

2024–2025 Florida Citrus Production Guide: Rootstock and Scion Selection¹

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When preparing for a new planting or replanting, an important factor to consider is the choice of rootstock and scion. Choosing the proper rootstock and scion combination can result in higher economic returns without any additional cost. The rootstock affects scion vigor, canopy architecture, yield, fruit size and quality, disease susceptibility, 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. Many new rootstock selections are now available, replacing the historically used rootstocks. Therefore, limited information exists on their long-term performance under different environmental conditions and different cultural management practices. 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 selections suitable for the fresh-fruit

market. Many of the newest scions are 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. For example, although Cleopatra mandarin can tolerate conditions of higher salinity and alkalinity better than most rootstocks, it is not well suited for poorly drained soils which can have suboptimal effects on fruit quality. It has been reported that Cleopatra mandarin produces smaller fruit when planted in these soils than do other rootstocks.

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High-pH or calcareous soils suit Volkamer lemon, too. C-22, a Californian cultivar also known as ‘Bitters,’ is considered tolerant of calcareous soils. C-35, Carrizo, and Swingle are among the poorest performing rootstocks in the presence of high pH and salinity. Swingle does not perform well in poorly drained, heavy soils such as on the Florida east coast and in southwest Florida. US-942, which has been the most propagated rootstock since 2018, seems to perform better in southwest Florida than in central ridge production sites. US-812 appears to outperform US-942 in terms of juice quality on ridge sites.

Rootstock Effects on Pests and Diseases

Many of the newer rootstock cultivars are hybrids of trifoliolate orange, 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 Huanglongbing (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, can produce 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. Two of the historically used rootstocks, Carrizo and Kuharske, are susceptible to blight. Decline may become evident after eight or more years in the field.

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 to be 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. Two more SuperSour rootstocks, SS4 and SS5, were released in 2023 because of their superior performance relative to standard sour orange and other rootstocks. Among the released SuperSour rootstocks, only SS2 exhibits good genetic uniformity among seedlings.

Among the newer UF/IFAS rootstock releases are UFR-1, UFR-2, UFR-3, UFR-4, UFR-5, UFR-6, UFR-15, UFR-16, and UFR-17, which are managed by the 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 will 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](#)), 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 as any potential graft incompatibilities may take several years to manifest.

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, somaclonal selection, 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 its 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 compared to standard Valencia. An attractive feature of Vernia is that fruit often 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 (OLL-4 OLL-8, and OLL-20), which are late-maturing varieties that have demonstrated relatively higher pound solids and yields at several sites. OLL-20 has demonstrated high color and exceptional flavor. Among the late-season varieties, Valencia UF B9-65 has superior quality in terms of yield and pound solids and there is some evidence of better performance in the HLB environment compared to conventional Valencia

budline selections. The variety US Sun Dragon, released by the USDA, is orange-like and HLB-tolerant, and it may have potential for the juice market.

Other scions with potential for the fresh-fruit industry include LB8-9 (Sugar Belle®) 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 challenging but 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 semi-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. HLB-affected fruit can also become misshapen later in the season, affecting fresh market packout. Growers in North Florida do not have the same problem as those in central and south Florida. 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, although its smaller size may affect packing operations. 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. However, major fruit drop and size issues have been reported with this variety in recent years, except in north Florida. Several UF/IFAS-USDA collaborative field trials are underway to identify rootstocks most suitable to combine with both Sugar Belle® and Bingo.

Tango, an irradiated mandarin, is an excellent low-seeded (virtually seedless) variety with good internal color. Compared with Early Pride, Tango performs better in terms of HLB tolerance. Fruit matures in December but does 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. Growers in North Florida do not seem to have major problems with coloration of this variety. One of the newest varieties in the UF/IFAS germplasm 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; and fruit maturity can come relatively early. Marathon has shown some level of HLB tolerance in a demonstration block at the CREC.

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 Florida 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.

Web Address for Link

DPI Citrus Budwood Annual Report: <https://www.fdacs.gov/content/download/108719/file/2021-2022-citrus-budwood-annual-report.pdf>