



Farmnote

Citrus rootstocks for WA

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Selecting the right rootstock for your orchard is very important. A healthy root system that is compatible with your chosen variety and well suited to its environment is essential if your orchard is to be a success.

There is no such thing as the perfect rootstock. Selection is a matter of determining which stock will perform best in your situation (see Table 1).

Rootstocks should be selected for their:

- ability to perform under your soil and climatic conditions
- resistance to pests and diseases
- compatibility with the variety you are planting
- positive impact on fruit yield and quality.

To choose the right rootstock it is essential to have all the relevant information. All of the factors listed below will impact on the performance of different rootstocks in your situation:

- soil type and structure, depth, drainage, pH and salt content
- pests and diseases present
- whether it is replant or virgin soil
- climatic conditions expected, for example extreme summer and winter temperatures (frosts etc)
- water quality (salt and pH) and the type of irrigation system (sprinklers, drippers)
- compatibility with the variety you intend to grow.

Interstate, there has been a trend towards obtaining comprehensive soil surveys that include a soil profile description of proposed orchard sites prior to planting. This is a positive move that should be considered by all growers to help in rootstock selection and overall planning and management of the orchard.

When purchasing trees it is very important to ensure that they are free of major viroids and other diseases. Rootstock seed should come from a reliable source, and budwood for propagation should be sourced from Auscitrus



Incompatible rootstock and variety combinations can cause 'benching' at the union leading to tree decline, lack of productivity and tree death

to ensure freedom from exocortis viroid (CEV) and other viroids that can affect tree health and vigour. Nurseries should be certified free of major diseases and have a good reputation for consistently producing high quality trees.

Commonly available rootstocks

Benton citrange

This was developed by the NSW Agriculture rootstock-breeding program and selected for its tolerance to footrot (*Phytophthora* spp.) and compatibility with Eureka lemon. It is a hybrid of Ruby Blood sweet orange and trifoliolate orange (*P. trifoliata*). This stock has not been used in any volume in WA and it is likely that it will be superseded by Cox mandarin hybrid as a stock for Eureka because it is easier to grow and propagate in the nursery.

Benton produces trees with similar vigour to Troyer and Carrizo, however, there have been mixed results from trial plantings in Australia. In some trials with Eureka it has performed well, while other trials with oranges have been less encouraging.

It is *Phytophthora* and tristeza-tolerant.

Important disclaimer

The Chief Executive Officer of the Department of Agriculture and Food and the State of Western Australia accept no liability whatsoever by reason of negligence or otherwise arising from the use or release of this information or any part of it.

Table 1 **Characteristics of commonly used citrus rootstocks in WA**

Rootstock	Fruit size	Rind thickness	Fruit quality				
			Rind texture	Fruit maturity	Sugar content	Acid content	Juice content
Trifoliata	medium-large	thin-medium	smooth-medium	mid-late	high	high	high
Troyer citrange	medium	thin-medium	smooth-medium	mid	medium-high	medium-high	high
Rough lemon	large	medium-thick	coarse	early	low	low	low-medium
Volkameriana	medium-large	medium-thick	medium-coarse	early	low	low	low-medium
Swingle citrumelo	medium-large	thin-medium	smooth-medium	mid-late	medium-high	medium-high	high
Sweet orange	medium	medium	medium	mid	medium	medium	medium
Cleopatra mandarin	small-medium	thin-medium	medium	mid	medium	medium	medium

No incompatibility with Eureka lemon is reported. It is also compatible with most other orange and mandarin varieties.

This stock has rarely been used in WA and very little local information is available. Local nurserymen have described it as being difficult to propagate.

C-35 citrange

Developed in California, this is a hybrid of trifoliolate orange (*P. trifoliata*) and Ruby Blood sweet orange. It has not been trialled extensively under WA conditions. There is some interest in it as an alternative rootstock for navel oranges.

C-35 citrange reputedly produces medium-sized trees, which are around 25 per cent smaller than trees produced by Troyer and Carrizo. Yield and other characteristics are reputedly similar to other citranges.

It is tolerant of *Phytophthora*, citrus nematode (*Tylenchulus semipenetrans*) and tristeza.

Very limited compatibility data are available at this time.

This stock has been planted in large numbers in recent years, however very little local information is available on its performance. Early evaluation in a Newhall navel rootstock demonstration block in Bindoon showed that trees grew well in the establishment stage but it is too early to determine what yields can be achieved.

Cleopatra mandarin

Cleopatra is a small-fruited mandarin which has been used as a rootstock for many years. It has not been used extensively in WA. It is the most salt- and lime-tolerant of the commercially available stocks. Trees are slow growing in the nursery.

Early production tends to be poor with trees taking a long time to settle into cropping. Fruit quality is good but small fruit size has been an issue with some varieties. Trees perform well on both heavy and light soils with best results on loam.

Cleopatra is tristeza- and exocortis-tolerant and moderately susceptible to phytophthora root and

collar rots. It is susceptible to citrus nematodes and not generally recommended for replant sites.

There are no reported compatibility problems and it is considered a good stock for most mandarin varieties.

This stock has rarely been used in WA and very little local information is available. In a Newhall navel rootstock demonstration block at Bindoon small fruit size was observed in the first few cropping seasons. A good yield of small to medium-sized fruit was achieved in the 2012 season.

Cox mandarin hybrid

This is a hybrid of Scarlet mandarin and trifoliolate orange (*P. trifoliata*) bred by NSW Agriculture. It was released in 1995 and is compatible with Eureka lemon. It has not been extensively trialled under WA conditions.

Cox is resistant to phytophthora root and collar rot. Seedlings are moderately vigorous and easier to grow than Benton citrange, making it more nursery-friendly.

Information on performance and compatibility (other than with Eureka lemon) is very limited.

This stock is currently only present in a limited number of trial sites in Western Australia. Eureka lemons planted on this stock in both Bindoon and West Gingin have grown excellent trees which have produced good yields. Newhall navel on this stock in Bindoon has produced small sized fruit.

Rough lemon (Citronelle)

During the establishment of the citrus industry in WA rough lemon was the most popular rootstock. It is still widely used for lemons and backyard plantings of oranges and mandarins.

It produces large, vigorous, highly productive trees that are drought-tolerant. It grows well on a wide range of soils but is particularly well adapted to deep sandy soils. It does not perform well on poorly drained soils and is also sensitive to saline conditions. Fruit quality can be poor. Poor skin colour and thick skins are a potential problem.

Salinity tolerance	Calcium tolerance (alkalinity)	Soil conditions			Disease
		Suitability for sandy soils	Suitability for loamy soils	Suitability for poorly drained soils	Phytophthora resistance
low	low	poor	good	good	high
medium	low	good	good	average-good	medium-high
low	medium	good	average	poor	low
low	medium	good	average	poor	low
medium	low	average	good	good	medium-high
medium	high	average	average	poor	very low
high	high	average	good	average	medium

Good water and nutrient management is important to get the best out of this stock.

Rough lemon is susceptible to citrus nematodes and phytophthora root rot and is not recommended in replant situations. It is tolerant of tristeza virus, and exocortis and xyloporosis viroids.

Rough lemon is unsuitable for some mandarins such as Ellendale and Satsuma types. As with Volkameriana, it should not be used with mandarins like Imperial that are susceptible to internal granulation (drying), especially in areas where this is a problem.

This stock is no longer used extensively because of its susceptibility to phytophthora. Its main use is for Eureka lemon. Yield has been quite good in a Newhall navel rootstock demonstration block planted at West Gingin in 1995. In the sandy soils there it has outyielded many stocks including Trifoliata and Swingle, especially in the early years. As with Volkameriana, fruit sugar and acid levels are usually lower than that achieved with other stocks and can drop relatively quickly. Fruit should not be left on the tree too long or they can become bland.

Imperial mandarins on this stock have had problems with internal granulation (drying) especially on sandy soils.

Sweet orange

Seedlings of sweet orange have been used as rootstocks around the world for many years. Although widely used in the Sunraysia and Riverland areas of Australia in early plantings, this stock has not been widely used in WA because of its susceptibility to phytophthora root and collar rot, and citrus nematode.

Sweet orange does best on well-drained deep sandy soils and can tolerate calcareous soils. It is sensitive to dry conditions and will not tolerate waterlogging. Fruit quality is generally good. It is tristeza- and exocortis-tolerant but not suitable for replant sites.

There are no reported incompatibilities.

This stock has rarely been used in WA and very little local information is available. It did

not perform well in a Newhall navel rootstock demonstration block in West Gingin.

Swingle citrumelo

Hybrids of grapefruit and trifoliolate orange are referred to as citrumelos. Swingle has been the most widely and thoroughly tested of the many named and unnamed citrumelos throughout the world. It is a hybrid of Duncan grapefruit and trifoliolate orange. In Australia, Swingle is attracting attention as an alternative to Troyer and Carrizo for grapefruit, navel and Valencia oranges.

The size of trees varies depending on the variety and soil type. Grapefruit are known to be very productive on Swingle overseas while in Australia some navel oranges have performed well. It is thought to be more salt- and drought-tolerant than other trifoliolate hybrids. Swingle will not perform well on shallow poorly drained sites and highly calcareous soils.

Swingle is tolerant of *Phytophthora*, tristeza and the exocortis and xyloporosis viroids. It is also resistant to nematodes and suitable for use in replant situations.

Swingle is incompatible with Eureka lemon and there are reported incompatibility problems with some mid-season orange and mandarin cultivars. In WA there have been major incompatibility problems on Navelina and some orchards have suffered major decline and tree deaths at around 10–15 years of age.

Swingle was popular with many WA growers, particularly in the Bindoon/Chittering area, however recent incompatibility problems with Navelina and some other varieties have eroded that popularity. It appears to be more salt-tolerant than some commonly used stocks and produces reasonable-sized manageable trees. Experience suggests the vigour varies depending on soil type and climate. In general, it is more vigorous than Trifoliata (especially in the establishment years) and less vigorous than Troyer and Carrizo citrange. In trials at West Gingin it has taken a while for trees to reach production and it is probably not suited to the light sands of this area.

Trifoliata (*Poncirus trifoliata*)

Poncirus trifoliata or trifoliolate orange has been used worldwide for many years and is commonly used where soils are heavy in WA. It produces small to standard sized trees depending on soil type. They bear well for their size and fruit quality is good. Trifoliata performs best on heavier clay loams to loamy soils and is not well suited to sandy soils where growth is slow. It is cold hardy but has poor drought tolerance and is poorly suited to saline and highly alkaline or acidic soil conditions.

This rootstock is resistant to citrus nematode, tristeza virus and some species of *Phytophthora*. However, it is very susceptible to the exocortis viroid. It is responsive to viroid dwarfing and suitable for use in replant sites.

Trifoliata is incompatible with Eureka lemon and because of reports of incompatibility with some minor varieties it should be used cautiously with untested varieties.

Trifoliata has become less popular in recent years as it produces small trees that can take a long time to yield. It is not as tolerant to saline conditions as some other stocks (an increasing problem in some areas). It is known for good quality fruit and is better suited to heavy soils. It has performed poorly in deep sands at West Gingin where trees are slow to reach a good bearing size.

Troyer and Carrizo citrange

Hybrids of sweet orange and trifoliolate orange are referred to as citranges. These two citranges are virtually indistinguishable and are hybrids of Washington navel and *P. trifoliata*. Troyer citrange is the most widely used rootstock in WA.

Both rootstocks are cold hardy, produce vigorous trees and perform well on most soil types although they will not grow well in calcareous soils or under saline conditions. Trees on these rootstocks can be prone to micronutrient deficiencies, especially on calcareous soils.

They are tolerant of the citrus tristeza virus, citrus nematode (*Tylenchulus semipenetrans*) and phytophthora root rot but are susceptible to severe strains of the citrus exocortis viroid. Both are responsive to viroid dwarfing and are suitable for use in replant sites.

Troyer and Carrizo citrange are compatible with most common citrus varieties except Eureka

lemon. There is a long-term problem with Imperial mandarins that may be related to overgrowth at the bud union. Compatibility with some minor varieties is unknown.

Troyer and Carrizo are grown under a range of conditions in WA. They are commonly known as 'best bet' rootstocks throughout the state and have performed well on the deep sands at West Gingin and in heavier clay loams at Harvey.

Volkameriana (Volkamer lemon)

Volkameriana seedlings are fast growing and vigorous, and adaptable to a wide range of soil conditions. Like rough lemon, it will grow well in deep sands where some rootstocks struggle. Fruit quality is not as good as that produced on citrange and Trifoliata stocks, however, it is reported to be better than that produced by rough lemon.

Volkameriana is not susceptible to tristeza virus or exocortis and xyloporosis viroids. It is susceptible to citrus nematodes and phytophthora root rot but less so than rough lemon. It is not recommended for replant situations.

Volkameriana is compatible with lemons, most oranges and mandarins. Mandarin varieties that are susceptible to internal granulation (drying) such as Imperial should not be planted on this stock which has been shown to enhance this problem.

This rootstock has performed quite well in a Newhall navel demonstration block planted at West Gingin in 1995. In the sandy soils it outyielded other stocks including Trifoliata and Swingle in the early years. Sugar and acid levels are not as high as for many other stocks and can drop relatively quickly, so fruit should not be left on the tree too long or they can become bland.

Imperial mandarins on this stock have had problems with internal granulation (drying), especially on sandy soils.

Related Farmnotes

- Note 540 Orange varieties for WA
- Note 541 Mandarins and tangors for WA



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