V. Study of rootstocks

Rootstocks are essential for cultivating fruit trees, as they form the tree's root system. They have been used for centuries for propagating trees. Recent experiments in several countries have led to the identification of rootstocks that promote successful growth and a good yield.

Trees are propagated by taking a scion, or cutting, from a mother tree with desirable characteristics, and grafting or budding it onto a suitable rootstock. Once the rootstock and scion have fused, the selected variety will grow and form the new tree. The rootstock can be planted directly in the ground or grafted in a nursery and grown in pots. The rootstock controls the tree's growth, ensuring its vigour and adaptability, while the scion determines the type and characteristics of the fruit.

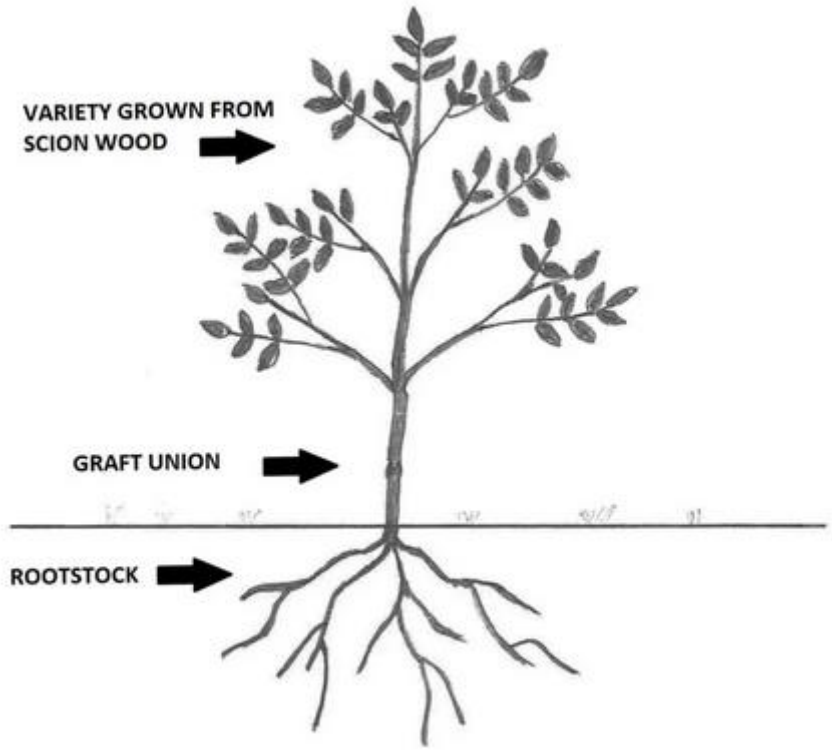

Fig.1. Parts of a grafted plant**.** https://www.frankpmatthews.com

Reasons for using rootstocks in fruit tree cultivation:

- Rootstocks are used in tree propagation for several important reasons.
- Controlling the growth rate and final size of the tree, which is useful when space is limited or trees of a uniform size are required.

- To provide resistance to disease; many rootstocks are chosen for their resistance to diseases such as woolly aphids or root collar rot.
- They preserve the original variety of the tree by ensuring that the known scion can be used for grafting or budding onto the rootstock.
- Adaptation to different soil types: some rootstocks perform better in wet, dry or low-quality soils.
- Tolerance to cold conditions and harsh winters.
- It can also increase fruit production and improve fruit size and quality.

1. Pome fruit rootstock

A. Apples

⇔ **M27 –** Very Dwarf .An extremely dwarfing rootstock for apples keeping most trees at 6-8 ft with some more vigorous varieties like Granny Smith and Gravenstein growing 8-10 ft tall. M27 induces heavy fruiting on young trees. Small root system that requires constant soil moisture and staking when young.

⇔ **M26 –** Semi Dwarf .Keeps tree at 45-55% of standard height. It is a vigorous, dwarfing rootstock. Very productive and promotes fruit on young trees. Small root system on these trees may require staking when young.

⇔ **MM106 –** A great semi-dwarf root stock that keeps apple trees to 60-70% the size of a standard seedling. Resistant to woolly apple aphid. Grows well in many soil types, but does not tolerate very wet soils well.

⇔ **MM111 –** Good all-around choice for apples. This rootstock keeps the tree at just 80-90% of standard, or 17-20 ft. However, trees can be held to any desired height with summer pruning. MM111 induces fruiting on young trees. Tolerates wet, dry or poor soil. Provides resistance to woolly apple aphids and collar rot.

⇔ **M.9** – Dwarf. Very productive and usually grows no more than 3 metres. Ideal for cordons. This rootstock provides good growth control with high productivity. Trees will need some support because yields are heavy and fruit size is particularly good.

⇔ **M.116 –** Medium. A robust rootstock, producing a tree about 4 metres tall. 10% less vigorous than MM.106. Resistant to phytophora, collar rot and woolly aphid. Perfect for bushes and half standards. Espaliers and other forms of trained fruit where large walls need covering should be selected within this vigour range.

⇔ **M.25 –** Very Vigorous .The best rootstock for traditional orchards. Produces apple trees about 6 metres tall. Ideal for full standard trees and straight leads (trees that have no had

their leader pruned out). Although slower into cropping, the fruit will be high quality. Trees grown on these rootstocks are not suitable for containers. Available to buy bare-rooted in winter.

Seedling rootstocks for apple trees :

⇔ **Antonovka –** extremely vigorous growth (7 – 11 m/25 – 35 feet), often creates suckers, hardy to USDA 3, adaptability to various soil types, Drought tolerant, long-lived

⇔ **Dolgo** – vigorous growth (6 – 9 m/20 – 30 feet), less suckering, hardy to USDA 3, adaptability to various soil types, Drought tolerant, long-lived

⇔ **Ranetka** – extremely vigorous growth (7 – 11 m/25 – 35 feet), hardy to USDA 2, adaptability to various soil types, Drought tolerant, long-lived

⇔ J-**KL-series** – vigorous growth (9 m/30 feet), hardy to USDA 3, fairly resistant to disseases, suitable also to higher altitudes and infertile soils, Drought tolerant, long-lived

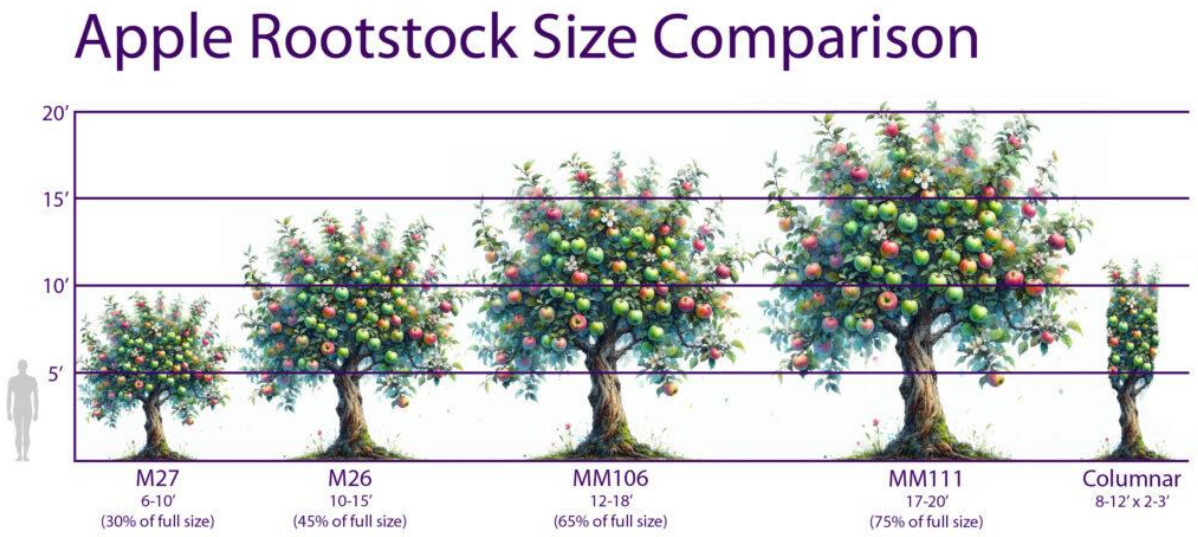

Fig.2. applerootstock size comparison . https://youngs-garden.com

B. Cherry Tree Rootstocks

⇔ **Gisela 5 – Dwarf**

Produces trees about 3 metres tall. Ideal for commercial orchards, gardens and patio pots. This rootstock provides good growth control with high productivity. Fruit is a good size and quality.

⇔ **Colt – Semi Vigorous**

Trees on this rootstock reach 4 to 5 metres. Very productive and fully compatible with all sweet and flowering cherries. A useful rootstock for those wanting compact, free-standing trees. Perfect for bushes or half-standards. There is enough vigour for covering walls as fan-trained trees.

⇔ **Prunus F.12.1. – Very Vigorous**

A vigorous rootstock that will ultimately produce trees 6 metres tall or more. Ideal for large specimens or traditional orchards. Although slower into cropping, the fruit will be high quality. Trees grown on these rootstocks are not suitable for containers. Available to buy bare-rooted in winter.

⇔ **ewroot-1 –**

Also known as Z-Dwarf rootstock for cherries. Keeps cherry trees at 8-12 ft if unpruned. Promotes bearing fruit early. Ideal for growing in containers. Better adapted to clay soils than Mazzard or Mahaleb.

⇔ **Maxma 14 –**

Dwarfing rootstock for sweet cherries keeping trees to 65% of standard size. Induces early, heavy bearing. Good tolerance to wet soils and also does well in calcareous soils. Resistant to bacterial canker and nematodes. Well anchored tree with very little suckering.

⇔ **Mahaleb –**

The most winter hardy of the commonly used cherry rootstocks. Semi-standard sizing, dwarfs trees to about 80% of standard size, 14-16′ H x 16-20′ W. No dwarfing on sour cherry types. Induces fruiting on young trees with heavy crops. Resists crown gall, bacterial canker and some nematodes. Not tolerant of wet soils.

⇔ **Mazzard –**

Standard size rootstock for sweet cherries, 18-20′ H x 20-25′ W. Vigorous and more tolerant of wet soils than Mahaleb (but still requires good drainage). Resistant to root-knot nematodes and oak-root fungus.

Seedling cherry rootstocks:

⇔ **wild cherry (*Prunus avium*)** – extremely vigorous growth (7 – 12 m/25 – 40 feet)

⇔ **Mahaleb – vigorous growth** (4 - 6 m/14 – 20 feet), suitable for well drained, dry soils (Intolerant of wet heavy soils), drought tolerant, resistant to bacterial canker, moderately resistant to crown gall and root-lesion nematode, shows buckskin infection quickly. Very susceptible to Phytophthora crown and root rot.

⇔ **Mazzard** – more vigorous than mahaleb (more than 6 m/20 feet), suitable for wet and heavy soils

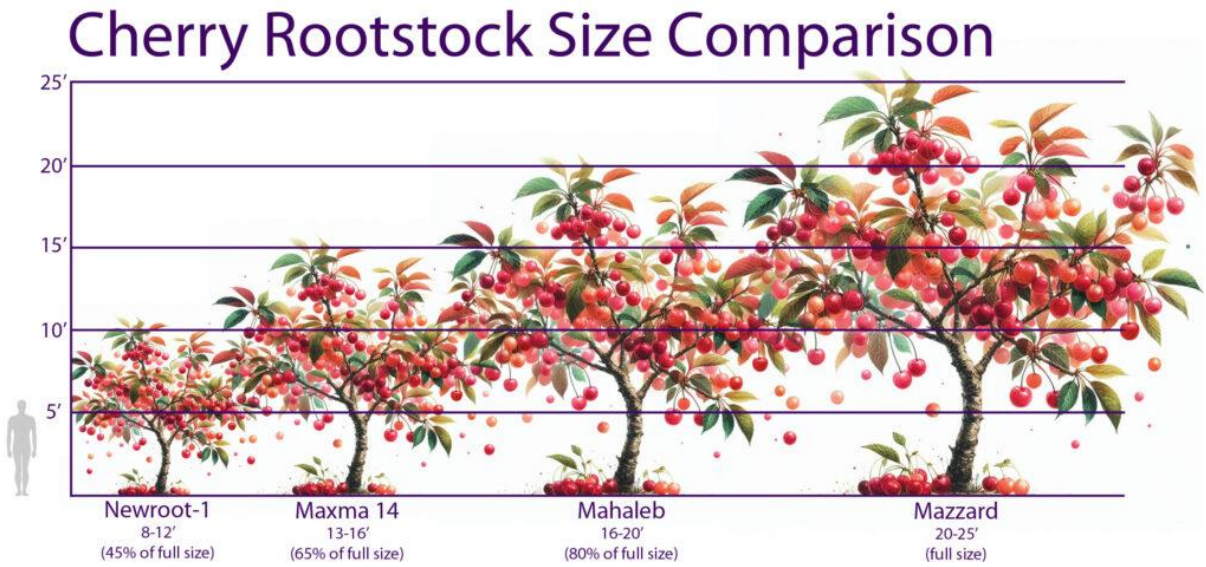

Fig.3. cherry rootstock sie comparison. https://youngs-garden.com

C. Pears

⇔ **Quince**

One of the most widely used dwarfing pear rootstocks. Keeps tree size at 50% of standard, 8-10′ H x 6-8′ W. Some pest & disease resistance.

⇔ **Quince 'C' –** Dwarf

Produces a tree 2 to 3 metres tall. Crops within the first few years. Prefers soils that are not chalky.

⇔ **Quince Eline® –** Dwarf

Similar size to Quince 'C' but more productive and copes better with cold winters. Produces smoother fruit with less russetting. Tree reach 2 to 3 metres tall. Crops within the first few years.

⇔ **Quince 'A' –** Semi Vigorous

The ideal rootstock for bush and half-standard trees. Ultimately growing to about 4 metres. A useful rootstock for those wanting free-standing trees. Also perfect for fan-trained trees and espaliers. Prefers soils that are not chalky.

⇔ **OHxF 87**

A semi-dwarf rootstock keeps tree size at 60-70% of standard size, 10-15′ H x 9-12′ W. Produces fruit very well, setting early and bearing heavily.

⇔ **OHxF97**

Vigorous trees that are widely adapted and disease resistant. Standard tree size, 15-20′ H x 12-15′ W. Tolerant of wet soils with few root suckers.

⇔ **P. betulifolia seedling**

Standard size rootstock pears, 15-20′ H x 12-15′ W. Tolerant of wet or dry soils.

⇔ **Pyrodwarf – Vigorous**

Specifically used for perry pear varieties. Produces a tree about 5 metres tall. The name is misleading as it is a more dwarfing version of the vigorous Pyrus communis and not actually a dwarf rootstock. A tough rootstock that produces good quality, uniform fruit.

⇔ **Pyrus communis – Very Vigorous**

Ideal for large, traditional orchard trees. Can reach a height of 6 metres or more. Although slower into cropping, the fruit will be high quality. Trees grown on these rootstocks are not suitable for containers. Available to buy bare-rooted in winter.

⇔ **Pyrus Kirchensaller – Very Vigorous**

Ideal for large, traditional orchard trees. Can reach a height of 6 metres or more. Although slower into cropping, the fruit will be high quality. Trees grown on these rootstocks are not suitable for containers. Available to buy bare-rooted in winter. A selection of Pyrus communis that has a more consistent vigour and form.

Seedling rootstocks for pear trees:

⇔ **Bartlett seedling** - vigorous growth (6 – 9 m/20 – 30 feet), hardy to USDA 4, adaptability to various soil types, drought tolerant, long-lived, susceptible to fireblight

⇔ **Pyrus betulifolia seedling** – extremely vigorous growth (7 – 12 m/25 – 40 feet), often used for asian pears which are not so vigorous, hardy to USDA 5, adaptability to various soil types, good fireblight and crown gall resistance, drought tolerant, long-lived

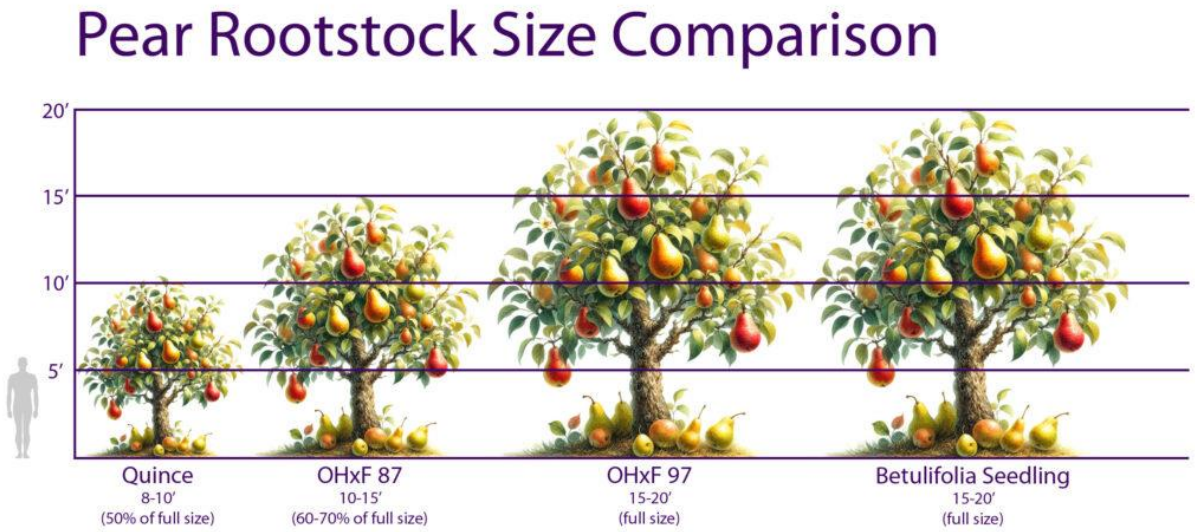

Fig.4. pear rootstock size comparison. https://youngs-garden.com

2. Rootstock for stone fruits (Rosaceae).

Rootstock of Stone Fruit – Almond, Apricot, Nectarine, Peach, Plum. Sizing on Apricot, Peach and Plum trees is primarily controlled through pruning rather than rootstocks.Trees can be held to any height with summer pruning.

⇔ **Miniature / Genetic Dwarfs** – These varieties are extreme dwarfs regardless of the rootstock that they are on. Typically 4-6′ tall. Primarily nectarines & peaches.

⇔ **Citation –** Dwarfs apricots and plums to 75% of standard size, 12-14′ H. Dwarfs peaches and nectarines to 8-14′ H. Very tolerant of wet soil, not drought tolerant. Very winter hardy and resists root-knot nematodes. Trees bear fruit at young age.

⇔ **Marianna 26-24 –** Semi-standard tree at 85% of standard size, 15-20′ H. Shallow root system is more tolerant of wet soils than Lovell or Nemaguard. Resistant to oak-root fungus and root-knot nematodes. Primarily for apricots, plums & almonds.

⇔ **Myro 29C –** Standard tree size with unpruned height of 15-25′. Shallow, but vigorous root system. Widely adapted and tolerates wet soils. Immune to root-knot nematodes with some resistance to oak-root fungus. Excellent all-around rootstock. Primarily for apricots & plums.

⇔ **Lovell –** Traditional benchmark rootstock for standard sized trees, unpruned height of 15-25′. More tolerant of wet soils and more cold hardy than Nemaguard. Susceptible to nematodes in sandy soils. Used for almonds, apricots, nectarines, peaches & plums.

⇔ **Nemaguard –** Widely used standard size rootstock, 15-25′ H. Vigorous and resistant to root-knot nematode. Not tolerant of wet soils. In slow draining soils plant on a mound or hill slope. Used for almonds, apricots, nectarines, peaches & plums.

⇔ **Halford –** Traditional standard size rootstock, 15-25′ H. Similar to Lovell. Used for almonds, apricots, nectarines, peaches & plums.

VVA-1 – Semi Dwarf. Produces a tree about 3 metres tall. Good fruit size, yield and winter hardiness. A useful rootstock for those wanting compact, free-standing trees.

⇔ **Torinel – Semi-Dwarf.** Particularly good for apricots. Trees reach a height of about 3 metres. A specialist rootstock for improved fruiting yield and fruit size. A useful rootstock for those wanting compact, free-standing trees. There is enough vigour for a good fan-trained tree against a wall.

⇔ **Krymsk 86 – Medium.** Compatible with apricots, peaches and nectarines. More tolerant of heavy wet soils with better anchorage. Larger, more robust tree form reaching about 4 metres. Bushes and half standards are grown on these rootstocks. Fan trained trees on large walls can be grown with this rootstock.

⇔ **Wavit – Semi Vigorous.** A robust disease resistant, free standing and non-suckering rootstock for plums, gages, damsons, mirabelles and apricots. Grows well on a wide range of soils and conditions. A useful rootstock for those wanting compact, free-standing trees. There is enough vigour for covering walls as fan-trained trees. About 10% less vigorous than St. Julien ‘A’.

⇔ **St. Julien ‘A’ – Semi Vigorous**

Produces a tree about 5 metres tall. This is fully compatible with all plums, damsons, gages, peaches, nectarines and apricots and many ornamental prunus species. A useful rootstock for those wanting productive, free-standing trees. Also ideal for large, fan-trained specimens.

⇔ **Brompton – Vigorous.** Ideal for large standards in traditional orchards. Trees on this rootstock can reach 6 metres. High quality fruit appears after the first few growing years. Not suitable for containers. Available to buy bare-rooted in winter.

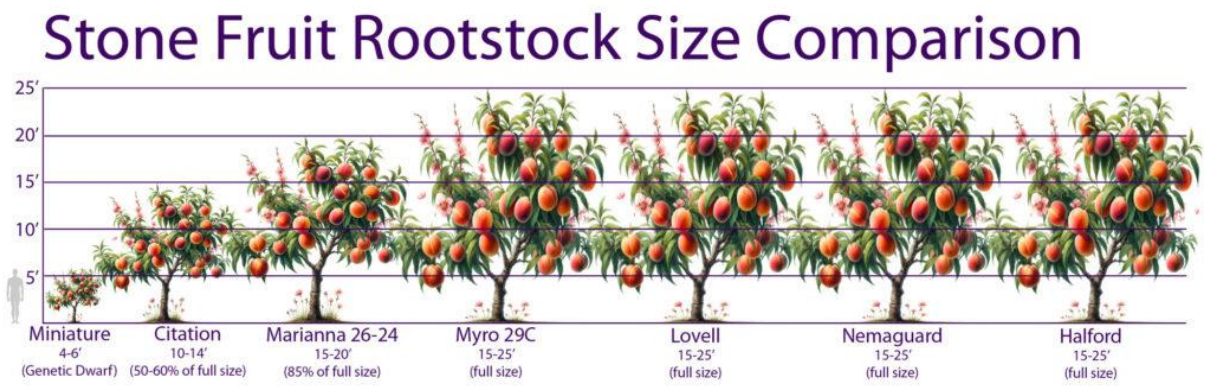

Fig.5. stone fruit rootstock size comparison. https://youngs-garden.com

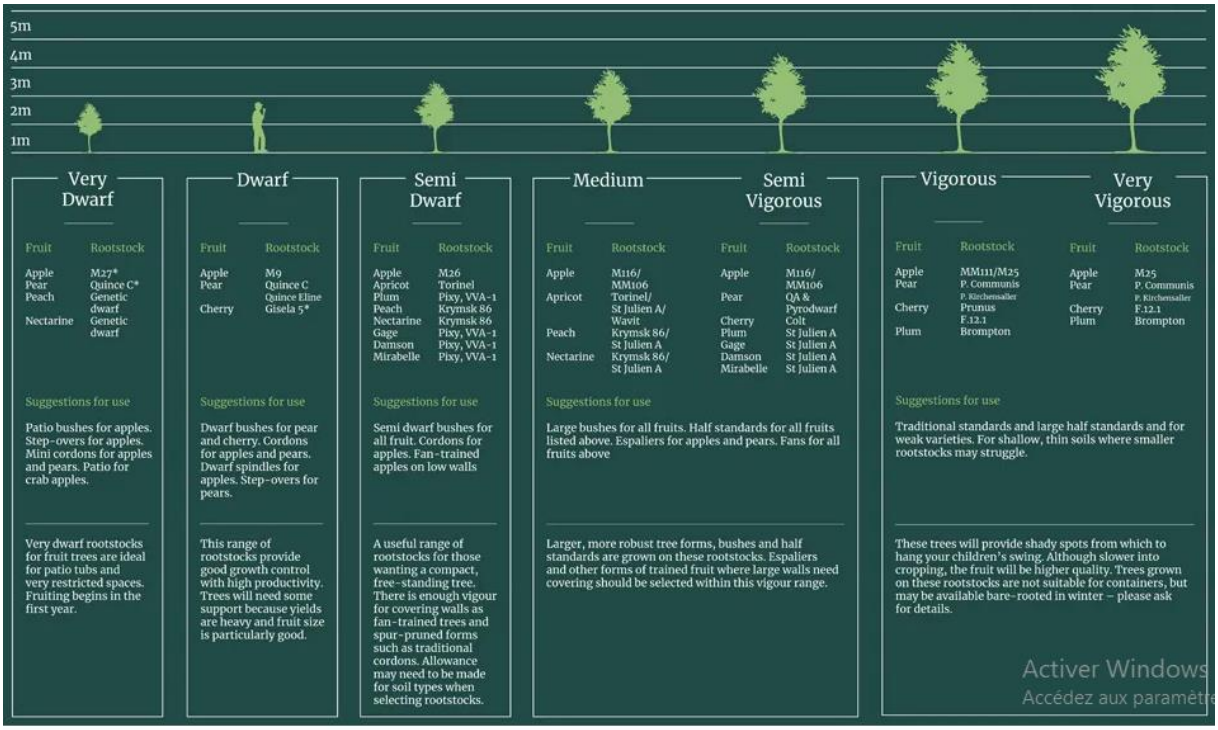

Fig. 6. A guide to fruit tree rootstocks. https://www.frankpmatthews.com

3. Citrus rootstock

a. **Sour orange:** the only rootstock that truly is an orange (the Citrus × aurantium or bitter orange). It is vigorous and highly drought-resistant.

b. **Poncirus trifoliata:** a close relative of the genus Citrus, sometimes classified as Citrus trifoliata. It is especially resistant to cold, the tristeza virus, and the oomycete Phytophthora parasitica (root rot), and grows well in loam soil. Among its disadvantages are its slow growth.it is the slowest growing rootstock and its poor resistance to heat and drought.

c. **Swingle citrumelo:** tolerant of tristeza virus and Phytophthora parasitica and moderately resistant to salt and freezing.

d. **Troyer citrange and Carrizo citrange:** reasonably vigorous rootstocks, resistant to Phytophthora parasitica, nematodes, and tristeza virus and with good cold tolerance. They also are highly polyembryonic, so growers can obtain multiple plants from a single seed. Citrange, however, does not do well in clay, calcareous or high-pH soils, and is sensitive to salinity. It is not feasible as rootstock for mandarin scions, as it overgrows them by producing branches of its own in competition with the grafted budwood
e. **Cleopatra mandarin:** tolerant of salinity and soil alkalinity and also suitable for shallow soils. Nowadays, however, it is considered an inferior rootstock because it is sensitive to many diseases, grows slowly, and is difficult to propagate.

f. Volkamer Lemon – C. volkameriana

Strong root system, vigorous growth, and large tree. Good production in many cases. Fruits are often large and store well. Limitations: Vigour varies depending on the cultivar planted and may be inconsistent in some specific cultivars (e.g., Satsuma). Good choice for relatively active growing conditions.

g. Nelspruit 639 (x639)

Generally good performance with certain varieties such as Washington navel and Murcott tangors. Produces medium to good sized trees and relatively high yields. Can show grafting issues with some mandarin varieties. Reliable choice with some common varieties.

4. Criteria for selecting rootstocks

A. **Tree Size and Vigor Control**

The type of rootstock used for grafting determines the final size of the tree (dwarf, semi-dwarf or standard), as well as the ripening period and fruit quality. Smaller rootstocks reduce tree height and make pruning and harvesting easier, and are also associated with earlier fruiting. In contrast, larger rootstocks provide vigorous growth and a longer lifespan.

B. **Soil and Site Adaptation**

Soil and Site Adaptation The type of rootstock for seedlings should be chosen according to the soil type, taking into account factors such as pH, texture and fertility. Some rootstocks tolerate clay and poor soils, while others prefer fertile, well-drained soil. Inappropriate soil adaptation can compromise the health and productivity of the tree.

C. **Climate and hardiness**

Each type of wall has a different ability to withstand high temperatures, frost and drought. Therefore, we select the type of wall that can withstand the harsh local climate in cold or hot regions.

D. **Disease and Pest Resistance**

In order to reduce our reliance on pesticides and protect our plants, we need to select root varieties that are resistant to soil-borne diseases and pests, such as *Phytophthora root rot*, *fire blight* and nematodes. This reduces losses and pesticide costs, while improving the productivity and resilience of the orchard.

E. **Time to fruiting (early ripening)**

Choosing the right variety of rootstock helps to shorten the tree's production period. Dwarf and semi-dwarf rootstocks are best for early fruit production, often within 2–3 years, compared to standard rootstocks, which can take 4–7+ years. This reduces the time needed to generate profits from the orchard.

F. **Root strength and structural support requirements**

Wall strength is also related to its type. Dwarf roots are characterised by weakness, meaning they are dependent on support.

G. **Compatibility with scion types**

To avoid incompatibility, rootstocks must be selected that are compatible with the scion. Other factors to consider are poor yield, tree health and age.