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2019–2020 Florida Citrus Production Guide: Grove Planning and Establishment[1]

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Main points:

- Plan all aspects of a new planting in coordination with your management program.
- Prepare soil and irrigation/fertigation infrastructure before planting.
- Use only good-quality planting material for planting.
- Careful planning prior to grove establishment will result in higher productivity and economic gain.

"It's complicated"

Every choice in grove management affects other aspects of management, and many of these decisions must be made even before the grove is planted. For instance, decisions on planting density will have to consider the rootstock and scion varieties because plant vigor will determine how quickly the space between plants will be filled. Because these choices are irreversible for the lifetime of the planting, each of them should be considered together, keeping the whole puzzle in mind when putting pieces together. This chapter addresses the most important decisions that should be made before and immediately after planting and refers to other chapters with more detailed information. Generally, the most important factors before planting fall into site selection and grove planning and preparation. Planting and early tree care are also essential to long-term grove success. Coordinated planning of all aspects of grove establishment and careful planting establishment can set you up for success and reduced frustration in the future.

Site Selection

Every potential site has some challenges when establishing a new grove. In this section we will discuss the most important factors to consider when selecting a site, including pest and disease history, soil type, and quality of irrigation water.

a. Pest and Disease History

Soilborne pests tend to persist over many years. Make sure you know whether the site has a history of Phytophthora or Diaprepes root weevil. Poorly drained soils are more likely to have Phytophthora, even if there are no records for the site. When sites are available that do not have histories of these problems, it is better to choose those sites. If you cannot choose another site, there are measures to manage sites with a history of soilborne pests or diseases, which we will discuss in the site preparation section.

Management of neighboring groves must also be considered because it can greatly affect disease pressure, especially from HLB. If neighboring groves are managed poorly, high psyllid populations will likely be present in your grove at most times during the year. Having no citrus nearby or well-managed groves with active psyllid management is preferable.

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b. Soil Fertility

Several soil characteristics affect soil fertility. These include pH, organic matter, and cation exchange capacity. Although most native Florida citrus soils historically have a low pH in the upper 6 inches, at present most have a high pH. This is because most irrigation water is alkaline and raises the pH over time, leading to high pH in soils that have been in irrigated crop production, especially citrus production. The optimum pH of soil and irrigation water is between 6.0 and 6.5.

Cation exchange capacity (CEC) is a measure of how well the soil holds most mineral nutrients. Most soils used for citrus production in Florida are sandy and have a very low CEC, usually between 0 and 2 (meq per 100 g soil). Below we will discuss approaches to managing low-CEC soils. Soil organic matter affects both nutrient- and moisture-holding properties of the soil. Most soils in Florida's citrus production areas have low organic matter (between 0 and 1%). A higher content of soil organic matter is generally preferred because in most cases it will lead to higher CEC and water-holding capacity.

c. Soil Moisture

It can be difficult to achieve a happy medium of soil moisture in Florida soils. Upper layers of sand drain rapidly after rain or irrigation, leading to water deficits. However, high water tables or clay pans with poor drainage may result in waterlogging in the deeper layers of the soil. Waterlogging reduces the amount of oxygen that is available for root respiration and therefore inhibits root growth. In addition, growth of harmful microbes may occur in this oxygen-limited environment. If these conditions last for longer than 72 hours, root death is likely to occur. Root injury and death also open up infection sites for soilborne pathogens such as Phytophthora, which can further reduce root growth. Information on the history of flooding in the selected site will help assess whether waterlogging is likely to occur. In flood-prone regions, it is imperative to raise beds and establish a drainage system consisting of furrows, ditches, or tile drains.

d. Water Access and Quality

Access to water for irrigation is essential for citrus production in Florida. The site must have permits for well or surface-water pumps. Additionally, pump volume capacity must meet the maximum volume needed for the planting. Chapter 15 of this guide, "Irrigation Management," provides more information on determining the volume of water needed to irrigate the area supplied by the available pumps. This is especially important in areas where irrigation is used for freeze protection. If sufficient water volumes cannot be delivered during the freeze, then the system will fail. Consider the available infrastructure when choosing the site.

The quality of the water available for irrigation is as important as the available quantity. The best-quality water should not be alkaline nor contain high levels of bicarbonates. The specific concentration at which bicarbonates begin to affect citrus root growth is not known, but lower concentrations should be preferred over higher concentrations. Some evidence suggests that concentrations higher than 100 ppm of bicarbonates will negatively affect root growth. Any grower using non-surface irrigation water should consider approaches to remediate bicarbonate levels.

e. Weather—Freeze Risk

Although freezes do not occur often in Florida, if they do, they can result in great economic losses and set a grove back by years in terms of production. The risk of freezing temperatures is the major reason for the expansion of citrus production areas southward since their initial establishment in northern Florida. The history of freezes is a good way of understanding the relative future risk of a freeze event in a particular location. Most freezes in Florida are advective, meaning they result from cold air that moves in fronts from the north. These freezes pose regional risks, though the risk is higher further north. Sites close to a large body of water may have some relief from an advective freeze if they are on the leeward (downwind) side, because the water will warm the cold air as it crosses. However, some freeze events are convective, which means that they result from warm air dissipating upward as colder air settles. In a convective freeze topography makes all the difference. Lower-lying areas between hills are more likely to accumulate cold air in frost pockets and are therefore more prone to freezes than sites that are elevated above their surroundings. Especially in northern production areas, frost pockets should be anticipated and adequately prepared for to avoid major crop losses. The risk of freezing should be considered when choosing the planting site, as well as when choosing rootstock and scion variety and irrigation systems.

Grove Planning and Preparation

No site is perfect. In this section we discuss how to overcome challenges presented by a selected site and approaches to reduce risks and improve productivity.

a. Grove Design

Before the site is prepared and the irrigation system is installed, you should consider tree spacing and orientation because they can greatly affect profitability of a planting. Sunlight is the source of energy for tree and fruit growth; therefore, a grove should be designed so that the tree canopies capture sunlight most efficiently. Tree spacing should be based on the expected vigor of the scion/rootstock combination and the expected lifespan of the grove. Tree rows oriented north to south will maximize sunlight interception. However, row orientation may also depend on the row length and the direction of water drainage. A good grove design results in healthier, more productive trees with only minor pruning required.

Spacing between rows is a question of infrastructure. Rows need to allow enough space for a tractor to pass through without harming the trees when they are mature. Typically, row spacing is 18–22 feet. This allows enough space for an 8-foot-wide tractor to pass between trees with canopy widths of 10–14 feet. The between-row spacing should be as narrow as your equipment allows. Anything wider than necessary will result in fewer plants per acre, and thus fewer boxes of fruit per acre. Within rows, growers typically plant 8–12 feet apart, though there are no studies comparing planting densities with currently planted varieties in Florida. A spacing of 18 feet between rows and 8 feet within rows allows for 302 trees per acre, whereas a spacing of 22 feet between rows and 12 feet within rows only allows for 165 trees per acre. Within this range, climate, soil, scion variety, influence of rootstock on tree vigor, and expected disease pressure should be considered. In general, groves planted at higher densities provide earlier returns than groves planted at lower densities, though they do not produce higher yields at maturity. Because the expected life span of a tree is considerably shorter under the present endemic conditions of HLB, in combination with reduced yields of infected trees over time, maximizing yield during the early production years is essential. For a detailed assessment of the economics of planting density, see the new planting economics chapter of this guide.

b. Pest History

It is best to avoid sites that have a history of Diaprepes root weevil or Phytophthora. If this is not possible, measures can be taken to minimize the effects of this pest-disease complex. Generally, Phytophthora problems are intensified in poorly drained soils. Therefore, improving drainage will reduce disease pressure (see Soil Moisture section below). If the selected site has a history of Phytophthora or Diaprepes root weevil, choosing the proper rootstock is essential. Several rootstock options are available; see the Rootstock Selection Guide for more information.

c. Soil Fertility

One of the major fertility challenges in Florida citrus soils is high pH. Adjustment of the pH to the optimal range of 6.0–6.5 is recommended because at a higher pH, availability of some nutrients is limited. However, soils that have high pH will tend to be high for a long time. Therefore, if the pH begins high, you should consider planting with one of the few rootstocks that tolerate high pH.

Florida citrus soils often require adjustment prior to planting. Our soils often have high pH accompanied by low nutrient-holding capacity. Pre-planting applications of acidifying fertilizers, such as ammonium sulfate, can help lower the soil pH. Additionally, acid-injection systems to acidify irrigation water should be considered. For more information, see the irrigation and nutrition management chapters of this guide.

In addition to pH adjustment, pre-plant practices that increase or preserve soil organic matter can improve soil fertility during establishment. These practices include the planting of cover crops and using minimal tillage to prepare the ground for planting if additional shaping, such as bedding, is not required. Although costly, additions of composted materials increase soil fertility and therefore tree growth and productivity of newly planted trees because they help maintain a balanced pH and improve nutrient-holding capacity. For further information about cover crops, SARE offers a well-documented cover-crop manual for free download here.

d. Soil Moisture

Excessive soil moisture can be more damaging to citrus trees than drought. More than 3 days of rootzone flooding will cause severe damage to the roots, followed by tree decline and possible death of trees. Sites in the southern and coastal areas of the state, referred to as flatwoods, are poorly drained, and therefore more prone to flooding than other parts of the state. To improve drainage in poorly drained areas, trees are usually planted on double-row raised beds. The crown of raised beds should be 3–4 feet above the bottom of the furrow. Drainage systems consist of water furrows, ditches, tile drains if needed, and a perimeter ditch to remove excess water. The drainage system in the flatwoods should be designed to remove 4 inches of water per day. Drainage is usually adequate in the sandy soils of the central Florida ridge, so these groves typically do not require bedding or additional drainage measures.

Because of seasonal prolonged periods without adequate rainfall, in combination with the predominantly sandy soils in Florida's citrus production areas, installation of an irrigation system is required prior to planting. Microirrigation, including low-volume emitters such as drippers or microsprinklers, are preferred over other systems because they are more cost-effective and water-use efficient than traditional sprinkler systems. Microirrigation systems are easily automated and operate at lower pressures and hence use less energy. Microsprinkler systems can be engineered to offer some degree of cold protection by installing one emitter per tree and using additional "spaghetti" tubing to hang the emitter in the lower canopy when there is threat of a freeze. Compared to overhead irrigation, microirrigation also reduces incidence of diseases that thrive in a moist environment by not wetting the canopy.

The goal of designing an irrigation system is to apply the water uniformly across the grove, improve water-use efficiency, and minimize water losses to evaporation, runoff, or deep percolation below the root zone. Uniform application means that each tree receives the same amount of water. Water-use efficiency means that the plants receive just enough water to grow optimally. This will also minimize nutrient leaching. When designing an irrigation system to optimize water-use efficiency, emitter type and strategies to schedule and monitor irrigation need to be considered. For details of irrigation management, see the irrigation chapter of this guide.

Nutrient management should also be considered when selecting an irrigation system. Injection systems can allow you to acidify the soil through acid injection or to fertilize through the irrigation system ("fertigation"). There are other options to reduce soil pH, including acid-forming fertilizers and elemental sulfur. However, for sites with high soil and water pH, an injection system may be the most effective. Injection systems should be installed pre-planting.

e. Water Supply

When planning for an adequate supply of water, well capacity and permits for any additional wells need to be considered. Well capacity should be calculated for the maximum volume needed, whether for cold protection or for irrigation. In the dry season, calculations need to include the estimated volume of water lost to total daily evapotranspiration of the crop per acre. For cold protection, calculations need to include the maximum volume needed to ensure the crop remains above freezing temperature. See the irrigation management and cold protection chapters of this guide for how to calculate these values. It is important that these calculations are conducted before designing the irrigation system so as to avoid a situation where the system is not capable of delivering the amount of water needed to keep trees alive and productive.

f.Variety Selection

Both scion and rootstock selection should consider soil type, expected disease pressure, and desired planting density. Choosing the rootstock that is best adapted to the conditions of the soil in the selected site is essential for maximum productivity. In addition, rootstock will influence tree size, fruit quality, and yield. If the planting is desired to be high density, small- to mid-size-inducing rootstocks should be preferred over more vigorous rootstocks. Small- to mid-size-inducing rootstocks should also be preferred if fruit quality is of concern. Similarly, vigorous scion varieties such as Sugar Belle are also not well suited to high-density planting. Vigorous varieties will generally require more pruning, especially when planted at a higher density. For more information on rootstock and scion selection, see the chapter of this guide on rootstock and scion selection.

Planting

a. Sourcing High-Quality Trees

High-quality nursery trees are essential for maximum productivity. Citrus growers should purchase only from certified nurseries to obtain healthy, uniform, and true-to-type trees. Healthy trees should have retained the majority of their foliage and have a well-developed root system. Roots should not be pot-bound. Trees should be of good vigor with a mature woody stem (larger than 3/8" in diameter) to ensure survival and rapid growth after planting. Trees with mature flush are preferred over trees with tender new flush as the new flush may compete with roots for available resources after growth. A good sign of tree health is how long the leaves have remained on the tree; the lower in the canopy the leaves have been held, the more likely the plant has not had a debilitating stress while in the nursery.

b. Planting Day

Young citrus trees can be planted during most times of the year. However, in regions where there is potential for freezing temperatures, planting should be delayed until the spring. Ideally, trees should be planted on the same day they are received. Under no circumstances should the roots be allowed to dry out. To minimize root desiccation and damage, trees should be kept shaded and moist until they are planted. Trees should be removed from the container and roots should be inspected. Roots that are tangled, if will remain so, can restrict growth and therefore productivity of the tree. Therefore, pot-bound roots should be removed or untangled prior to planting. If roots are moderately pot-bound, use a clean, sharp knife and make several vertical slashes about one-inch deep through the root ball to encourage new root growth. These slashes will also allow the roots to interface more closely with the soil in the planting hole. If planting severely pot-bound plants cannot be avoided, it is advisable to cut off the outer ½" of the root ball. Alternatively, some of the outer roots may be exposed by pulling them so they protrude from the root ball and extend into the soil in which the tree is planted. If the roots are left in a pot-bound state, the tree will not grow quickly, and growth may be hampered for the life of the tree. Trees with irregular root systems should not be planted, because this indicates other problems, such as Phytophthora. For more information on root health, refer to the root health section of this guide.

c. Other Considerations

Plastic tree tags from nurseries may girdle a tree if they remain on the trunk and become buried in the soil during planting. Remove tree tags or ensure they remain aboveg-round, where they will usually deteriorate over time and not girdle the tree. Tree damage can also occur from metal tree stakes. Close contact of stakes with the tree trunk can lead to injury and pathogen infection and therefore restrict tree growth.

Caring for Young Trees

Because of Florida's sandy soils, high temperatures, and frequent rainfall, young tree care requires regular fertilization, insect and disease management, and weed control. The primary objective during the first few years is rapid development of the tree canopy. Due to high levels of vegetative growth, young trees are more sensitive and more attractive to pests than mature trees. Monitoring for insect pests and diseases in new plantings is essential, and adequate control is imperative. Weed management is especially important in newly established groves to reduce competition and ensure rapid tree growth. Application rates of crop-protection chemicals need to be adjusted based on the size of the trees. Proper irrigation and nutrition are also critical factors to ensure rapid growth of young trees. Minor selective pruning (especially of water sprouts) can be beneficial during the first two years to develop good canopy architecture. The goal of such pruning should be to develop a canopy that allows light penetration into the center of the canopy.

a. Weed Control

Weeds compete with young citrus trees for water, nutrients, soil-applied pesticides, and sunlight and should be controlled before planting and during the early years of growth. If herbicides with residual activity are used prior to planting, they should be applied at least 30 days in advance of planting to avoid negative impacts on the young trees. Herbicides should always be applied at recommended rates, which are lower for young trees. Not all herbicides are suitable for young trees; be sure to read labels carefully for restrictions. To minimize herbicide contact to young trees, using tree wraps is advisable. When using wraps, be sure to monitor the space between trunk and wrap for ants or other pests that may damage the tree. For more information, refer to the weed control chapter of this guide.

b. Suckering

Rootstock sprouts, called "suckers," should be removed during the growing season before the sprouts become large and compete with the scion shoots. Young trees require regular sprout removal. Tree wraps usually reduce the need for removal.

c. Irrigation & Drainage

Because of their smaller root systems, young citrus trees require frequent but moderate irrigation for survival and proper growth. Irrigation systems should be in place before planting. Trees should be monitored frequently to be certain they are receiving sufficient but not excessive amounts of water. For more information, refer to the irrigation management chapter in this guide.

d. Fertilization

Regular fertilization of young trees is imperative to promote vigorous vegetative growth that rapidly produces a canopy with high fruit-bearing capacity. Applying fertilizer in several small doses is more efficient than applying fertilizer in few large doses because it ensures constant nutrient availability and reduces losses due to leaching. Frequent application of water-soluble fertilizers with irrigation water (fertigation) or use of controlled-release fertilizers can greatly increase nutrient-use efficiency. The quantities of water and fertilizers needed increase each year as the trees grow and should be based on tree size and canopy density. Great care must be taken to ensure that proper rates of fertilizer materials are dispensed to prevent nutritional deficiencies or toxicities. For more information, refer to the citrus nutrition management section of this guide.

e. Pest Control

Because young trees flush more frequently than mature trees, they are more attractive and sensitive to pests. Therefore, special care is needed to control Asian citrus psyllids and leafminers to reduce leaf damage, severity of citrus canker, and incidence of HLB. Maintaining young trees free of citrus canker and HLB is of utmost importance because trees that become infected during the early years will never become productive. Relying solely on foliar-applied contact insecticides for young trees is not a good strategy. Recently, non-insecticidal approaches, such as the use of kaolin particle films or individual-tree pest-exclusion nets have been developed. For more information on management of citrus psyllids and leafminers, refer to the pest management sections in this guide. Under the current HLB-endemic conditions in Florida, trees are very likely to become infected, but any practice that prevents or delays infection will ensure productivity and higher economic returns in the long term.