

2026–2029 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, tolerance to abiotic stress (cold, drought, wind), 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 the [NVDMC Varieties](#) webpage 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.

Volkamer lemon and C-22, a Californian cultivar also known as ‘Bitters’, are also 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 among the most propagated rootstock since 2018, seems to perform well both in southwest Florida and in central ridge production sites. US-812 also performs well in both production regions and appears to outperform US-942 in terms of juice quality. Among the newer rootstocks, US SuperSour 4 (SS4) appears to be promising, although large-scale data are not yet available.

Rootstock Effects on Pests and Diseases

Many of the newer rootstock cultivars are hybrids of trifoliate 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 (a seedling of Carrizo), 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 trifoliate 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; the other SuperSour rootstocks are propagated by tissue culture.

Among the newer UF/IFAS rootstock releases are UFR-1, UFR-2, UFR-4, UFR-5, UFR-6, UFR-15, UFR-16, and UFR-17, which are managed by the Florida Foundation Seed Producers, Inc. (FFSP). See the FFSP webpage on [Citrus Rootstocks](#) for more information.

Large-scale commercial field trials evaluating the effect of systemic delivery of oxytetracycline by trunk injection showed strong positive tree responses, regardless of the rootstock. Although the extent of responses to OTC injection can vary by rootstock, effects generally do not affect other aspects of rootstock performance. For example, vigorous rootstocks will continue to increase grafted tree vigor compared to dwarfing 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. However, Flying Dragon is a slow-growing rootstock that is not recommended for commercial growers. Yield efficiency and quality of fruit on these small-tree-size-inducing rootstocks are 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, and rough lemon 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. Under the current HLB-endemic growing conditions, it is advisable to plant trees at higher densities than in the past as the disease appears to stunt growth, reducing overall productivity per unit land.

Check the "[Florida Citrus Rootstock Selection Guide](#)" for more information on spacing.

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 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. Mandarins have the most uncertainty when it comes to graft incompatibilities.

One trend increasingly followed by 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; however, 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 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. These scions, EV1, EV2, and Vernia, have not been performing well in the HLB environment in central and south Florida in recent years, but could be excellent selections for north Florida and for citrus under protective screen (CUPS) growers.

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, OLL-20, OLL-DC-3-36, and OLL-DC-3-40), 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 and was released due to input from a major processor. 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 (peel is tighter toward the bottom of the fruit), and retention is good and well past normal market maturity. Some growers have reported fruit softening in trees, although the severity of this problem seems to vary every year and OTC trunk injections seem to improve fruit quality. 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, with OTC trunk injection

helping, although not on a whole-tree level. Sugar Belle® has exceptional fruit quality (over 15 Brix some years), with low limonin after processing, which is an important trait for juice processing. Titratable acidity can be rather high (up to 1.2%).

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. However, Tango has had a problem with Brix at multiple locations in central Florida. 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. Its fruit maturity can come relatively early. Marathon has shown exceptional HLB tolerance for tree health in a demonstration block on sour orange rootstock at the UF/IFAS CREC, but granulation is a problem.

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 it 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 Addresses for Links

DPI Citrus Budwood Annual Report:
<https://ccmedia.fdacs.gov/content/download/120276/file/24-25-annual-budwood-report-final.pdf>

UF/IFAS publication SP248, "Florida Citrus Rootstock Selection Guide": <https://ask.ifas.ufl.edu/publication/HS1260>

Florida Foundation Seed Producers, Inc. (FFSP), Citrus Rootstocks: <https://ffsp.net/varieties/citrus/citrus-rootstocks/>

NVDMC Varieties: <https://nvdmc.org/nvdmc-varieties/>

¹ This document is HS1308, one of a series of the Department of Horticultural Sciences, UF/IFAS Extension. Original publication date September 2017. Revised annually. Most recent revision August 2026. Visit the Ask IFAS website at <https://ask.ifas.ufl.edu> for the currently supported version of this publication. For more detailed information on citrus rootstocks, please refer to 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/. © 2026 UF/IFAS. This publication is licensed under [CC BY-NC-ND 4.0](#).

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