

2022–2023 Florida Citrus Production Guide: Rootstock and Scion Selection¹

Ute Albrecht, Fernando Alferez, and Mongi Zekri²

When preparing for new planting or replanting, an important factor to consider is the choice of rootstock and scion. Choosing the right rootstock and scion combination can result in higher economic returns without any additional cost. The rootstock affects scion vigor, yield, fruit size and quality, and pest tolerance. However, tree growth, yield, and fruit quality interact strongly with climate, soil type, tree spacing, and other abiotic and biotic factors, often producing inconsistent reports on rootstock performance in different areas.

Rootstock selection should be based on soil type, soil pH, pest and disease pressure, desired tree spacing and size control, and other horticultural traits. Several new rootstock selections were recently released; therefore, not much information exists on their long-term performance under different environmental conditions and different commercial management. Also important is the choice of scion to be used in combination with the selected rootstock. Several novel scion varieties have been released by the breeding programs at UF/IFAS and the USDA. These novel varieties are expected to have better field performance, disease tolerance, and fruit quality, making some of them suitable for the fresh-fruit market. Many of the newest scion and rootstock combinations have been evaluated under the Fast Track program managed by the New Varieties Development

and Management Corporation (NVDMC). This program makes advanced citrus selections available to growers and nurseries for trial and potential early commercialization. Check <http://nvdmc.org/nvdmc-varieties/> for the newest commercially available varieties.

Soil Characteristics

Choosing the right rootstock for your soil type is critical. Rootstocks performing satisfactorily on the well-drained sandy soils of the central Florida ridge may not be suitable for the wet “flatwoods” soils of the southwest and eastern Florida citrus production areas. Equally important is the ability to tolerate conditions of high pH and salinity. Unfortunately, few rootstocks have shown to be as adaptable to suboptimal soil conditions as sour orange. Although Cleopatra mandarin can tolerate conditions of higher salinity and alkalinity better than most rootstocks, it is not well suited for poorly drained soils. Also suitable for high-pH or calcareous soils is Volkamer lemon. C-22, a Californian cultivar also known as ‘Bitters’, is considered tolerant of calcareous soils. Rootstocks such as C-35, Carrizo, and Swingle are among the rootstocks that perform most poorly in the presence of high pH and salinity. Thus far, little is known regarding the impact of soil type on the performance of the newer rootstock cultivars.

1. This document is HS1308, one of a series of the Horticultural Sciences Department, UF/IFAS Extension. Original publication date September 2017. Revised annually. Most recent revision June 2022. Visit the EDIS website at <https://edis.ifas.ufl.edu> for the currently supported version of this publication. For more detailed information on citrus rootstocks, please refer to SP 42, *Rootstocks for Florida Citrus*, and HS1260, *Florida Citrus Rootstock Selection Guide* (which was developed through a collaborative effort of citrus researchers from UF/IFAS and USDA). The interactive guide assisting in the selection of rootstocks best suited for the individual needs of a citrus operation can be found at https://crec.ifas.ufl.edu/extension/citrus_rootstock/.
2. Ute Albrecht, assistant professor; Fernando Alferez, assistant professor, Horticultural Sciences Department, UF/IFAS Southwest Florida Research and Education Center; and Mongi Zekri, citrus Extension agent, UF/IFAS Extension Hendry County; UF/IFAS Extension, Gainesville, FL 32611.

Rootstock Effects on Pests and Diseases

Many of the newer rootstock cultivars are of partially trifoliolate origin, thereby inheriting some degree of tolerance to phytophthora. In respect to the phytophthora/Diaprepes root weevil complex, US-802, US-897, US-942, UFR-4, and UFR-5 are more tolerant in comparison with other common rootstocks. Unfortunately, damage from phytophthora is exacerbated in roots already compromised by HLB. Although thus far no rootstock has shown to induce the desired levels of tolerance to HLB, trees grown on some rootstock cultivars produce good yields under high HLB pressure and exhibit lower-than-average rates of fruit drop. These rootstocks include US-942, US-812, UFR-4, UFR-5, and the Californian cultivars C-54 ('Carpenter') and C-57 ('Furr'). X-639, developed in South Africa in the 1950s, produces very healthy and vigorous trees despite HLB, but fruit production may be low during the early production years. Whereas most of the newer available rootstocks are tolerant to citrus tristeza virus, little is known regarding tolerance to blight, except for US-896, US-812, and US-942, which are considered tolerant.

In 2015, five rootstocks with improved tolerance to HLB were released by the USDA: US-1279, US-1281, US-1282, US-1283, and US-1284. All five are hybrids of mandarin and trifoliolate orange, produce medium-sized trees, and appear adapted to Florida's flatwood soils. In 2018, the USDA released three new SuperSour rootstocks, US SuperSour 1 (SS1), US SuperSour 2 (SS2), and US SuperSour 3 (SS3). SS1 performs well with sweet orange on both the ridge and east coast flatwoods, whereas SS2 and SS3 perform well on the ridge and the east coast flatwoods, respectively. All three SuperSour rootstocks induced higher yield than standard sour orange in the presence of HLB under the tested conditions.

The UF/IFAS rootstocks UFR-1, UFR-2, UFR-3, UFR-4, UFR-5, UFR-6, UFR-15, UDR-16, and UFR-17 were released under the Citrus Fast Track Release Option and are managed by Florida Foundation Seed Producers, Inc. (FFSP). More information can be found at <http://www.ffsp.net/varieties/citrus/citrus-rootstocks/>.

Tree Spacing and Size

Trees should be spaced based on the expected size of the tree and lifespan of the grove. A more densely planted grove may provide earlier economic returns despite an initially higher investment. C-22, US-897, and UFR-6 rootstocks produce relatively small trees, which should be spaced at

6–8 feet within the row and 15 feet between rows. The only rootstock producing an even smaller tree is Flying Dragon, allowing for an in-row spacing of 5–7 feet as well as closer between-row spacing, if feasible. Yield efficiency and quality of fruit on these small-tree-size-inducing rootstocks is usually high compared with some of the more vigorous rootstocks. Most of the other available rootstocks will induce trees of average size with a recommended spacing of 8–12 feet and that produce fruit of intermediate to high quality. If the desired grove architecture is for a larger in-row spacing of trees (12–15 feet), rootstocks such as US-802, X-639, Volkamer lemon, rough lemon, and Cleopatra mandarin are appropriate. The high vigor of these rootstocks may be advantageous in that they allow a tree to cope better with the damaging effects of HLB compared with less vigorous trees. Although yield will be high on these rootstocks, fruit quality will generally be lower, which may be disadvantageous when used in combination with some scion varieties. Check https://crec.ifas.ufl.edu/extension/citrus_rootstock/ for more information on rootstocks.

Rootstock/Scion Combination

Choice of rootstock will also depend on the scion variety selected for the new planting. An excellent example is sour orange, which is susceptible to tristeza virus when used in combination with sweet orange and most other scion varieties. Although sour orange is still among the top ten most propagated rootstocks (DPI Citrus Budwood Annual Report, <https://www.fdacs.gov/content/download/101636/file/CitrusBudwoodAnnualReport2021v3.pdf>), it is not recommended for extensive use in Florida because of the endemic presence of the tristeza virus. Most of the more recently released rootstocks have been evaluated in combination with few scion varieties, mainly sweet oranges, and it is recommended to be cautious when choosing new combinations. Recently, US-1283 was discovered to exhibit incompatibility with several fresh-fruit cultivars (Bearss lemon, Star Ruby grapefruit, and Tango mandarin). Field trials of different scion/rootstock combinations that include new releases are under way, and it is expected that new information on compatibility and other horticultural traits will be available soon.

In general, to hit the juice market earlier, there is a need to advance the harvesting window for Valencia selections. One trend increasingly followed by the industry and researchers is to develop high-quality sweet orange varieties that reach commercial maturity in early and mid-season with reduced production costs. Higher fruit quality and maturation standards achieved earlier would also reduce the need for juice blending with late varieties. Moreover, developing

varieties with an early maturation window and improved internal fruit quality would allow replacement of Hamlin, which is particularly sensitive to citrus canker and HLB. New varieties have been developed through irradiation and other techniques by UF/IFAS and the USDA. Among the newer UF varieties are the early Valencia somaclone Valquarius and the Florida EV1 and EV2. Juice quality of EV1 is typical of Valencia in sugar and acid content, color, and flavor, but fruit are difficult to peel and slightly seedier than standard Valencia. Fruit matures from December to January in central Florida, about 8–12 weeks earlier than standard Valencia. Yield, juice quality, and maturity dates (February/March) for Vernia, a midseason sweet orange somaclone, are also quite desirable when compared with standard Valencia. An attractive feature of Vernia is that fruit have the highest color score of any orange at time of harvest.

Although not new, Midnight and Delta are also noteworthy choices. These South African selections reach commercial maturity several weeks before traditional Valencia oranges grown in Florida. Midnight trees are less vigorous than other Valencia selections and grow well on Carrizo and Swingle rootstocks. Delta trees are more vigorous, and because fruit has lower Brix than other Valencia selections, Swingle and Carrizo rootstocks are recommended for this scion. So far, no information is available about the performance of these two varieties on newly released rootstocks from UF/IFAS or the USDA.

Other interesting varieties are the OLL series, which are late-maturing varieties with high pound solids and yields. Among the late-season varieties, Valencia UF B9-65 has superior quality in terms of yield and pound solids. The variety US Sun Dragon was recently released by the USDA. It is orange-like and HLB-tolerant, and it may have potential for the juice market.

Newer scion releases with potential for the fresh-fruit industry include LB8-9 (SugarBelle®) as the most promising variety. These trees are vigorous and relatively tolerant to HLB and Alternaria. Mature trees can reach 20 feet in height, depending on the rootstock. This makes regular pruning, hedging, and topping imperative to maximize light exposure and achieve good yield. Fruit matures from late November to early January and may be seedy, depending on cross-pollination incidence. Fruit is easy peeling, and retention is good and well past normal market maturity. Some growers have reported fruit softening in trees between 5 and 10 years of age, although the severity of this problem seems to vary every year. It appears to be more prevalent in fruit from trees with a heavy load,

and fruit softening is more common in the bottom end of the fruit, when the peel is thinner. Efforts are underway to understand and alleviate this fruit disorder. Bingo, an easy-peeling seedless mandarin with a deep-orange color, is suitable for the fresh-fruit market. It matures early in the season and can be harvested between early October and early November. It provides all attributes to compete with California clementines. Several UF/IFAS-USDA collaborative field trials are underway to identify rootstocks most suitable to combine with both SugarBelle® and Bingo.

Tango is an excellent low-seeded variety with good internal color. Compared with Early Pride, Tango performs better in terms of HLB tolerance. Fruit mature in December but do not degreen well, and the response to postharvest ethylene is poor if not enough chilling hours accumulate during the season, especially in central and south Florida. One of the newest varieties in the UF/IFAS arsenal of fresh-fruit varieties is Marathon mandarin, which is seedless and easy to peel. Marathon obtained its name from its exceptional ability to hold long on the tree.

Other commercial protected varieties managed by the NVDMC with interest for the fresh market include Roe tangerine, Mandalate, and UF-Glow. Roe, like Bingo, is low-seeded and easy peeling, resembles a traditional Florida tangerine, which matures around Thanksgiving, and has good tree retention (holding through January), but requires clipping. Mandalate is a seedless, easy-to-peel, and juicy Mediterranean mandarin that shows some tolerance to HLB and is especially interesting for northern FL counties in the Panhandle and Big Bend regions with climatic characteristics more like the Mediterranean. UF-Glow is also seedless and easy peeling. An early variety that matures by mid-October, it is self-fertile and cold tolerant, and it shows some HLB tolerance.