• Adaptable to a wide range of soils.
• Tolerates wet, poorly drained soils.
• Trees reach larger size compared to Marianna 26-24.

Pixie
Compatible with European and Japanese plums

Size: European plums to 9 feet (to 36 % of standard),, Japanese plums to 6 feet (to 40 % of standard)

Pedigree: Dwarf clone of St. Julian A
Precocity: Very productive
Anchorage: Good, shallow root system
Hardiness: Cold hardy
Suckering: Few

Comments:
• Fruiting in 3 years
• Disease resistance is unknown.
• Thorny and needs good soil.
• Will not tolerate drought.

St. Julian A (St. Julian A EMLA)
Compatible with apricot, peach, nectarine, plum and almond.

Size: About 50 to 60% of standard, "medium sized tree." Apricot from 15-18 feet, peach & nectarine from 12-15 feet, plum from 12-15 feet, and almond from 17-21 feet

Pedigree: Damson plum (*Prunus insititia*). Plum rootstock from clonal selection of 'St. Julian.'
Precocity: Very productive
Anchorage: Well anchored
Bacterial canker: Resistant
Crown & Root Rots: Tolerant
Hardiness: Cold hardy

Suckering: Slight

Comments:
• Not compatible with ‘Stanley.’
• Drought tolerant.
• Will tolerate a wide variety of soils.
• Planting distance, 12 ft (3.6m) apart, 15 ft (4.5m) between rows.

St. Julian GF-655-2:
Compatible with: apricot, peach, nectarine and plum.

Size: slightly dwarfing (semi–dwarf). Less than 30 feet for apricots, 25 feet for plum, peaches & nectarines

Pedigree: Plum rootstock from clonal selection of ‘St. Julian.’
Compatible with apricot, peach, nectarine and plum.
Precocity: Very productive
Anchorage: Well anchored
Bacterial canker: Resistant
Crown & Root Rots: Resistant
Hardiness: Cold hardy
Suckering: Slight

Comments:
• Well known for its semi-dwarf, anchorage, hardiness and disease resistance.
• Does well in heavy soils (clay).

Glossary

Cultivar: (See *Variety*)technically different, a cultivar is the result of humans crossing two different kinds, example; 'Karmine', a cross between 'Cox's Orange Pippin' X 'Jonathan'. Variety is the result of nature crossing two different kinds, example; 'Gravenstein'. The two terms are used interchangeably.

Dwarfing Rootstock: beware when "dwarfing" is on a nursery label. Then "dwarfing" means any height less than a seedling (See page 2 for seedling tree heights).

Interstem–one of two scions grafted to a rootstock when the desired variety is not compatible to the rootstock, the variety will not graft successfully to the rootstock. Interstem is the scion grafted to the rootstock that is compatible to both the rootstock and variety.

Girdling–removal of a bark strip or sections of bark from around the circumference of a limb or trunk to stimulate flowering and/or fruit set, will also inhibit vigor.

Pedigree–genetic background of a variety; i.e., pedigree of 'Jonagold' is 'Golden Delicious' x 'Jonathan.' Important that neither parent in the pedigree may be used as a pollinator of 'Jonagold.'

Precocious–early in the life of a tree that flowering and fruiting begins. Generally the more dwarfing a rootstock the more precocious (earlier fruiting) the tree.

Primordia–above ground root *primordia* that form under shaded conditions (either from trunk wrap or excessive suckering) in burrknots. This "warty" growth may result in abnormal tree growth. They are also sensitive to winter injury, and a potential point of entry for fireblight bacteria. The rootstocks M.26, Mark, M.7 and MM.111 are susceptible to burrknots.

Rootstock–root system for a fruit tree on which the scion variety is grafted or budded. Rootstock may be used to control tree size (dwarfing), induce precocity of the scion variety, and provide adaptation to specific climate and soil conditions.

Scion– detached shoot or bud of a desired variety (scion wood) used for grafting or budding onto a rootstock. Top portion (as opposed to the rootstock portion) of a nursery or orchard tree.

Scoring–cutting the bark around the cir circumference of a limb or trunk to stimulate flowering and/or fruit set, will also inhibit vigor.

Stoolbed–technique using underground parent tissue for vegetative propagation of plants on their own roots; the base of shoots originating form underground parent tissue is mounded over with loose material (soil, sawdust) to induce basal rotting.

Variety: (See *Cultivar*)–technically different, variety is the result of nature crossing two different kinds. Cultivar is the result of humans crossing two different kinds. Used interchangeably.

Vigor–many factors enter into the equation to determine tree size: rootstock, soil fertility, growth habit, and vigor. Each cultivar (variety) has its own vigor. Predicting vigor is a rough estimate on how large the tree will grow on a particular rootstock.

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