

Your Florida Dooryard Citrus Guide - Introduction¹

James J. Ferguson²

Citrus in Florida

Our citrus industry developed from 16th-century Spanish introductions of sour orange, sweet orange, lemon, lime, and citron from either seeds or seedlings (plants grown from seed). Many wild citrus groves³ originated from these seeds and seedlings.

Citrus was spread further by Indians and by pioneers who settled the hammocks, rivers and lakes of north Florida and the eastern Florida seaboard. These wild plantings were cultivated on a limited scale. It was not until better transportation stimulated demand that growers improved horticultural practices to increase fruit yield.

In the 1830s, citrus trees were first grafted or budded on sour orange rootstock in order to raise citrus for the commercial, fresh market. Budding allowed growers to readily propagate and increase their better-producing trees while encouraging interest in additional rootstocks. Budding soon became the accepted practice in citrus nurseries, eventually eliminating seedling trees.

Seedling Trees and Budded Trees

Citrus is unusual in that most citrus cultivars can produce seed, trees, and fruit with the same genetic composition as the parent plant. **(Note: some hybrid cultivars like Robinson and Fallglo tangerines or mandarins and Ambersweet orange may be exceptions to this rule so avoid these cultivars if you plan to grow a seedling tree. Chances are they won't produce the same fruit as the parent tree.)**

Even though you can grow citrus from seeds, budding works best for most citrus enthusiasts. Here's how it works.

Budding

You've probably heard of surgery involving skin or organ transplants where living tissue is transplanted or grafted from one part of a person to another part, or from one compatible individual to another. A successful transplant union then results in growth of replacement tissue. The same procedure has been done with plants for years.

Budding is one type of grafting that involves removing a small, rectangular or oval patch of bark, including a bud, from the donor plant (the scion).

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Your Florida Dooryard Citrus Guide - Selecting A Citrus Tree for Your Climate¹

James J. Ferguson²

Cold Tolerance

Except when cold fronts swoop down from the Arctic, Florida has a mild subtropical climate. For this reason the most important factor in selecting your dooryard citrus tree is your geographic location, especially in terms of cold tolerance.

Example: Coastal counties and areas near Lake Okeechobee have traditionally suffered less freeze damage than other parts of Florida. However, citrus trees, even in these areas, occasionally suffer freeze damage.

Of course, other factors like tree size, intended use (fresh fruit or juice), capacity of tree to store fruit on the tree for an extended harvest period, drought tolerance, and resistance to pests and diseases are important and will be discussed.

Although no major freezes have occurred since 1989 (at this writing), six major freezes from 1981 to 1989 killed or damaged thousands of acres of citrus trees. Chances are, severe freezes will occur again in Florida. In spite of this, homeowners throughout Florida, using current strategies for cold protection, can bring their dooryard trees through most freezes

and, with some care, regrow damaged tree canopies within several years to bear crops at pre-freeze levels. Now, let me tell you about the horticultural and environmental factors that affect cold tolerance.

Cold tolerance in citrus is influenced by these factors:

- rootstock
- scion
- fruit load
- temperatures preceding a freeze.

Most rootstocks can be placed in one of three general groups according to their relative effect on cold tolerance.

- Trees on rough lemon, Rangpur lime, Volkamer lemon, Milam, Palestine sweet lime and *Citrus macrophylla* are the least cold tolerant. But because of their vigor, they recover rapidly if not severely damaged or subjected to succeeding freezes in one winter or over several years.

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- Trees on sweet orange and Carrizo citrange induce intermediate cold tolerance.
- Trees on sour orange, Cleopatra mandarin, trifoliate orange and Swingle citrumelo are the most cold tolerant. However, trees on sour orange rootstock are susceptible to strains of a widely spread virus disease (tristeza) and are not readily available.

Finally, a given rootstock's cold tolerance is highly dependent on environmental conditioning. The best example is trifoliate orange. As a seedling it is very cold hardy and even sheds its leaves like a deciduous tree. Trees budded on this stock develop their superior cold hardiness only after being exposed to temperatures that induce cold hardiness: 70° F day/50° F night for about two weeks before a freeze.

The least cold-tolerant rootstocks don't become cold tolerant until temperatures reach 45° F day/26° F night. Since soil and air temperatures in the warmest areas of Florida often do not reach the 70° F day/50° F night temperature range in the winter, even the most cold tolerant rootstocks may not be exposed to temperatures that induce cold tolerance. In such locations normally cold tolerant combinations like tangerines on Cleopatra mandarin rootstock may be damaged as much as Valencia orange on rough lemon rootstock.

A note on cold tolerance: If your citrus trees develop cold tolerance after several weeks of cool weather, extended, unseasonably warm fronts can work in reverse, stimulating new tender growth and canceling newly acquired cold tolerance.

The scion influences cold tolerance even more than rootstock. If you plan to raise citrus, you should know there are inherent differences in cold tolerance among scion cultivars regardless of the rootstock. Mandarins, as a group, are the most cold tolerant, followed by sweet oranges and grapefruit. Lemons and limes are very susceptible to cold.

Post-freeze observations in Florida, Texas, and California have clearly shown that the scion influence is greater than that of the rootstock during freezes preceded by favorable cold-hardening conditions. However, rootstocks also have a measurable effect on cold tolerance.

Scion/Rootstock Selection

Scion/rootstock combinations, with their advantages, disadvantages, and regional recommendations are listed in Appendixes A, B and C. You will find it worth your time to review this information.

Pollination

Many citrus cultivars are self-fertile: they produce fruit when self-pollinated. However, many mandarin cultivars require a different pollenizer cultivar to set a crop of fruit. Pollenizer cultivars must have four qualities to be potentially successful:

- a bloom period that overlaps with the main cultivar,
- consistent annual production of a good crop of flowers,
- cold-hardiness the same as the main cultivar, and
- the capacity to be self-fruitful.

Pollenizer cultivars should not require cultural practices that differ widely from the main cultivar. For example, Minneola tangelos and Temple oranges (or pollenizer cultivars) are susceptible to scab, a fungal disease controllable with copper sprays, whereas Orlando tangelos and Sunburst tangerines (main cultivars) are usually not susceptible. Sunburst tangerines are also very susceptible to mite damage whereas other commonly used pollenizers are not.

Commercially, pollenizers are planted no further than the third tree row or approximately 60 to 90 feet from the main cultivar, so use this as a guide if you plan to plant any of the cultivars listed in Table 1.

Another alternative may be to graft pollenizer cultivars onto the main cultivar to produce a "fruit salad" tree, which bears fruit of different cultivars. If you do this, you may have to prune more vigorous scions, like lemons, more frequently to maintain balanced growth of different scion cultivars on the same tree. Also remember to remove all mature fruit

from the pollinizer cultivar to promote a good bloom the following year.

A note on flowering and fruit set: Citrus trees flower and produce fruit in response to environmental stress. In the tropics, drought during the dry season provides the stress. In Florida, cold weather (day temperatures between 50° to 64° F and night temperatures between 46° to 55° F) usually provide this stress.

Winter temperatures in Florida can hasten or delay the bloom period that normally occurs in March-April. The time (number of weeks) that citrus trees are exposed to cool weather can also affect the intensity of flowering. However, when late winter freezes kill tender blossoms, few, if any, fruit may be produced, except from erratic late blooms. In temperate climate zones north of Florida, potted citrus should also be exposed to cold - but not freezing - temperatures before you bring these trees inside for the winter.

Table 1. Pollenizer cultivars for important self-incompatible citrus cultivars.

Pollenizer Cultivar	Main Cultivar				
	Minneola	Nova	Orlando	Robinson	Sunburst
Minneola ^{1,2}	U	U	U	U	U
Nova	?	U	S	S	S
Orlando	U	S	U	S	S
Robinson ³	U	U	S	U	U
Sunburst	S	S	S	S	U
Temple ^{2,4}	S	S	S	S	S
Murcott ^{1,2,5}	U	U	U	U	U
<p>S=Satisfactory; U=Unsatisfactory; ?=Unknown</p> <p>¹Tends to alternate bearing</p> <p>²Scab Susceptible</p> <p>³Produces too little pollen unless used as the main cultivar</p> <p>⁴Much more sensitive to freeze damage than the other cultivars</p> <p>⁵Bloom does not overlap any of the other cultivars</p>					
<p>Note: No sweet orange or grapefruit cultivar is considered a satisfactory pollenizer, even though some seedy cultivars of oranges are slightly effective.</p>					

That patch with its bud is then carefully inserted beneath the bark of the recipient plant (the rootstock). The intention is that the bud will unite with the rootstock and grow there.

The type of budding most commonly used by citrus nurseries in Florida is called the inverted T-bud (Figure 1, Figure 2, Figure 3, Figure 4, Figure 5, Figure 6). T-budding is best done when the rootstock bark is “slipping” (loose) because the plant is actively growing, producing new leaves and shoots.

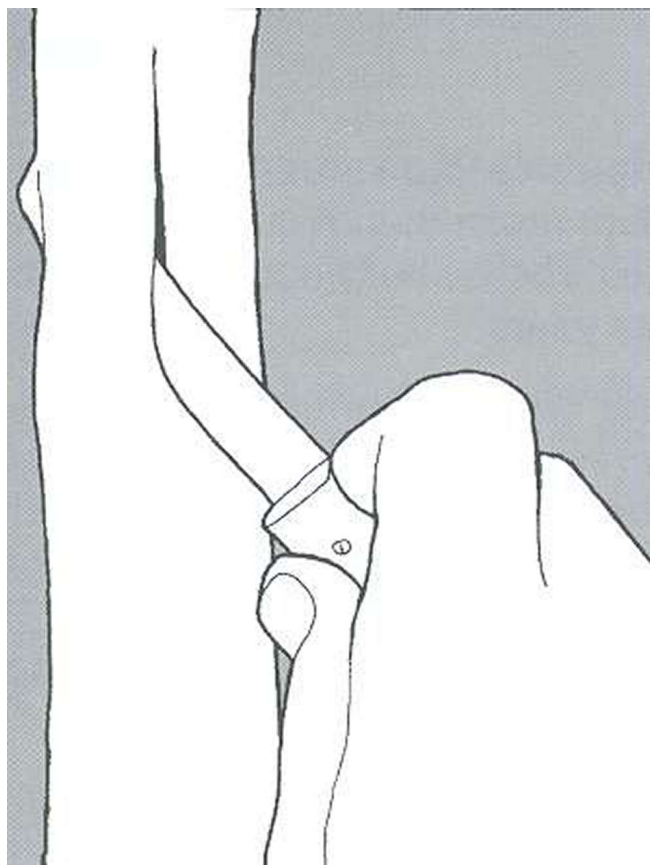


Figure 1. Using a very sharp knife, make a vertical cut in a smooth area of the rootstock 6 to 8 inches above the soil level, make the cut 1 1/2 inches long, and deep enough to cut through to the wood beneath the bark.

Exposing the rootstocks leaves to direct light will maximize bud growth. Six to eight weeks later, when the bud has grown, remove the rootstock stem with a sloping cut about 1/2 inch above the bud union. As the bud grows, stake and tie the bud at regular intervals to prevent breakage. Remove all other buds from the rootstock as they appear.

The purpose of budding is to incorporate the most desirable characteristics of the scion plant and

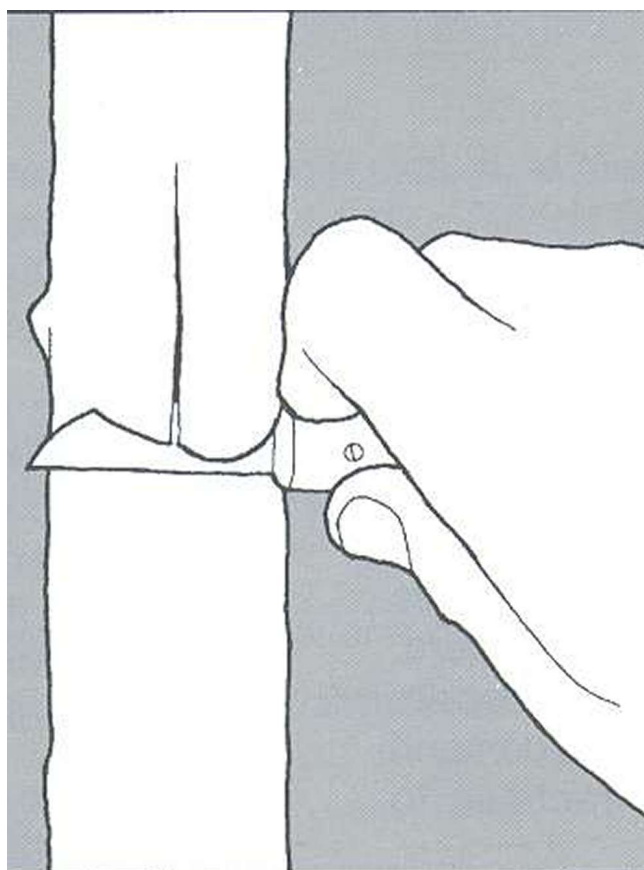


Figure 2. To complete the inverted T, make a horizontal cut 1/2 inch long through the bark at the bottom of your vertical cut.

the rootstock plant into a single tree. These characteristics include tolerance to unfavorable soils, pests, diseases, cold, and greater yields of high quality fruit for juice or fresh fruit. Budded trees also bear fruit earlier than seedling trees.

For example, if you plant the seed from an especially tasty orange and nurture that tree for better or worse, you may have to wait 8 to 15 years for that seedling tree to bear fruit. Your seedling tree may grow straight up without much branching and may be very thorny. (Even budded Meyer lemon, Bearss lemon, and grapefruit trees can be thorny too.) In most cases, your seedling tree will produce fruit similar to that of the parent plant. Even then, fruit quality from the seedling tree may not be as good as that from the parent tree for several years after fruit is first produced. And you'll never get the added, beneficial effects from a carefully chosen rootstock.

Bottom line: unless you're adventuresome, totally patient and have a bright green thumb, buy a

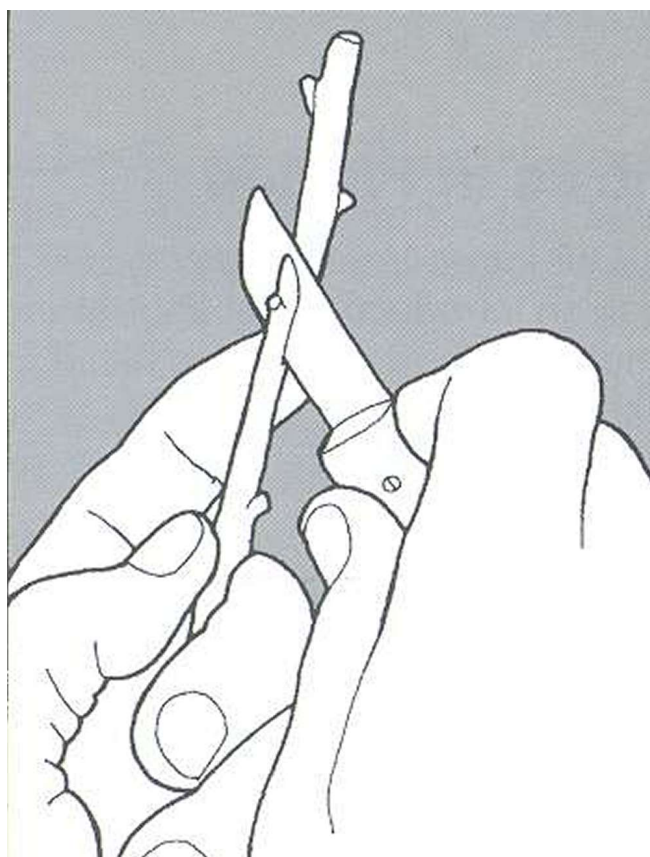


Figure 3. Holding the budstick away from you (with buds pointing up), remove a bud by cutting 1/2 inch above the bud and 1/4 inch below it. Holding your knife at a right angle, cut out your bud.

budded tree with an identifiable scion/rootstock label (e.g., Hamlin orange/ Swingle citrumelo) from a reputable nursery in your area.

Citrus Seed

If you insist on growing your own tree from seed, plant seed from a Mexican or Key lime (small, round fruit), which should bear fruit within two to three years, or an Orlando tangelo or Dancy tangerine, which will bear fruit within four to six years. Seedlings of these cultivars grow vigorously and bear fruit earlier than less vigorous cultivars.

If you want to go the whole route, planting seed from a rootstock cultivar (See Appendix B, Rootstock Characteristics) and then budding that rootstock seedling with buds from the desired scion cultivar, read on.

Unless you purchase your citrus rootstock seed from a citrus nursery, you should extract your seeds

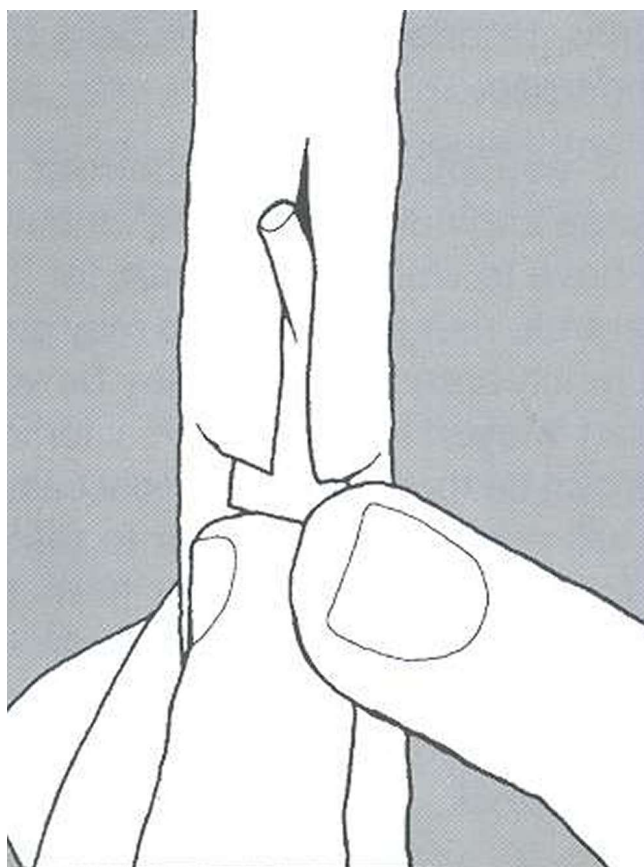


Figure 4. Insert the bud into your vertical cut until the bottom of it is even with the bottom of your T.

from mature fruit harvested directly from a known rootstock cultivar. Avoid fruit that has fallen on the ground because it may be infected with soil-borne fungi that can rot the seeds and kill young seedlings. After extracting seeds, rinse them thoroughly in water and plant them as soon as possible. If you cannot plant these extracted seeds immediately after rinsing, spread them evenly on absorbent paper, away from direct sunlight for drying. After the seeds have dried, store them in marked polyethylene bags at 40°-45° F in the vegetable drawer of your refrigerator.

When planting, place seeds 1/4 to 1/2 inch deep in pots or flats containing a well-drained potting medium or soil and be sure the seeds get enough sunlight, warm soil temperatures, and moisture. Under ideal conditions, seeds will take about two weeks to germinate. Removing the outer layer of the seed (the seedcoat) prior to planting reduces germination time.

When the plants are about 4 inches tall, repot them into larger containers or plant them in the

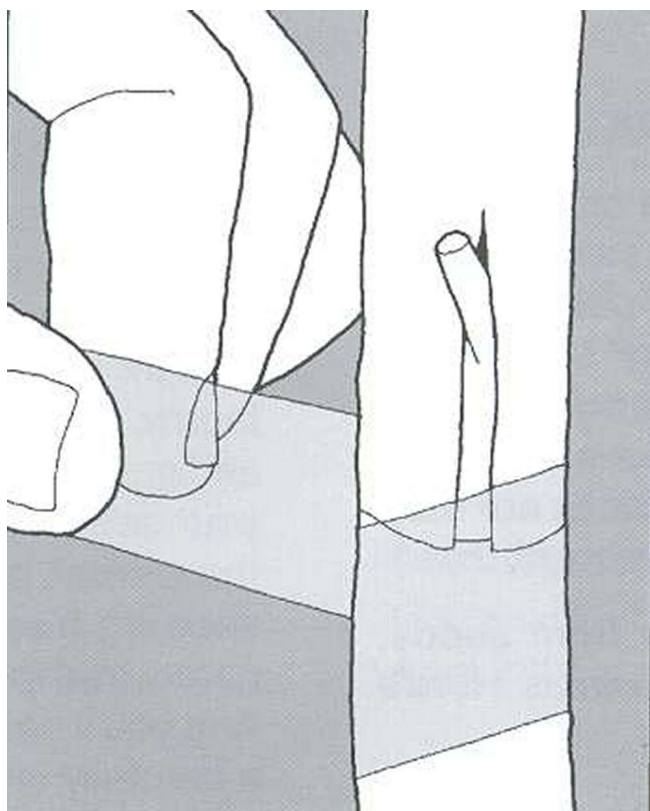


Figure 5. Wrap 1/2 inch polyethylene tape, firmly but not too tightly, securing the end of the tape with the last turn of the wrap.

ground in your “field nursery.” Train the repotted seedlings to a single stem - with no branches - within 6 to 8 inches of the soil. You can bud these rootstock seedlings when their stems are 1/4 to 3/8 inch in diameter, about the diameter of a pencil.

Follow the budding procedure in Figures 1-6. As the bud you grafted continues to grow, tie it to a metal or a treated bamboo stake to prevent breakage. Continue to remove all other buds and unwanted sprouts from the rootstock to encourage growth of the main shoot.

Budwood Selection: Choose budwood from vigorous, disease-free trees of the desired cultivar for your locale, using Appendix A as a reference.

Since citrus trees usually flush or grow new leaves and twigs three to four times per year (spring, summer, and fall), collect budwood from the next-to-last growth flush or from the current growth flush after it has begun to harden. Choose round budwood, not angular, with longitudinal gray lines on the green bark (Figure 7, 8). For a good fit, choose

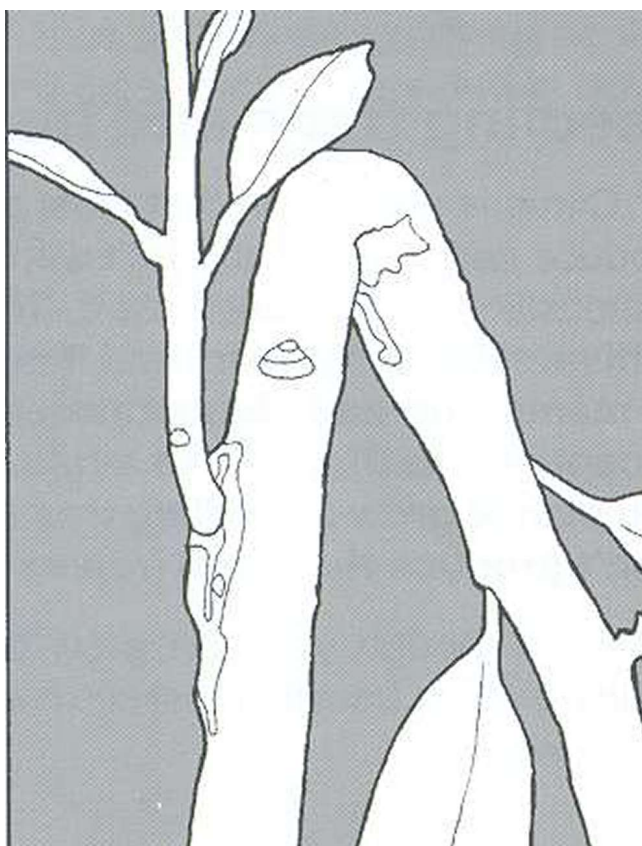


Figure 6. Remove the wrap 2 to 3 weeks later when union should have occurred. Force bud growth by bending the rootstock stem above the bud union and tie it down.

budwood that has about the same diameter as the rootstock stem. After budwood is cut, remove unneeded wood and leaves (Figure 7, 8, 9) and trim the remaining budwood to 8-to-10 inch lengths. When leaves are removed, be careful to leave a section of the leaf petiole or stem, about 1/8 inch long, to protect the bud. Use the trimmed budstick immediately or store the labeled, trimmed budsticks, if necessary, in a polyethylene bag at 40°-45°F for no longer than 2 to 3 months.

Air Layering: After a branch or stem has been girdled (its bark cut away in a ring) and that ring enclosed in a moist rooting medium at the cut, roots will form on a branch. This is called air layering or marcottage. In Florida, lychees and Persian or Tahiti limes are propagated commercially by air layering. Tahiti limes propagated in this way generally fruit earlier than grafted trees, primarily because air layering is done with twigs or branches about 1/2 to 1 inch in diameter. Such plants are larger than grafted trees and produce fruit earlier. The trade-off here is that they tend to be less long-lived than budded trees.



Figure 7. Comparison of budwood stages: Current (fall) flush.



Figure 8. Comparison of budwood stages: Previous (summer) flush.

Air layers are usually made in the spring on wood of the previous seasons growth or in late summer with partially hardened shoots. Wood older than one year can be used but rooting is less satisfactory, and the larger plants produced are more difficult to handle after rooting.

The first step in air layering is to girdle (cut) the bark of the stem at 6 to 12 inches or more from the tip end of the wood from the previous seasons growth. You may also girdle the stem in late summer when shoots are partially hardened.



Figure 9. Comparison of budwood stages: Oldest (spring) flush.

Then, remove a strip of bark about 1/2 to 1 inch wide and scrape the exposed wood surface slightly (Figure 10). Apply indolebutyric acid (sold as a rooting hormone in garden stores) to the cut surface. Then wrap about two handfuls of slightly moistened sphagnum moss around the stem, enclosing the cut surfaces (Figure 11). Wrap the moss and stem with a piece of poly or aluminum foil so the sphagnum moss is completely covered. Twist the ends of the wrap and secure the entire wrapping with waterproof tape (Figure 12).

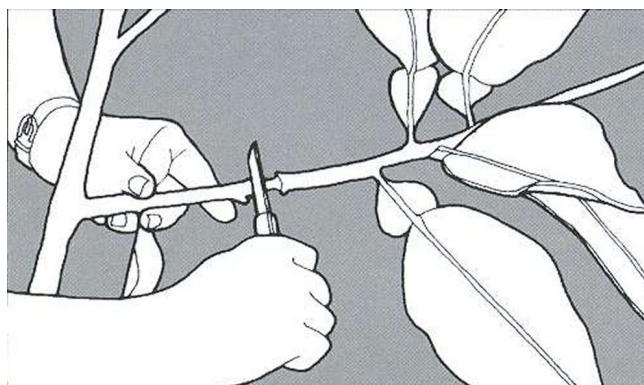


Figure 10. Remove a strip of bark 1/2 to 1 inch wide and scrape the exposed surface slightly. Apply indolebutyric acid to the cut surface.

Within 2 to 3 months roots should grow from within the wrap. When they do, carefully remove the rooted branch from the tree. Then prune the top back to a reasonable size and pot the new plant with frequent, light watering to aid growth while avoiding moisture stress.

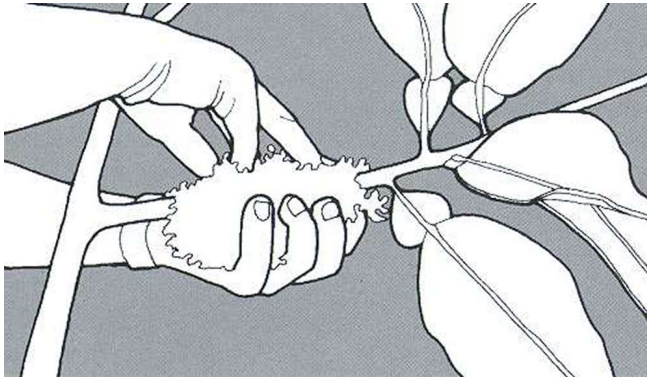


Figure 11. Wrap about two handfuls of slightly moistened sphagnum moss around the stem, enclosing the cut surface.

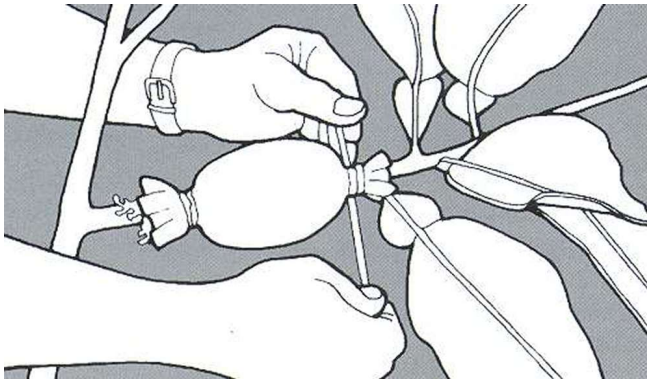


Figure 12. Wrap the moss and stem with a piece of polyethylene or aluminum foil so the moss is completely covered. Twist ends of the wrap and secure the entire wrapping with waterproof tape.

Rooted Cuttings

Rooted stem cuttings, propagated under mist systems, have also been used for cultivars like Orlando tangelo. These cuttings have performed as well as budded trees and are preferred over seedling trees.

Additional Notes:

3. Grove originally referred to a group of randomly planted citrus trees, while orchard referred to a planting of specific citrus cultivars with uniform spacing between trees and between rows of trees. Today all commercial citrus trees are planted at uniform spacing but are still commonly called groves in Florida.



Your Florida Dooryard Citrus Guide - Site Selection¹

James J. Ferguson²

Spacing

General considerations for planting sites for dooryard trees include adequate space for growth, maximum exposure to sunlight, good air circulation, plus adequate irrigation and drainage (Figure 1 and Figure 2).

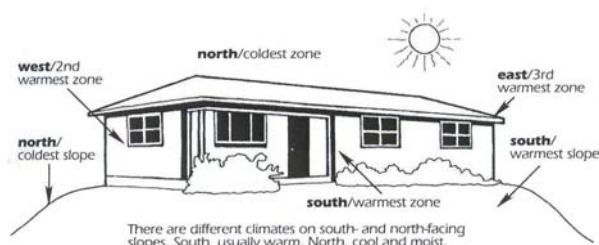


Figure 1. A south-facing house with typical microclimate that can change with the season and angle of the sun. A walk around your house at various times of the day indicate the best sites for growing citrus.

Microclimates

You can have some influence over the hardiness of your young citrus tree(s) by paying attention to the climate around your home. First, make a location

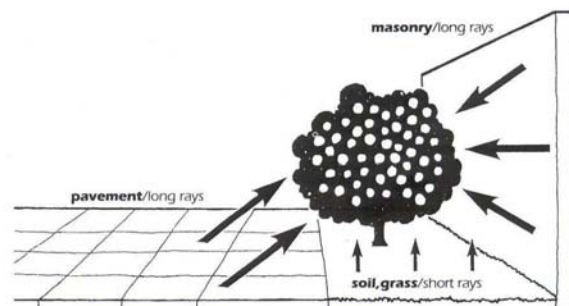


Figure 2. Range for frost-tender citrus can be extended by planting them against a surface that absorbs daytime heat and releases it slowly at night. Different surfaces vary as to heat and light reflected, absorbed or stored, with masonry and pavement reflecting more heat than soil.

sketch of your home, noting the south and west sides. The reason for this is that south is the warmest zone and west the second warmest zone (Figure 1). If you live in the parts of Florida subject to frosts or occasional freezes, you should locate your tree in the south or west zone to give young citrus a good start. (If drought, not cold, is your major climatic influence, note that the north zone is usually the coldest, most moist zone.)

Different surfaces vary in the amount of heat reflected, absorbed, and stored, with light colored surfaces reflecting more heat than dark colored

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ones. Different types of stone, masonry or concrete absorb approximately 50% of available heat, depending on their color and density. Soil absorbs about 20 to 30%, with bare soil absorbing more heat than a grass or sod cover or leafy mulch. *Hint: keep the soil around your citrus tree bare during the winter months to take advantage of the heat storing capacity of the soil.*

If you have features such as mature trees, walls or fences, pencil them in. They can provide additional shelter and should be taken into consideration. You can often intensify sheltering effects for your citrus by utilizing the south slope of a rise - the warmer slope - and planting your citrus according to the different rates that different surfaces store and radiate sunlight back (Figure 2).

Finally, walk your landscape with your house and zone map and note spots where it seems warmer or colder than the median temperature you've noticed for the property. The warmer micro-zones are potential citrus sites.

If you're planting several trees, put them in a row, oriented on a north-axis to allow better sun exposure. In commercial groves, orange trees are generally planted with 10 to 15 feet between trees within the row, and with rows planted about 20 to 25 feet apart. If you're planting grapefruit, plant them with rows about 5 feet further apart (25 to 30 feet) because grapefruit trees grow larger than orange trees.

Other planting variations: Tahiti limes are commonly planted 22 to 25 feet between rows and 18 to 20 feet apart as single trees. Smaller trees like satsuma mandarins on trifoliate orange and kumquats can be planted closer to (15 feet in all directions). Use these commercial spacing guides to plant your dooryard tree for optimum sun exposure and to avoid crowding out other plants. In your decision-making consider both tree vigor and growth habits since some rootstock/scion combinations are more vigorous than others. Some, like mandarins, have an upright growth pattern whereas lemons have a more spreading growth pattern.

Planting Time

Citrus trees can be planted any time of the year in Florida, although most commercial growers plant in either the fall or spring. Trees planted in the fall have time to establish a root system before the spring growth flush, but they also face the prospect of winter freezes. Trees planted in the spring (after the threat of cold weather has passed) have nine to ten months to grow and harden off before the next winter. But these trees require additional attention during dry spring and hot summer months.

Site Preparation, Plant Preparation and Planting

Prepare the site well before planting and you will eliminate headaches later on. Remove weeds; rake the area. If you're planting a tree where another tree has been recently removed, you may have problems with fungal diseases spread from the old, decaying roots to the newly planted tree; termites may move from old wood to destroy the roots of the newly planted tree. Minimize these risks by removing the remaining old roots and debris.

Inspect your citrus for evidence of pot binding, a mass of roots growing in a spiral around the root ball, or J-rooting, horizontal growth of the main roots. Either pot binding or J-rooting may restrict root growth after planting. If roots are pot bound, make several vertical slashes through the root ball, or carefully remove obviously crowded roots to allow the potting soil and roots to interact with the soil of your planting site. It may be easier to cut some of the roots with pruning shears and to pull them until they protrude from the ball.

If roots are not pot bound, don't cut them. Roots should be moist before planting, so soak them in a bucket of water while you prepare the planting site.

Digging the Hole

Dig the planting hole wide and deep enough to accommodate the root system, especially if your tree wasn't grown in a pot (Figure 3). In either case, spread the roots out in the hole and set the plant higher than it grew in the field nursery or container (Figure 4).

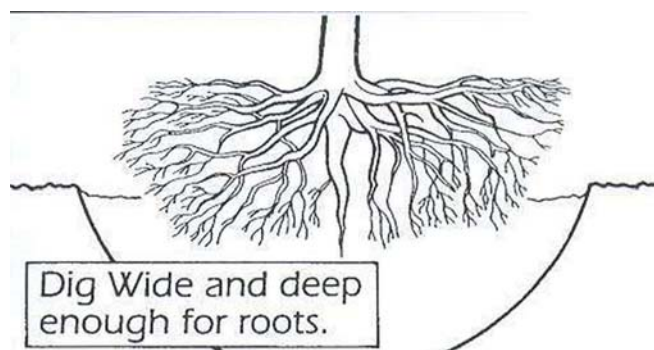


Figure 3.

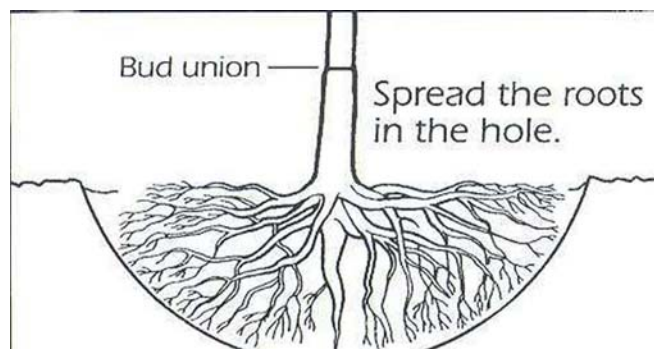


Figure 4.

Keep the bud union above soil level to avoid infection with a widely spread, soil-borne fungus that causes foot rot at the base or foot of the tree. Place a long board, rake or hoe over the center of the hole with each end extending over undisturbed soil. This helps determine proper planting depth by showing exactly where the soil line should be. Since the soil and tree are likely to settle, set the soil line of the young tree several inches higher than the bottom of the board or hoe handle (Figure 5).

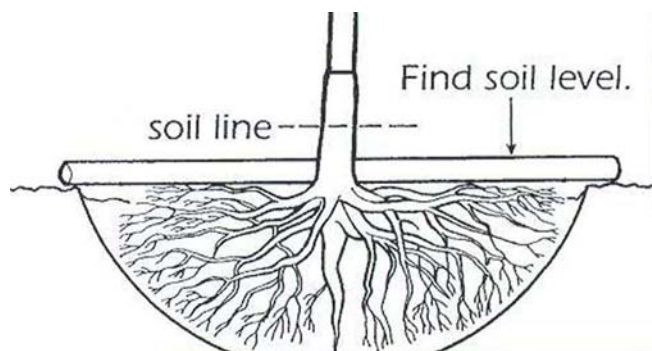


Figure 5.

Next, backfill around the plant to half-fill the hole and press the soil down to remove air pockets (Figure 6). Water the hole thoroughly (Figure 7) and allow the soil to settle. Backfill, again, to near the top of the hole, firm the soil around the tree (Figure 8) and form a water basin that will hold 7 to 10

gallons of water (Figure 9). Slowly add more water and take a break. You've done a good job!

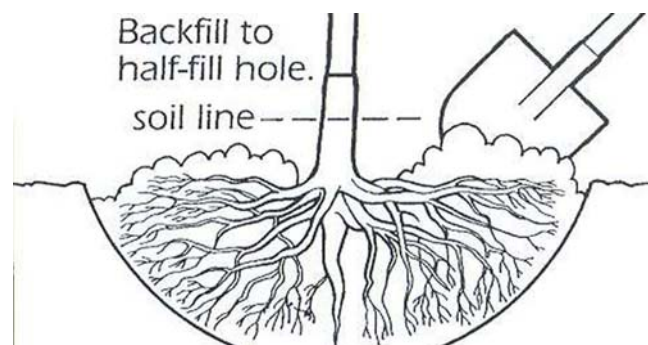


Figure 6.

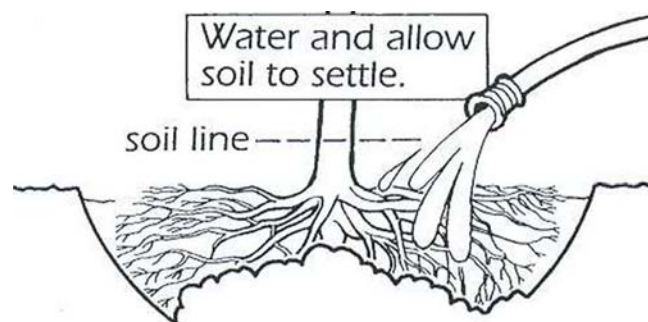


Figure 7.

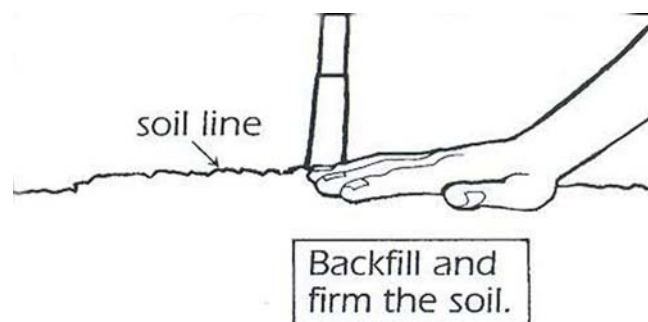


Figure 8.

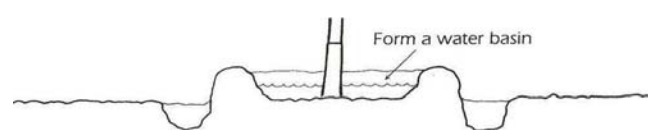


Figure 9.

First Fertilization

Fertilize lightly about 2-3 weeks after planting but be careful to avoid burning the roots of the young tree with fertilizer or herbicides. See the fertilizer section for more detailed information on this topic.

Planting in Containers

You can also grow citrus trees in containers if planting space or environmental conditions are limiting. Don't expect as big a tree as one grown in the landscape. Citrus trees that grow and fruit well as containerized trees include calamondin, Key lime, kumquat, limequat and Tahiti lime. If you want only one containerized tree, avoid cultivars like Orlando, Minneola, and Nova tangelos, and Robinson, and Sunburst tangerines that require a different pollenizer cultivar.

The biggest advantage of containerized trees is that they can be protected during freezing temperatures by temporarily storing them in an enclosed area. You can plant your trees in a variety of containers: plastic, metal, clay, ceramic, wood or any others available at nurseries and garden supply stores. Recycled whiskey barrels cut in half are excellent or you may want to build a treated wooden box. Weight and durability are factors to consider.

All citrus containers should be big enough to allow for root growth over time and have adequate drainage holes. To insure good drainage, place about 2 inches of gravel in the bottom of the container. Be aware that soil in plastic, metal, and ceramic containers retains moisture longer than soil in wood or clay containers. These last two allow water to evaporate through the sides. Cool weather generally reduces citrus water use, so water accordingly. As with most plants, allow the upper surface of the soil to become dry to the touch, then water thoroughly by slowly filling the container.

Nutrition

Good nutrition is essential but over-fertilization can result in excessive vegetative or leafy growth, poor fruiting, and possible dieback due to fertilizer salt accumulation. Salt accumulation is a common problem, often indicated by a white crust on the soil surface. It may be due to excess fertilization and/or water containing soluble salts. Should this occur, thoroughly leach the soil by slowly running water through the container for about 30 minutes. This flow should carry excess salts through the soil and out the drainage holes.

Problems associated with over-fertilization can be avoided by applying controlled-release fertilizers, commonly used for potted citrus and other woody ornamental plants, and need be applied only once or twice a year.

Pruning or Cutting Back

With few exceptions citrus trees will develop and maintain their natural shape with little or no training or pruning. They occasionally become "leggy" when grown indoors or in poor light for too long. Cut leggy branches back partially to force branching and bushiness.

Frequently, the trees branches and leaves will grow rather large and begin to exceed the capability of the root system. Consequently, some leaf drop and twig dieback will often occur. When this occurs, prune the tree heavily to rejuvenate and shape it as well. Reduce fertilizer and water rates according to the reduction in canopy size.

Citrus grows best in full sunlight. However, avoid rapid changes in light exposure. Acclimatize your tree gradually to increased sunlight.



Your Florida Dooryard Citrus Guide - Young Tree Care¹

James J. Ferguson²

Weeds and Mulching

Since the canopy of a young citrus tree produces very little shade and will be watered and fertilized frequently, weeds are almost certain to be a problem during the first, crucial year of tree establishment. Weed by hand frequently or with a hoe. Frequent, light weeding, especially after a good rain or regular irrigation, will do the job without damage to roots. If you use a hoe, use it carefully: working the soil too deeply with a hoe may damage fibrous feeder roots that are close to the surface.

Mulching with organic material like grass clippings, leaves, or black plastic can reduce weed growth and conserve water. If mulch is applied around your citrus trees, apply it no thicker than 3 to 6 inches to optimize root aeration. Keep all mulch at least 12 to 24 inches from the tree trunk to decrease the chance of disease problems caused by soilborne fungi splashing onto the trunk or fruit. If you cover the entire root zone area with a thick layer of mulch, you make it more difficult for fertilizer and water to penetrate the soil to reach plant roots. You then must apply sufficient water and fertilizer to satisfy the water requirements and fertilizer needs of microorganisms living in the mulch before any water

and nutrients will be available to meet the needs of your overly mulched tree.

Herbicides

Several herbicides are available at your nursery or chain store that are safe to use at low rates on young trees. Since newly planted trees are especially sensitive to herbicide damage, be sure to follow label instructions very carefully.

Routine Care

As your tree begins to grow, pinch off young sprouts that occur on the rootstock (and lower trunk of the scion) in order to stimulate growth in the canopy of the tree. When these sprouts are young and tender, they can be pinched or rubbed off easily. If they have hardened off and become woody, use pruning shears to remove them. Tearing woody sprouts off will remove strips of bark that may later predispose the young tree to insect damage and/or soil-borne fungal diseases.

Wait several weeks after planting to make the first, light fertilizer application, being careful to spread fertilizer in about a 3-foot diameter around the tree but not up against the tree trunk.

1. This document is HS 887, one of a series of the Horticultural Sciences Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Originally published in hardcopy, 1995. Publication date: August, 2002. Please visit the EDIS Web site at <http://edis.ifas.ufl.edu>.

2. James J. Ferguson, professor, Horticultural Sciences Department, Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, 32611.

Young trees require considerable water for survival and growth. Competition for water is accentuated if the young tree is close to older trees or if weeds are allowed to grow in the rooting zone of the plant. Anything that can be done to discourage competition for available soil moisture will be beneficial to the young tree.

Flood Tolerance

Dooryard trees may occasionally be planted in areas subject to periodic flooding, which damage citrus roots and even kill trees. Although trees on all rootstocks are eventually damaged to some degree under flooded conditions, limited observations indicate that rough lemon, Volkamer lemon, Milam and Swingle citrumelo are the most tolerant to flooding. Cleopatra mandarin, Carrizo citrange and Citrus macrophylla exhibit the least tolerance while sour orange, trifoliate orange, and Palestine sweet lime are intermediate.

Salt Sensitivity

Citrus is generally classified as a salt-sensitive plant because relatively low levels of salinity can cause leaf damage and reduce tree vigor and yield. Salt problems result from sodium chloride and other salts present primarily in the irrigation waters used in flatwoods areas near Florida's east and west coasts. The rootstock affects salt tolerance in a citrus tree primarily by preventing the accumulation of sodium and chloride ions in leaf tissue. Cleopatra mandarin and Rangpur lime rootstock have been consistently ranked as relatively tolerant to sodium chloride and should be planted in coastal areas where salt damage occurs. Rough lemon, Swingle citrumelo, and Carrizo citrange rootstocks are sensitive while Milam and trifoliate orange rootstocks are very sensitive. If you live in a coastal area, salt tolerance may be a higher priority than the above-mentioned factors.

Irrigation

Florida's average annual rainfall of 50 to 62 inches exceeds the 42 to 48 inches per year required for an acre of mature citrus trees. However, our seasonal rains (primarily from June to September), combined with the low water-holding characteristics of Florida's sandy citrus soils, make irrigation

necessary. In commercial groves, mature trees can use from 10 to 90 gallons of water per day, depending on environmental conditions. While these rates are not necessarily recommended for homeowners, they can be used as guidelines.

In commercial groves, current recommendations call for established, young citrus trees to be watered one to seven times per week, depending on the type of irrigation system used, time of the year, climate, geographic location, and other factors. Mature trees are irrigated from one to five times per week (Table 1 and Table 2).

For young trees, the goal of irrigating twice per week, for short durations, from March through June is to maintain optimum moisture in the upper soil layer where most of the roots are. If you have a feel for the field capacity (amount of water held after excess water has drained) of your soil, maintain approximately 65% of field capacity in the top five feet of soil during the crucial period of leaf expansion, bloom, fruit set and fruit enlargement (that occurs during Florida's dry season - January/February to June).

In other words, maintain the above soil moisture levels until fruit is greater than 1-inch in diameter. Proper irrigation during this period also affects tree size, fruit yield, size, and color, as well as juice content and quality. For the rest of the year, approximately 35% of field capacity is adequate.

The highly efficient drip and microsprinkler irrigation systems mentioned in these tables can maintain optimum soil moisture for tree growth and fruit production. Drip systems deliver 1-2 gallons per hour and microsprinkler systems deliver 5-25 gallons per hour. Modify these recommendations according to your irrigation system and landscape needs.

Soil Type

Soil type should also be considered. The finer-textured but poorly drained soils typically found along the coastal areas and flatwoods generally will hold greater amounts of water than the coarser, deeper sands found on the Ridge areas of central Florida.

The tree's rooting depth will also influence irrigation requirements. Citrus grown on well-drained sands will normally have a rooting depth of 4 to 6 feet, depending on the rootstock, with 80% of the roots in the top 3 feet of soil. Citrus grown on flatwoods soils seldom have more than 1.5 to 2 feet of rooting depth, with 98% of the roots in the top two feet of soil.

Water Management

Water management is a critical concern in Florida. In recent years, the trend in commercial citrus irrigation has been to use low-volume drip systems and microsprinkler irrigation that place water when and where it is needed for tree growth, with minimal loss due to evaporation.

Drip emitters and microsprinklers provide good coverage in most situations and use less water than many other methods of irrigation (Figure 1A;1B).

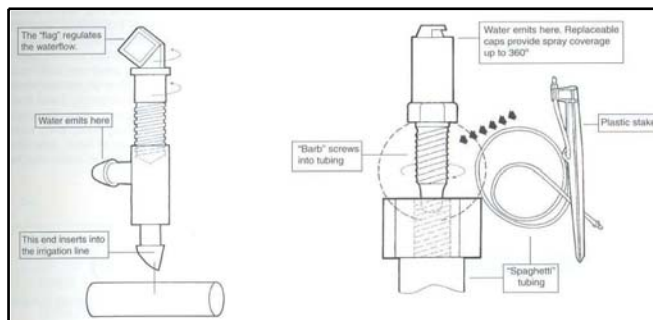


Figure 1. 1A. Drip irrigation; 1B. Microsprinkler

There are other reasons for using the newer water-delivery technologies. Traditional irrigation methods that apply water over or into the tree canopy cause salt burn on leaves if water (especially in coastal areas) with greater than 800-1000 parts per million total dissolved salts are used. Drip and microsprinkler irrigation can use water with higher salt levels (1500-2000 parts per million) without causing comparable leaf damage.

The incidence of major fungal diseases of foliage and fruit (*citrus scab* and *Alternaria brown spot*) can also be reduced by avoiding overhead irrigation that spreads fungal spores in the canopy. In recent years microsprinklers have also become widely used for cold protection.

Root Zone Coverage

Another important aspect of irrigation is coverage of the root zone. When you use drip and microsprinkler irrigation, 50-60% of the root zone should be covered to optimize fruit production. The number of emitters is therefore extremely important, especially for larger trees that may require 4 or more drippers or 2-3 microsprinklers per tree. Microsprinklers provide different spray patterns and ground coverage (Figure 2), while drippers irrigate a more limited area.

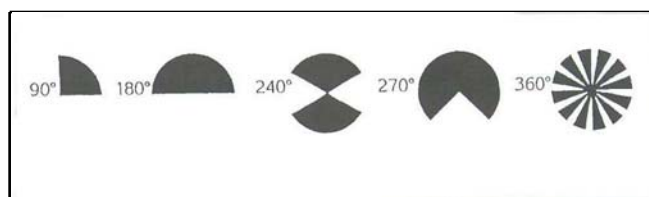


Figure 2. Typical microsprinkler coverage patterns.

Drought Tolerance

Some rootstocks are more drought-tolerant than others, but all trees must first become established before they can withstand water stress.

The characteristics of a root system adapted to drought stress are exemplified by rough lemon, a rootstock long recognized for superior adaptability to the deep sandy soils of our central Ridge. Trees on rough lemon have a wide, spreading root system, extending as much as 50 feet laterally and more than 25 feet deep in sandy soils. When the advantage of soil depth is removed (as it is for trees planted on shallow soils with a high water table like southern Florida), rough lemon is still a drought-tolerant rootstock. However, trees on rough lemon rootstock are not readily available because they are very susceptible to citrus blight – a widespread disease of unknown cause.

In contrast, trees on shallow-rooted rootstocks (Ridge pineapple, Rusk citrange, sweet orange, and trifoliate orange) are often the first to wilt during prolonged periods of drought.

Dooryard trees planted in situations where they will receive minimal care, especially during the dry spring months, should be planted on rootstocks that have good drought tolerance. (Carrizo citrange,

Citrus macrophylla, Milam lemon, Palestine sweet lime, Rangpur lime, rough lemon and Volkamer lemon). Note that these rootstocks offer little cold tolerance.

If you plan to spend only the winter months in Florida, plant your dooryard tree in the landscape as soon as you can and tend it well. Establishing a relatively drought-tolerant tree may be a higher priority for you than cold tolerance, salt tolerance or other factors.

Fertilizing

During the first few years, apply fertilizer to young trees to stimulate vigorous growth of leaves and branches that become the framework of the mature tree. Beginning about 2 weeks after planting, frequent, light applications of fertilizer should be made approximately every 6 weeks. Avoid burning roots with high levels of soluble fertilizer applied all at once.

Fertilizer should not be applied between October 1 and February 1 for the first year or two, especially in regions north of Polk county where severe cold damage has occurred. This will reduce the possibility of untimely growth flushes in the winter.

It is important to understand that warm winter temperatures, not irrigation or fertilization, play the major role in stimulating untimely winter flushes of large, mature trees. However, when unseasonably warm temperatures occur, young trees may flush more easily than larger, mature trees, especially trees planted the previous fall. If such young trees flush during winter months, fertilization may stimulate additional, tender growth, making trees even more susceptible. Consider the degree of flush, tree size, time of year, and geographic location when making this decision.

Table 1. Suggested number of times to irrigate young trees per week if no rainfall.*

Months	Young Trees	
	Frequency (times per week)	
	Dripper	Microsprinkler
Nov-Feb	2-4	1-2
Mar-Oct	3-7	2-3
Duration (hours)	3-6	2-3
*Schedule varies depending on number of emitters, soil type, temperature, and wind. Drippers produce 1-2 gallons per hour. Microsprinklers can produce 5-25 gallons per hour.		

Table 2. Suggested number of times to irrigate mature trees per week if no rainfall.*

Months	Mature Trees			
	Frequency (times per week)			
	Dripper		Microsprinkler	
	Ridge	Flatwoods	Ridge	Flatwoods
Sept-Feb	1-2	2-4	1-2	
Mar-Aug	2-4	3-5	2-3	3
Duration (hours)	6-10	6-10	4-6	2-4
* Schedule varies depending on number of emitters, soil type, temperature, and wind. Drippers produce 1-2 gallons per hour. Microsprinklers can produce 5-25 gallons per hour.				



Your Florida Dooryard Citrus Guide - Bearing Trees (Years 3 to 5+)¹

James J. Ferguson²

After about 2 to 5 years young trees begin to bear fruit. The quality of fruit produced on young trees is usually poor compared with that produced by the same tree when mature, so don't get discouraged.

The goal of the fertilizer program for young, bearing trees is to continue to stimulate vigorous growth of leaves and branches that may compete with early fruit production. After the tree has become established, the goal will be to replace nutrients removed with the fruit and to provide enough nutrients to sustain continued tree growth.

Many different fertilizer formulations are available for use on dooryard citrus trees. In general, the numbers on a fertilizer bag refer to the percent of nitrogen, phosphorus, as P_2O_5 , and potassium, as K_2O , plus other secondary and micronutrients.

For example, if the numbers 8-8-8 were listed on a fertilizer bag, it would contain 8% nitrogen (N), 8% phosphoric acid (P_2O_5), and 8% potassium expressed as potash or potassium oxide (K_2O). Other nutrients like magnesium (Mg), copper (Cu) and boron (B) may also be listed. If there are any numbers after the first three numbers, read the information on the

fertilizer bag to determine the percentage of other nutrients that are included.

This type of fertilizer would be ideal for a nonbearing young citrus tree. Higher analysis, mixed formulations such as 12-0-12 or 15-0-14 are used on mature trees. Controlled-release fertilizers that slowly release nutrients over a 6- to 9-month period can also be used.

Composted or processed animal manure may also be used. However, nutrients from these materials become available for plant use more slowly than from synthetic, granular, or liquid fertilizers. Composted cow manure usually has less than 1% nitrogen with composted chicken manure ranging from 2 to 3% nitrogen, with both materials containing other nutrients.

For example, to obtain the suggested 0.15 lbs. N using cow manure containing 0.5% nitrogen, you would have to apply 30 lbs. of cow manure (30 lbs. cow manure x .005 or 0.5% N = 0.15 lbs. N). To obtain the suggested 0.15 lbs. N using chicken manure containing 3% nitrogen, you would have to apply 5 lbs of chicken manure (5 lbs. chicken manure

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x .03 or 3% N = 0.15 lbs. N). Adding composted manure at these suggested fertilizer rates will supply needed nutrients over time but will not increase soil organic matter because of rapid organic matter decomposition under Florida conditions of high temperatures and rainfall.

The amount of fertilizer applied depends on the analysis of the fertilizer you are using.

Question: How much 6-6-6 fertilizer does it take to provide 0.15 lbs of nitrogen applied in 6 applications during year one? Solution: Divide lbs nitrogen by % nitrogen. Result: $0.15/.06=2.5$ lbs of a 6-6-6 fertilizer. Apply .4 lb in each of 6 applications.

Table 1 provides a range of fertilizer rates (amounts per tree per year) you can use.

Fertilizer nutrients leaching into groundwater are becoming a major problem in Florida. Dooryard enthusiasts, like commercial growers, can help maintain water quality by following recommended fertilization practices.

Notice in Table 1 how the amount of fertilizer needed decreases when the percent nitrogen increases. No amounts are given for years 1-3 for the 10-10-10 fertilizer because only lower analysis fertilizers should be used during this time to avoid damaging young citrus trees with fertilizer burn. If controlled-release fertilizers are used, fertilizers can be applied once every 6-9 months, according to recommendations on the fertilizer bag.

For young trees, apply fertilizer uniformly in a 3-ft. diameter circle around the tree. As the tree becomes older, the area fertilized should be enlarged as the root system expands. As a rule of thumb, fertilize an area twice the diameter of the tree canopy. Care should be taken to avoid root or trunk damage by uneven placement or mounding the fertilizer against the trunk.

For mature bearing trees on well-drained soils, three applications of fertilizer per year are sufficient, one application in the fall or winter followed by a second application in the late spring or early summer and a third in late summer.

Avoid or minimize applications of soluble nitrogen fertilizers during the summer rainy period to reduce nitrogen leaching and potential groundwater contamination. For trees planted on coarse, shallow soils and where the root system is limited, more frequent applications (3-4 times per year) will result in better utilization of nutrients and reduce leaching. Apply nutritional sprays when deficiency symptoms appear.

To summarize these fertilizer recommendations: apply up to 0.3, 0.6 and 0.9 lbs. nitrogen per tree during years 1, 2, and 3 respectively. Thereafter, increase the amount of nitrogen applied according to tree growth, up to but not more than 1.5 lbs. nitrogen per tree per year. Fertilization rates can also be reduced if your citrus tree is planted in a landscape where turf and shrubs are well fertilized.

Soil pH

Soil pH is an important factor in the nutritional program, as it affects the availability of soil nutrients. The pH of most native Florida soils ranges from 4.0 to 5.0. Soil pH units are exponential; i.e., for each whole-unit change in pH there is a tenfold increase or decrease in soil alkalinity or acidity. Macronutrients like nitrogen, phosphorus, potassium, calcium, magnesium and sulfur are more available to the plant in the pH range of 6.0 to 7.0. Micronutrients like iron, manganese, boron, zinc, copper, and molybdenum are more available when the soil is more acidic.

Adding lime to the soil usually increases soil pH and calcium levels. Two common sources of lime are dolomite and calcitic limestone. Dolomite is the preferred material because it supplies both calcium and magnesium in addition to adjusting soil pH. For best results, apply lime to the soil surface, and then incorporate it well into the soil.

Table 1. Suggested fertilization schedule for citrus trees from planting to maturity.

Tree Age*	Lbs Nitrogen/tree/yr range	Lbs Nitrogen/tree/yr range** Fertilizer analysis			Applications/year
		6-6-6	8-8-8	10-10-10	
1	0.15-0.30	2.0-5.0	1.8-3.8		6
2	0.30-0.60	5.0-10.0	3.8-7.5		5
3	0.45-0.90	7.5-15.0	5.6-11.3		4
4	0.80-1.0	13.5-17.0	10.0-12.5	8.0-10.0	3
5+	1.1-1.4	18.0-23.5	13.8-17.5	11.0-14.0	3
<p>*Tree age = years planted, with year 1 beginning right after planting.</p> <p>**Do not use a fertilizer with higher than an 8-8-8 analysis on young trees during years 1-3.</p> <p>Divide "Lbs Fertilizer/tree/yr" by "Applications/year" to determine how many lbs fertilizer to apply for each application.</p>					

Your Florida Dooryard Citrus Guide - Pruning¹

James J. Ferguson²

Although large machines prune closely planted trees in commercial citrus groves on a regular basis, dooryard citrus need not be pruned at all. There are exceptions: aesthetic purposes, to prevent shading of other plants, to prevent soilborne diseases, to remove cold-damaged limbs, and to rejuvenate old trees with reduced vigor, twig and small branch dieback, and small fruit.

If you are pruning to rejuvenate, prune a short time before a major growth flush. The more you cut, the greater the stimulation because the undisturbed root system now provides the same amount of water and nutrients to a reduced canopy. This effect is greatest in the parts of the tree where the most severe cuts are made, so the pruned tree tends to regain its natural shape. The severity of your pruning should be related to the amount of growth stimulation needed to restore vigor and fruit production.

Less pruning is required when the cause of the decline can be corrected by other means or when extra care can provide some of the needed revitalization. Rejuvenation pruning is not always successful, and it is best to replace the tree if the desired response is not obtained.

The best time for severe pruning is after the danger of freezing temperatures is past and just before the spring growth flush. At this time new foliage will grow rapidly to cover exposed limbs. Bark that has grown in the shade is easily sunburned and may be killed in severe cases. Never prune trees drastically when they are suffering from drought.

Removing Large Tree Branches

Large branches too heavy to be held by hand (1 1/2 inches or more in diameter) require three separate cuts to prevent trunk bark stripping. The first cut is made on the underside of the branch about 15 inches away from the trunk and as far up through the branch as possible before the branch weight binds the saw. The second cut is made downward from the top of the branch about 18 inches from the main trunk to cause the limb to split cleanly between the two cuts without tearing the bark. The remaining stub can be supported easily with one hand while it is cut from the tree. This final cut should begin on the outside of the tree bark ridge and end just outside of the branch collar swelling on the lower side of the branch (Figure 1). (The bark ridge is usually rough, always darker than the surrounding bark and fairly obvious on most species.) Note that the cut is usually made

1. This document is HS 889, one of a series of the Horticultural Sciences Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Original publication date August 2002. Reviewed November 2005. Visit the EDIS Web Site at <http://edis.ifas.ufl.edu>.

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angling down and outward from the tree. If the cut must be made straight down (parallel to the trunk), do not make it flush with the tree trunk. A flush cut will cause serious injury. Although this was once standard practice, research has conclusively shown that flush cuts cause extensive trunk decay because wood that is actually part of the trunk gets cut. When the bottom of the branch collar is hard to see, prune as shown in Figure 2. In this way, only branch tissue is cut, and there is no damage to the trunk.

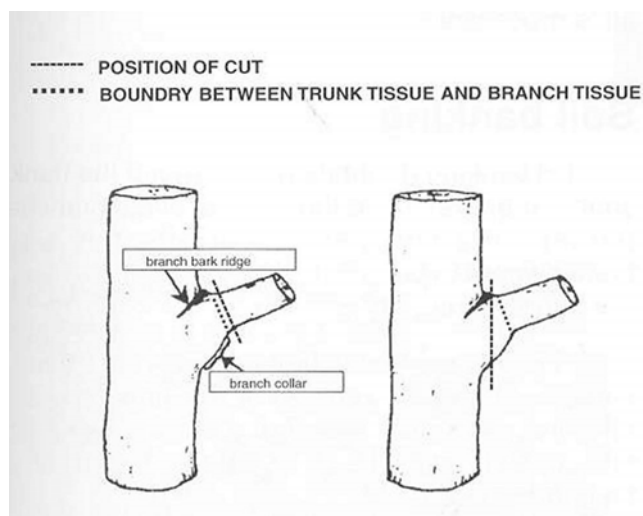


Figure 1. Correct (left) and incorrect (right) final pruning cuts for branches of any size.

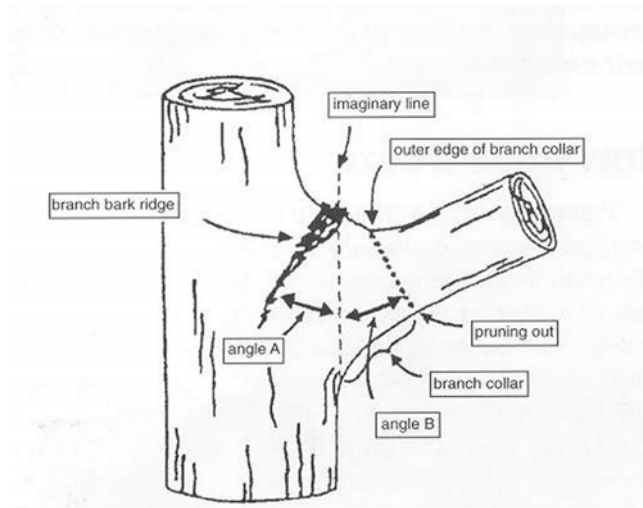


Figure 2. When the bottom of the branch collar cannot be seen from above the branch, the angle of the cut can be estimated. Think of an angle (A) created by the branch bark ridge and an imaginary line flush with the tree trunk. Duplicate that angle (B) in the branch to be trimmed and then make the pruning cut.

Painting wounds with tree wound dressing has become a controversial practice. The standard recommendation was to paint wounds with a quality tree wound dressing to protect the surface from wood rotting organisms and from cracking upon drying. However, research has shown that wound dressings do not prevent decay. When exposed to the sun, the protective coating often cracks, allowing moisture to enter and accumulate in pockets between the wood and wound covering. This situation may be more inviting to wood rotting organisms than one with no wound covering. In situations where aesthetics are important, the practice may be justified.

After a severe freeze that causes damage to major limbs, wait several months to prune. During the spring flush following a freeze, leaves on freeze-damaged limbs may grow but then will wilt soon after. After this wilt occurs on the spring flush, you will have a better idea about which limbs to prune. However, limbs with minor cold damage and split bark can continue to reduce fruit production for months, and even years, after a freeze.

Sometimes when a tree is weak, frozen back or broken off, a sucker or shoot will grow from the rootstock. The fruit from this rootstock shoot will usually be different than on the original tree. (The tree may produce two kinds of fruit if a portion of the scion remains. Fruits from rootstocks may be sour orange, rough lemon, trifoliate orange, Carrizo citrange, or Swingle citrumelo or other rootstocks.) Cut the sucker off to allow the desired variety to become dominant.

If your tree is completely destroyed, it is usually better to plant a new tree of the desired variety than to try to bud the rootstock. If you're thinking of moving a mature tree to a different location, it is also usually more economical to plant a new tree in the site.

Cold Tolerance

Although citrus trees are cold-tender plants of subtropical and tropical origin and have not developed the effective cold hardening processes typical of temperate, woody, deciduous species, they have the capability for acquiring considerable cold tolerance. Citrus does not enter a deep dormancy (resting condition) characteristic of temperate-zone

deciduous tree species such as apples or peaches. Rather, citrus enters a period of nonapparent growth (quiescence) as cooler temperatures (approximately two weeks of 40-60° F) occur.

Cold tolerance develops most readily when trees are not flushing (producing new leaves). Severely pruning dooryard trees during the late fall or winter months can reduce the size of the canopy, limiting its heat retaining capacity and stimulating untimely growth of tender flushes. The healthier, less injured, and less stressed trees are, the more they respond to cooler temperatures that induce quiescence.

In general, the degree of cold tolerance acquired by a tree is influenced by environmental conditions - mainly cool temperatures - as well as by tree health, its rootstock, and scion. Maximum cold tolerance ordinarily develops in citrus in the northern part of the state because of lower average winter temperatures, compared with citrus growing in the southern areas and along the coasts. But warm temperatures at any time during the winter may cause citrus trees throughout the state to resume growth and reduce their cold tolerance.

How Trees Freeze

Trees are most vulnerable to cold damage during their first 5 years, especially during growth flushes and when the trees are recovering from stress caused by lack of water, drought conditions, diseases, insect pests, nutritional deficiencies, and previous cold damage. Parts of the tree exposed to the atmosphere and the smallest parts of the tree (twigs, leaves, developing fruit) cool the fastest and are the most vulnerable to cold damage. Flowers are the first tissues to freeze, followed by tender, new growth (leaves and twigs), then older fully mature growth, small-diameter wood, and then large-diameter wood, with the trunk being the last to freeze.

Young, developing fruit tends to freeze before mature fruit and smaller size fruit before larger fruit of equal maturity. Fruit with thin peel tends to freeze sooner than fruit with thick peel. As a rule of thumb, citrus trees generally freeze from the top to bottom and from the outside to the inside of the tree.

Ice formation in citrus tissues - not low temperatures as such - kills or damages citrus trees and fruit. However, tissue where ice forms does not always die. The critical temperature for ice forming in citrus tissues is approximately 28° F, except when trees are in bloom and/or visible frost (frozen dew) occurs. Because of a phenomenon called supercooling, citrus flowers, fruit, leaves, and wood sometimes have the ability to supercool (to exist in an unfrozen, undamaged state below critical freeze temperatures) to as low as 16° F in leaves and 10° F in fruit, depending on the severity and duration of the freezing temperatures.

Satsuma trees on trifoliate orange rootstock demonstrate perhaps the greatest freeze survival among commercial citrus cultivars, having frequently survived temperatures of 14° F with only slight injury when adequately cold hardened. Common cultivars of sweet orange, other mandarins and grapefruit cannot withstand such low temperatures. Citrus flowers will freeze at about 28° F; fruit damage occurs when the temperature falls below 28° F for at least 4 hours. Even frozen fruit can be salvaged for juice. Within several days after a severe freeze, commercial growers harvest frozen fruit to obtain at least some return for their frozen fruit from juice processors.

Soil Banking

Soil banking (mounding soil around the trunk of a young tree, even up to the lower scaffold branches) is perhaps the cheapest, most effective way for homeowners to protect the trunk of young citrus trees from cold damage (Figure 3).

If the exposed portion of the tree is frozen, a new canopy will quickly grow from the protected portion after the soil is removed in the spring. Although soil banks can provide 12-15° F cold protection, they do have drawbacks.

Soil banks must be constructed before freezes occur (usually by mid-December) and removed as soon as possible after the seasonal threat of cold has passed (usually by mid-March). However, periods of warm winter temperatures may necessitate early removal of at least a small portion of the bank before the danger of cold has passed.

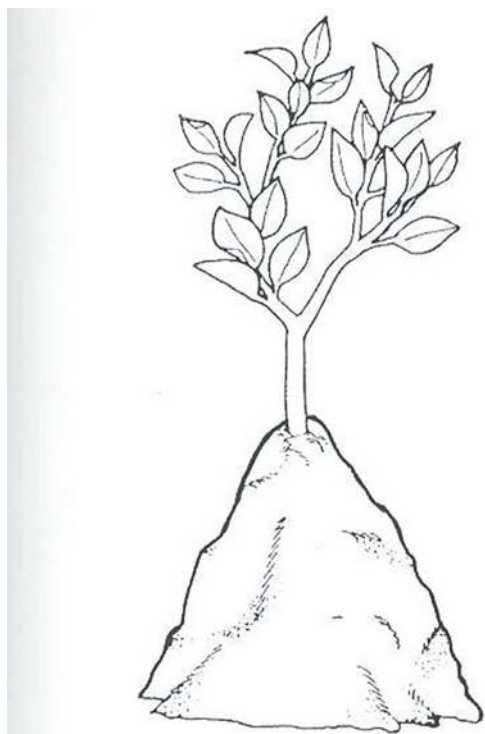


Figure 3. A typical soil bank.

Banks may have to be reconstructed periodically because of erosion from rainfall and irrigation. Some labor is involved in construction and removal of the soil bank. Unless you're careful, mounding and removing the soil with a hoe, rake or shovel may damage the tree trunk, predisposing it to insect and disease problems. Undetected, diseases like foot rot may develop and pest infestations may occur within the soil bank until the tree is severely damaged.

You can build a bank using a shovel or hoe and soil that is free of weeds, sticks, bags or other trash: these invite damage from both pests and disease. Build your banks as high as possible, up into the scaffold limbs when possible. Monitor banks during winter as wind and rain may erode the banks, leaving the tree vulnerable to cold.

Fungal diseases like foot rot sometimes occur when soil is mounded against the more susceptible scion portion of a young citrus tree. If you apply a suitable fungicide before banking, it will help reduce the incidence of this disease.

Trees can be safely unbanked as soon as the danger of cold has passed. In most areas this will be in mid- to late-February. If you leave banks on your trees too long in warm weather, disease and insect

problems increase. There is also danger of a physiological bark-sloughing disorder that can quickly kill a young tree.

Many regions in Florida have such a low cold damage probability that banks may not even be justified. Indeed, commercial citrus growers in much of south Florida do not bank trees at all. Growers in north and much of central Florida realize there is a high probability of cold damage and routinely bank young trees in the fall or use tree wraps as a regular production practice. Homeowners wishing to estimate the probability of the first and last freeze occurrence in Florida should consult Figure 4 and Figure 5.

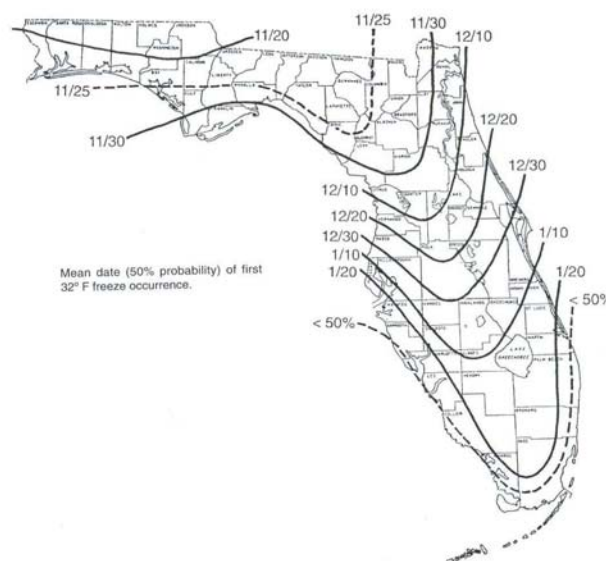


Figure 4. Mean date (50% probability) of first 32° F freeze occurrence.

Microsprinklers

If you already use microsprinklers for irrigation, you can use them for cold protection for both young and mature trees. Check first on water use restrictions that in some parts of the state may limit such applications.

Commercial Practices

In commercial groves both ground water and surface water are used for irrigation and cold protection. When ground water with a temperature of 68-80°F is applied to very young trees through

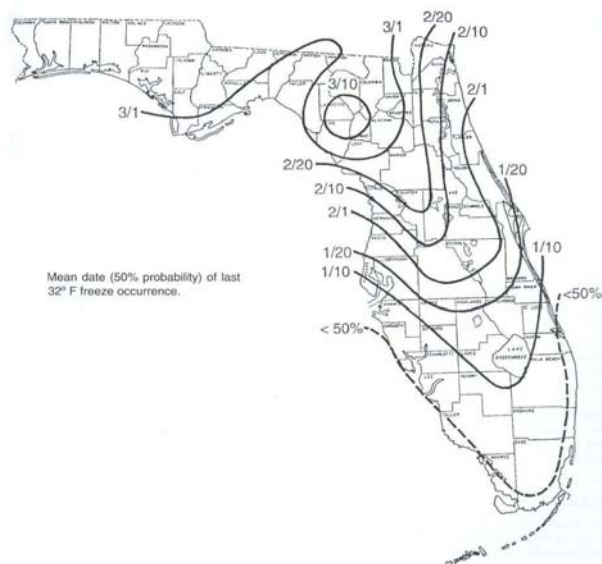


Figure 5. Mean date (50% probability) of last 32° F freeze occurrence.

microsprinklers during freezes, the heat stored in the water is released as this water turns into ice. If enough water is continuously applied, especially during windy freezes, the temperature of the citrus tissue beneath the ice will not drop much below 32°F. When the ice thaws, tissue covered with ice will be undamaged. Commercial growers are also now elevating microsprinklers to a height of 4 feet or more next to the trunk of mature trees to provide cold protection for as much of the canopy and branches of mature trees as possible.

In practice, growers place microsprinkler emitters approximately a yard away from the young tree on the northwest side of the tree, the direction of prevailing winds during most Florida freezes. Using a 90° spray pattern, they concentrate water on the trunk of young trees at the rate of 10-15 gallons per hour. When microsprinklers with a circular spray pattern are placed within mature trees, downward pointing spokes of water will offer good protection. (Some limb breakage may occur from ice loading, but this is unavoidable.)

Home Irrigation Systems

A microsprinkler irrigation system for home use would include an in-line water filter, 1/2 to 3/4 inch plastic irrigation tubing with a circular clamp to constrict the folded end of the tubing, and a

pre-assembled microsprinkler unit. Such setups are available retail at irrigation supply stores. For further information consult your county extension agent.



Your Florida Dooryard Citrus Guide - Common Pests, Diseases, and Disorders of Dooryard Citrus¹

James J. Ferguson²

You've probably already noticed that Florida's humid climate harbors all kinds of fungi and creepy crawlies. The good news is, like most of us, they don't change very much. Once you learn to recognize the major pests, diseases and disorders of citrus, you'll be able to identify them easily.

Strategies to control citrus pests include biological control, integrated pest management, and chemical control. In most cases, naturally occurring, biological control (letting nature take its course) is the easiest and best way for homeowners. Integrated pest management (IPM) involves a combination of biological control, cultural practices, and pesticides, when needed. Chemical control (application of pesticides) is quick but can upset biological control systems and demands strict adherence to label instructions. Never hesitate to consult your county extension horticultural agent for additional information on identification and management of citrus diseases, pests and disorders, even before they threaten to destroy or seriously damage your citrus tree.

Many of the pathogens and pests discussed here become active and increase in numbers in spring

when citrus trees develop new leaves, shoots, and fruit. Once you identify these problems, it may be too late to do anything for the current season. But, again like us, the pathogens and pests discussed here have a weak point—a fatal flaw—that I'll point out as the best management strategy. You can see what these pests, diseases, and disorders look like by turning to the pictures included of this manual.

Diseases

The most common fungal diseases of citrus in Florida are greasy spot, melanose, scab, and foot rot. The first three affect fruit, leaves, and twigs; the fourth, a disease of the “foot” of the tree, near ground level, directly affects the trunk of the tree. Over time, foot rot can weaken the entire tree.

Greasy Spot

Imagine you injected drops of old, dirty engine oil below the surface of citrus leaves—you'd see “greasy spots,” the kind dry cleaning can't get out of a white shirt or blouse after you've changed a flat tire. These grease spots are actually leaf tissue that has collapsed after infection by the greasy spot fungus (Figure 1).

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Citrus leaves function for 2 to 3 years before they drop. When foliage is heavily infected, severe leaf drop can occur prematurely (Figure 2), resulting in a gradual reduction in tree vigor. Weakened trees become more susceptible to other diseases and pests, as well as to additional cold damage.

The main impact of greasy spot is reduction of tree vigor. External fruit quality can also be affected. Look for pinpoint black specks on the rind, especially on grapefruit, lemons, and tangelos (Figure 3). (Sweet oranges and mandarins are less susceptible.) Greasy spot can be distinguished from melanose, a disease covered later on, by using a hand lens to see where the black spots occur. Greasy spot lesions do not cover the oil glands on the fruit rind; melanose lesions do.

Greasy spot is a lazy, summer disease in that infected, fallen leaves decompose during the summer rains and produce inoculum for one to four months to infect leaves that will drop the following spring. Once you have greasy spot, the cheapest, simplest, most effective control strategy is to remove and destroy fallen citrus leaves near the infected tree. Don't use infected leaves as mulch around your tree. Don't bury them. Make sure they're destroyed before summer rains occur. Oil and copper sprays can also control greasy spot.

Citrus Scab

Scab is undoubtedly the ugliest disease of citrus, appearing as a rash of scabs or warts on leaves, twigs, and fruit (Figure 4). Since new generations of *inoculum* (infectious material) can be produced within five days, scab is a "compound-interest" disease that can spread rapidly, given the right conditions, from overwintering infections on leaves and stems. Compared with the greasy spot fungus, the scab organism is an aggressive pathogen, with the first seasonal infection usually occurring with early spring cold fronts accompanied by rain during March and April. Water from rain, overhead irrigation and dew is, in fact, the most important factor affecting disease development.

Early stages of scab infection include well-defined, conical growths on one side of the leaf with a corresponding conical depression on the



Figure 1. Greasy Spot symptoms on leaves.



Figure 2. Heavy greasy spot infections cause severe leaf drop, reducing tree vigor.

opposite side. These lesions may occur singly or be grouped irregularly (Figure 4). The crests of these wart-like growths usually become covered with a scabby tissue ranging in color from pale to dark. Infected spots often run together and cover large areas with a corky, scab-like growth. Badly infected leaves and twigs become distorted and stunted. When fruit is infected when very young, it can become

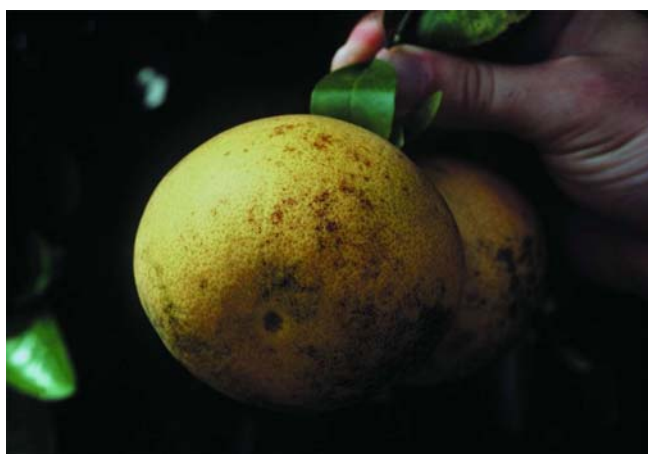


Figure 3. Greasy Spot rind blotch on grapefruit.

misshapen, with warty growths or projections, especially on Temples (Figure 5). However, interior fruit quality is usually not affected. The lighter coloring of the lesions usually distinguishes citrus scab from melanose, which may also distort young leaves.

Susceptible cultivars include Temple oranges, lemons, Minneola tangelos, Murcotts, and Page oranges. Other cultivars like satsuma tangerines, Orlando tangelos, Tahiti limes, and grapefruit are less susceptible. The best scab management strategy is to remove and destroy the source (infected leaves, twigs, and fruit) of inoculum, controlling the disease before it develops momentum.

Since scab also occurs on some rootstocks (sour orange, rough lemon, Rangpur lime, trifoliate orange, and Carrizo citrange), this disease is commonly introduced into the home landscape on already infected nursery trees.

When buying a nursery tree, carefully examine the leaves for disease lesions and evidence of insect damage and eggs. It may be worth your while to remove all infected leaves, twigs and fruit, if possible. In this way you can avoid introducing the pathogen or pest into your dooryard.

Avoid overhead irrigation that spreads scab. Install drip or micro- sprinkler irrigation. Copper sprays also can be applied 2-3 weeks after petal fall, and again 2-3 weeks later to control scab.



Figure 4. Scab: cone-like distortions on leaves.



Figure 5. Scabs or warts on leaves, twigs and fruit.

Melanose

The most recognizable symptoms of melanose are small, dark brown, raised lesions on leaves that have a rough, sandpaper texture (Figure 6). When the fungal spores stream down the surface of fruit, a “tear-streaking” symptom develops (Figure 7). When smaller lesions coalesce to form a large one, a “mudcake” lesion develops (Figure 8).

Melanose lesions on leaves and fruit are actually scar tissue formed when the host plant walls off infections. Both rust mite blemishes and melanose lesions on fruit are brown but melanose lesions have a rougher texture. Melanose lesions can also be distinguished from greasy spot lesions on fruit by observing lesions with a hand lens. Melanose lesions cover oil glands on the fruit surface but greasy spot lesions do not.

Inoculum is produced only on recently killed twigs. Rain or overhead irrigation splashes inoculum onto leaves and fruit from April to June. For this reason, melanose is usually more severe in older, neglected trees and cold-damaged trees with large amounts of dead wood and twigs.

All cultivars are affected by melanose, but fortunately it does not cause leaf drop and fruit damage is only superficial. Leaves are susceptible until fully expanded and fruit is susceptible for 12 weeks after petal fall. Copper sprays are usually applied 2-3 weeks after petal fall and a second spray 2-3 weeks later.

The best melanose management strategy is to remove small, dead twigs, and avoid overhead irrigation. If this is impractical, either spray with copper or don't spray and live with melanose, since it has little serious impact on mature trees.

Another form of the melanose fungus causes a post-harvest fruit rot. So if you plan to harvest and send fruit to your sister in Saskatchewan, control may be necessary.



Figure 6. Melanose symptoms - leaf lesions with rough, sandpaper texture.

Foot Rot

Remember, one of the advantages of a budded tree (consisting of a scion/rootstock combination) is resistance to diseases. Foot rot may well be the most common soilborne disease affecting citrus scions, rootstocks and even seedling trees. Actually, you can

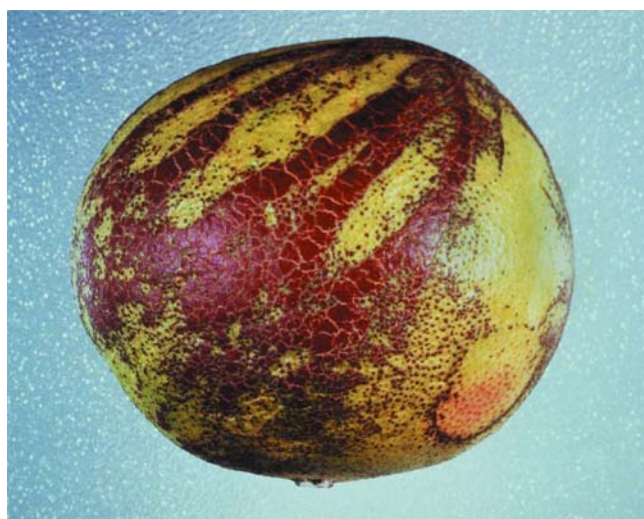


Figure 7. Melanose - tear-streaking symptoms on fruit.



Figure 8. Melanose - mudcake lesions on fruit at right.

have root rot, foot rot, and a fruit rot on the same tree, caused by a widely distributed fungus with a nearly unpronounceable name, *Phytophthora*, meaning plant destroyer.

Foot rot can affect only the scion, only the rootstock, or both scion and rootstock—if both are susceptible—and seedling trees. Foot rot lesions usually begin near the budunion, expanding either upward on the trunk or downward into the root crown (large exposed roots at the base of the trunk).

The first symptoms of foot rot are water soaking of the bark in irregular patches and oozing of varying amounts of gum. Over time, the diseased bark dries out, settles, cracks and weathers off, with the wood beneath the bark staining brown (Figure 9, Figure 10). Some healing may take place, with callus or scar tissue forming around the healthy margin of the lesion, limiting further progress of the disease.

Canopy symptoms are the same as those produced by any factor that disrupts the flow of water and nutrients from the roots to the canopy: nutrient deficiency symptoms, especially nitrogen, reduction in leaf and fruit size, leaf drop and dieback, and a general reduction in tree vigor (Figure 11).

The root rot phase of the disease is characterized by decomposition of the fine, fibrous feeder roots near the soil surface. *Phytophthora* can also cause brown rot of fruit, which is characterized by a light brown discoloration of the fruit rind or peel. This discolored area remains firm and leathery, but under humid conditions, white fungal growth will appear on the fruit surface and the fruit will smell rancid. Brown rot is usually associated with extended periods of rainfall and wetting caused by slow moving tropical storms or hurricanes. Since such conditions are more likely to occur in the early fall than later in the season, brown rot is found more frequently on early maturing cultivars, such as Hamlin oranges and grapefruit. Since the fungal spores that cause this disease are splashed from the soil onto the fruit, pruning low-hanging branches can prevent brown rot. You might lose some fruit, but you will also prevent the disease from spreading higher up into the tree.

The fungus that causes these diseases belongs to a group of organisms called “water molds,” which do well under high soil moisture, but not flooded conditions. Symptoms usually occur after heavy rains or excess irrigation has favored infection of susceptible plant tissue. If planting in soil that has naturally poor drainage, especially in the “flatwoods” area of southern Florida, plant your tree higher than usual by creating a mound or raised bed that will allow good drainage, even under flooded conditions. Be sure to plant your tree with the budunion at least 4 to 6 inches above the soil line.

Although mulching can prevent weed growth and conserve water, piling mulch up against the tree trunk can predispose your tree to infection by limiting air circulation and providing a path for the fungus from the soil to susceptible scion tissue above the budunion.

Anything you can do to encourage air circulation at the base of the tree will help, including pruning low hanging branches that scrape the ground and

removing plant and soil debris from the trunk and crown roots. Since this fungus usually penetrates through wound tissue, don't wound or scrape the bark at the base of the tree when you're hoeing or mowing.

The only rootstocks resistant to foot rot are trifoliate orange, *Citrus macrophylla* and Swingle citrumelo. Sour orange and Carrizo citrange are tolerant, while Cleopatra mandarin, rough lemon, Milam, Volkamer lemon and Rangpur and Palestine sweet lime vary from tolerant to susceptible. Sweet orange is generally considered the most susceptible when used as a scion, rootstock or seedling tree.

If your tree has already developed foot rot, scrape off the brown, discolored bark and surface wood until you reach healthy wood and paint the exposed area with a copper paint. Systemic fungicides are also available.



Figure 9. Foot rot bark lesions.



Figure 10. Foot rot - brown stains beneath the bark.



Figure 11. Foot rot symptoms - general tree decline.

Other Diseases

Other fungus diseases like *Alternaria* brown spot and post-bloom fruit drop cause fruit drop from time to time. *Alternaria* brown spot affects Dancy tangerines and Minneola tangelos most seriously, and can produce leaf spots, leaf drop, fruit spots (Figure 12) and fruit drop. Like most of the other fungal diseases, copper sprays can control it.

Post-bloom fruit drop has occurred widely on all cultivars in some years, especially when heavy rain, overhead irrigation, dew, or fog wets blossoms. Blossoms develop peach- to orange-color lesions and young fruit drop soon after fruit set, leaving a "button," the remains of the flower parts (Figure 13). From 50 to 90% of a crop can be lost. Systemic fungicides are applied commercially, but for the homeowner, little can be done except avoiding overhead irrigation during bloom. Sooty mold, a black, superficial fungal growth on leaves, twigs and fruit, grows on exudates from aphids, whiteflies, soft scales and other piercing, sucking insects (Figure 14). Sooty mold does little damage and can easily be washed off fruit. Oil sprays will also loosen this mold from leaves and twigs.

A number of viral diseases, causing bark scaling on the rootstock or scion, stunting, tree decline and death, also occur in Florida. Once a tree is infected, little can be done. Your best defense is to buy healthy, vigorous trees from a reputable nursery.



Figure 12. Alternaria Brown Spot on fruit.

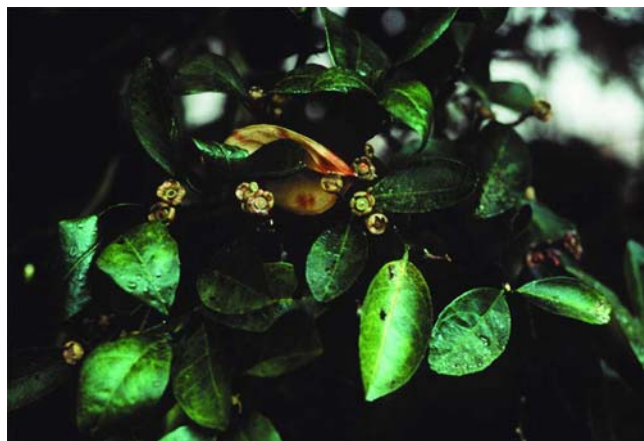


Figure 13. Post-bloom fruit drop: leaves a persistent calyx or "button" and distorted leaves with enlarged veins.

Pests

The most common pests of dooryard citrus include aphids, whiteflies, fire ants, mites, scales, plant bugs, and chewing insects like grasshoppers, katydids, and caterpillars. Descriptions of the organisms and the damage they cause are included



Figure 14. Sooty mold washes off easily from leaves and fruit.

here. Consult your county extension agent for recommended chemical controls.

You can usually depend on aphids and whiteflies to attack young, succulent leaves and shoots in the spring. When aphids feed, they cause young leaves and shoots to cup, curl and distort, reducing the growth of that particular flush (Figure 15). Usually the damage is done before you notice it, so it's important to watch for early signs of infestation. Young trees can be stunted if severe infestation retards canopy development. But in most cases, trees can tolerate aphids and survive.

Whiteflies also infest young leaves and flushes, sucking the sap from these tissues. But no leaf or shoot distortion occurs (Figure 16). Friendly orange-red fungi parasitizes immature whiteflies (Figure 17), so don't be alarmed when you see these good guys on the bottom leaf surface. However, if you apply copper sprays to control greasy spot, melanose, and scab, the copper spray will also destroy friendly fungi. Fire ants can kill young trees by eating the tender bark of the roots and trunk and branches, especially those of grapefruit (Figure 18).

Mites, especially rust mites and spider mites, feed on leaves and fruit, causing a variety of symptoms referred to as stippling, silvery and russetting. Mites can barely be seen with the naked eye but can be readily observed with a hand lens. Rust mites are yellow and wedge-shaped; spider mites actually look like tiny spiders. Populations of rust mites usually increase in the humid summer and again, to a lesser degree, in the fall, causing a

russetting of leaves and a russetting and brown staining of fruit (Figure 19). While feeding on fruit, rust mites avoid shade and move towards light but avoid direct sunlight, often resulting in heavily stained fruit with clearly defined, sunlight areas without damage (Figure 20). Excessive damage can lead to leaf drop. Infested fruit may be smaller at harvest but may be sweeter because fruit sugar may be more concentrated due to water loss from feeding injuries.

Often, a naturally occurring fungus (*Hirsutella*) acts as a biological control of citrus rust mites, but this beneficial fungus may not reduce rust mite populations until after damage has been done.

Populations of spider mites usually peak in dry spring and fall months, causing leaves to have a lightly colored, scratched look called stippling or etching that can lead to leaf drop—especially on very susceptible cultivars like Sunburst tangerines (Figure 21). These pests can also cause leaf blistering and distortion and leaf drop.

What about scales? Another common insect pest, immature scales insert their piercing-sucking mouthparts into host tissue. They remain fixed there, feeding on plant juices and can cause moderate to severe defoliation and fruit drop. The most commonly occurring scales are “armored” or hard scales like purple scale (Figure 22), snow scale (Figure 23), red scale (Figure 25), and “soft” scales like Caribbean black scale (Figure 24) and cottony cushion scale (Figure 26), which stimulate sooty mold fungus. Tiny wasps that act as a biological control parasitize many of these insects, but, when severe infestation occurs, chemical sprays can be applied, usually when the immature crawler stages are active. When you buy your nursery tree, inspect it carefully for infestation by scales. They are readily observed, if present, on leaves and twigs.

Chewing insects, including grasshoppers (Figure 27), crickets, root weevils (scalloped leaves indicate feeding of adults, Figure 28), katydids (Figure 29) and caterpillars, cause occasional leaf damage, especially on young trees, and fruit drop. Katydid eggs, laid along the leaf margin, usually arouse the interest of home gardeners. Orange dogs (the caterpillar form of a large black and yellow swallowtail butterfly) may grow to a length of 2

inches. During summer and early fall these caterpillars can completely defoliate young trees (Figure 30). During these times they can be easily picked off leaves by hand or with tweezers.

Citrus leafminers, now widespread in Florida, cause damage to newly emerged leaves and shoots. The larval form of this tiny moth eats a serpentine tunnel through leaves, twigs and, occasionally, fruit (Figure 31).



Figure 15. Aphids cause cupping, curling and distortion of young leaves.



Figure 16. Whiteflies feeding on leaves.



Figure 17. Beneficial orange-red fungus parasitizes of white flies.

Disorders

A combination of unfavorable environmental conditions and irregular fertilization and irrigation practices have been associated with the following fruit disorders:

- granulation or drying of the juice sacs within fruit,
- creasing (depressed areas in the peel), and
- fruit splitting and fruit drop.

Granulation usually occurs on rapidly growing fruit and excessively large fruit. While Valencia oranges are most frequently affected, other oranges, grapefruit, and tangerine cultivars are subject to this malady as well, especially when budded on rough lemon and trifoliate rootstocks. Good fertilization and nutrition practices and early seasonal harvesting may alleviate this problem.



Figure 18. Fire ant damage on roots and trunk of young tree.



Figure 19. Rust mite damage.

Creasing occurs when tissue in the spongy white layers beneath the peel separates, causing depressed areas in the peel itself (Figure 32). This condition doesn't affect internal fruit quality. Creasing may be related to unusual nutrition, temperature, and moisture conditions, and can be avoided by good cultural practices.



Figure 20. Rust mite damage except in clearly demarked areas in direct sunlight.



Figure 21. Spider mites cause stippling or etching on leaves.



Figure 22. Purple scale is brown to purple color with a comma-like oyster shape.

Fruit splitting usually associated with irregular development and expansion of fruit cells can best be prevented by uniform irrigation and fertilization practices (Figure 33).



Figure 23. Snow scale gives infected twigs and branches a white-washed look.

Some fruit drop occurs on most citrus cultivars, usually within 4 to 8 weeks of bloom—it's a natural process that allows the tree to adjust its fruit load for the coming season when an unusually large number of fruit have been set. Other cultivars (like Pineapple oranges and navel oranges) commonly drop fruit again, later in the season.

Even if you fertilize and irrigate your trees regularly, you may still see some nutritional deficiencies that warrant foliar sprays. Again, your county extension agent can be helpful in this situation.

Nitrogen Deficiency

Nitrogen deficiency is a general leaf yellowing (Figure 34) that commonly occurs in some cultivars like Orlando tangelos during late winter and early spring. Another form of nitrogen deficiency, in which the main veins turn yellow, occurs when the canopy receives an inadequate supply of nitrogen. Both forms of nitrogen deficiency may be due to poor



Figure 24. Caribbean black scale has an H-shaped longitudinal ridge.



Figure 25. Red scale has a central, light nipple within a reddish-brown ring.

fertilization practices or to other, more serious problems: foot rot, root rot, nematode damage, etc. These affect the movement of nutrients from roots to the canopy. If you maintain and monitor your fertilization practices and the tree still does not respond, investigate these other possibilities.



Figure 26. Cottony cushion scale is usually covered with waxy secretions; commonly parasitized by lady beetles.



Figure 27. Lubber grasshopper.

Magnesium and Manganese Deficiencies

Magnesium deficiency is characterized by an inverted, green, v-shaped area at the base of the leaf, with the rest of the leaf turning yellow (Figure 35). In manganese deficiency, bands along the midrib (the main vein running the length of the leaf) remain green; areas between the veins turn light green (Figure 36).

Zinc and Iron Deficiencies

Zinc deficiency also produces leaves that have irregular green bands along the midrib and lateral or side veins but can be distinguished from magnesium-deficient leaves because of their small, narrow size, pointed tips and the pattern of leaf clusters or rosettes caused by decreased stem elongation between leaf buds (Figure 37).



Figure 28. Scalloped leaves showing where adult root weevils fed.

Iron deficient leaves have a very fine network of green veins all over the leaf (Figure 38). Nitrogen and magnesium deficiency symptoms usually occur on the oldest leaves whereas zinc and manganese symptoms usually occur on the youngest leaves. Nitrogen and magnesium deficiencies can be corrected by applying a complete fertilizer containing



Figure 29. Katydid damaged on fruit showing depressions below uninjured area.



Figure 31. Citrus leafminers damage young leaves and twigs, and sometimes damage fruit.



Figure 30. Orange dog caterpillars chew entire leaves.

micronutrients whereas zinc and manganese usually require foliar sprays containing these micronutrients.

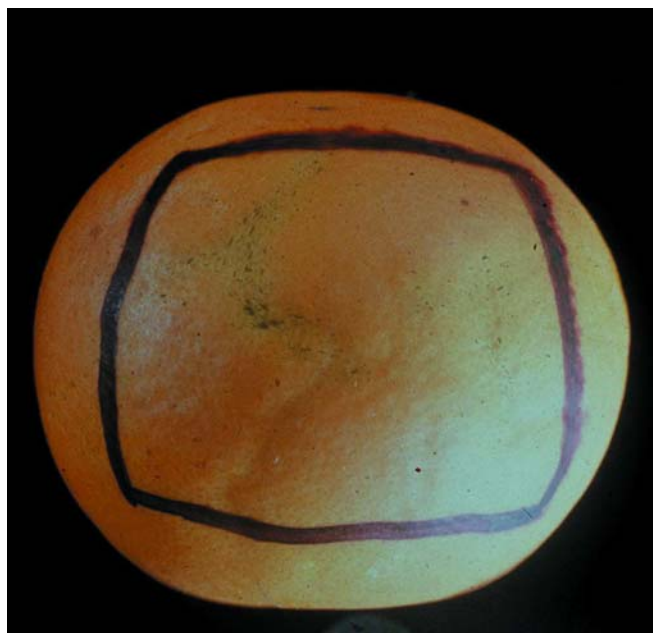


Figure 32. Creasing: depression in the peel.



Figure 33. Fruit splitting.



Figure 34. Nitrogen deficiency causes leaf yellowing.



Figure 35. Magnesium deficiency: inverted V-shaped area near leaf base.



Figure 36. Manganese deficiency: mangy, irregular bands along the midrib remain green.



Figure 37. Zinc deficiency small, narrow leaves in cluster.



Figure 38. Iron deficiency: a fine network of green veins all over the leaf.



Your Florida Dooryard Citrus Guide - Appendices, Definitions and Glossary¹

James J. Ferguson²

Appendix A. Scion Selection

Sweet Oranges

Oranges grown in Florida can be divided into three broad seasonal categories: Hamlin, Parson Brown, Ambersweet, and navels are considered early-season cultivars; Pineapple orange is a mid-season cultivar; Valencia is a late-season cultivar.

Early-Season Oranges

Hamlin orange

Harvest October to January

Trees of this early cultivar have a high degree of cold tolerance especially with early harvest before winter freezes. Fruit yield is high and juice has a light color. Fruit stores well on the tree but is susceptible to splitting and creasing. Seeds: 0-6 per fruit.

Parson Brown orange

Harvest October to January

Parson Brown is an early season orange that can be harvested slightly earlier than Hamlin. Its seediness and lower fruit yields make it less desirable than Hamlin for fresh fruit. Seeds: 0-30 per fruit.

Ambersweet orange

Harvest October to January

Trees are moderately cold hardy. Fruit can usually be harvested prior to damaging freezes. Fruit resembles navel orange, peels easily, has good fruit and juice color at maturity, but varies greatly in seediness. Trees on some rootstocks, especially Swingle citrumelo, grow slowly at first and appear to be quite susceptible to citrus rust mite. This is a new cultivar, so many questions remain about fruit production and fruit quality. Will probably be a very good early-season orange cultivar for either fresh fruit or juice. Seeds: 0-30 per fruit.

Navel orange

Harvest October to January

Navels differ from other oranges by having a rudimentary secondary fruit embedded at the blossom

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end of the fruit. Premature yellowing and rot of this secondary fruit often results in premature fruit drop. Fruit peels relatively easily, sections well. If juiced, drink within several hours before a bitter flavor develops. Tends to require more precise irrigation and nutrition management. Two periods of fruit drop, early- and late-summer, account for 15-20 percent of the crop in some years. Cara Cara navel is used for salads because of its near-crimson flesh. Seeds: 0-6 per fruit.

Mid-Season Oranges

Pineapple orange

Harvest December to February

This leading mid-season cultivar has good external color and internal quality but is the least cold hardy of orange varieties. It is subject to alternate bearing, pre-harvest fruit drop during heavy crop years, creasing and pitting. Seeds: 15-25 per fruit.

Sunstar orange

Harvest December to March

This variety has slightly darker juice color than Hamlin and about as much fruit. It is more cold hardy and subject to less pre-harvest fruit drop than Pineapple orange. It ripens about the same time as Pineapple.

Midsweet orange

Harvest January to March

Midsweet ripens later than Pineapple and holds well on the tree. Fruit yield and quality are about the same as Hamlin but juice color is deeper. Trees are cold hardier and less susceptible to pre-harvest drop than Pineapple orange.

Gardner orange

Harvest January to March

This midseason orange ripens around February 1, about the same time as Midsweet. Gardner is about as cold hardy as Sunstar and Midsweet.

Late-Season Oranges

Valencia orange

Harvest March to June

This cultivar carries two crops on the tree after bloom, the current seasons crop and the previous season's crop that takes about 15 months to mature. With its excellent internal fruit quality and juice color, the Valencia is the most important sweet orange variety. The tree tends towards alternate bearing. Fruit stores well on the tree and may regreen late in the season. Rhode Red "Valencia" orange has superior peel and flesh color. Seeds: 0-6 per fruit.

Grapefruit

Two basic types of grapefruit are grown in Florida, white-fleshed (Marsh and Duncan) and pink-fleshed or colored grapefruit (Redblush, Thompson, Flame and others).

Duncan grapefruit

Harvest December to May

Produces seedy, high quality fresh fruit with pale, yellow flesh. Popular for sectioning. Seeds: 30-70 per fruit.

Marsh grapefruit

Harvest November to May

This seedless fruit with pale yellow flesh and large, open cavity in center, is used commercially for juice. Seeds: 0-6 per fruit.

Redblush grapefruit

Harvest November to May

Widely grown ruby red grapefruit used for juice and cocktail products. The peel is a pink blush and the flesh pink to pale red. Seeds: 0-6 per fruit.

Star Ruby grapefruit

Harvest December to May

Peel has a dark-pink blush; flesh is deep red. Peel has a smoother texture than other grapefruit.

Trees are less cold hardy than other grapefruit cultivars and more susceptible to foot rot. Leaves often show blotchy chlorotic areas (a genetic trait).

Other grapefruit cultivars include Thompson, Ray Ruby, Flame, and Rio Red. Seeds: 0-6 per fruit.

Mandarin and Mandarin Types

Mandarins or tangerines include fruit of small- to medium-size; loose rind and fruit sections; distinctive flavor, color and aroma; and excellent eating out-of-hand qualities. Trees are usually very cold tolerant. The peel on some mandarins tears easily, so harvesting is done by cutting the stem with pruning shears. Seed numbers generally vary with the degree of cross-pollination.

Minneola tangelo

Harvest December to February

This seedy, well-sized fruit with characteristic flavor often exhibits a prominent neck at the stem end. Fruit production is enhanced by cross-pollination. Trees are extremely cold hardy, highly susceptible to *Alternaria* brown spot. Seeds: 7-12 per fruit.

Orlando tangelo

Harvest November to January

This early-season cultivar produces a large, cold-hardy tree with cup-shaped leaves. Trees must be fertilized more heavily and frequently than most other cultivars, especially with nitrogen, as foliage tends to turn yellow in the fall and late winter. Bears fruit within 3-4 years as a seedling tree, and is moderately susceptible to *Alternaria* brown spot. Seeds: 0-35 per fruit.

Nova

Harvest November to December

Cross-pollination required. Fruit tends to dry-out prematurely, particularly on lemon-type and Carrizo citrange rootstocks. Quite cold tolerant. Seeds: 1-30 per fruit.

Robinson

Harvest October to December

Cross-pollination required for this early tangerine of excellent eating quality. Fruit tends to dry-out early on vigorous rootstocks, is thin-skinned, and susceptible to splitting. Brittle wood and a tendency to bear fruit near limb ends can result in limb breakage and even tree collapse in heavy crop years. One of the more cold-hardy cultivars, but susceptible to twig and limb dieback. Scion is susceptible to *Phytophthora* foot rot. Seeds: 1-20 per fruit.

Sunburst

Harvest November to December

Cross-pollination required. Foliage and twigs are highly susceptible to environmental stress and rust mite damage. This thin-skinned fruit is also susceptible to splitting. Seeds: 1-20 per fruit.

Murcott (Honey tangerine)

Harvest January to March

Excellent eating-quality. Heavy alternate bearing sometimes results in limb breakage and tree collapse. Trees are normally cold hardy, but highly susceptible to cold damage when heavily laden with fruit, which is also susceptible to scab. Fruit is borne on the outside canopy, resulting in susceptibility to wind-scar and sunburn. Seeds: 10-20 per fruit.

Dancy

Harvest December to January

Produces large crops of small fruit, though highly susceptible to *Alternaria* brown spot. Limb breakage may occur with heavy crops. The fruit is excellent in quality and peels so easily it must be clipped to harvest. Seeds: 6-20 per fruit.

Temple (Temple orange)

Harvest January to March

An excellent eating-quality fruit with a pebbly rind that is easily peeled and susceptible to creasing.

Mature fresh fruit and juice are of superior flavor and color. Trees are very sensitive to citrus scab, cold temperatures and highly susceptible to aphids. Seeds: 15-20 per fruit.

Osceola

Harvest October to November

Cross-pollination required to produce this small, highly colored but seedy fruit. Tree is relatively cold hardy, but susceptible to scab. Clip fruit to harvest. Seeds: 15-25 per fruit.

Fallglow

Harvest October to November

Fruit is juicy, may have tart taste; usually larger than other citrus hybrids. The tree is not as cold hardy as most citrus hybrids and is highly susceptible to aphids. Young trees are susceptible to twig and limb dieback following planting. Seeds: 20-25 per fruit.

Page

Harvest October to February

Bears many small fruit of excellent eating quality. Tree is relatively cold hardy, but susceptible to scab. Seeds: 0-25 per fruit.

Owari (satsuma type, Kimbrough type)

Harvest September to November

Trees have a characteristic, open-growth habit with less foliage than other cultivars, and perform well on trifoliate orange rootstock. Produces its best-quality fruit in northern areas of the state. Fruit achieves excellent eating quality before good external color appears, but does not store well on the tree; clip at harvest. Kimbrough, an Owari type released in 1990, produces larger fruit and may have 1-2°F more cold tolerance than satsuma, the major Owari type planted in Florida. Seeds: 0-6 per fruit.

Ponkan

Harvest December to January

One of the more tropical mandarins, Ponkan is regarded as a good dooryard variety. Tree tends towards alternate bearing and has a low-acid content. Seeds: 3-7 per fruit.

Acid Citrus Fruit

This group includes lemons, limes and citrons. They usually bloom more frequently than other cultivars and are highly cold-sensitive.

Tahiti or Persian lime

Harvest June to September

These thorny trees are highly susceptible to cold injury, limiting their culture to south Florida. Fruit is large, acid, harvested while green. Maturity is based on size and juice content since fruit is pale yellow when fully mature. Seeds: 0-1 per fruit.

Key or Mexican lime

Harvest year-round

The small fruit are prized for the lime flavor they give pies. Juice is also used as condiment. Cold susceptible, these trees can be grown outdoors only in south Florida, and should be container-grown and moved inside during cold weather in other areas. Key lime will produce flowers repeatedly, so fruit in various stages of development are found on the tree at the same time. Seeds: 3-8 per fruit.

Meyer lemon

Harvest November to March

This variety's cold-hardiness make it a popular selection for dooryard plantings. It has a low-spreading growth habit with few thorns. Fruit are relatively large with high juice content, a smooth skin, and lower acid levels than other lemon varieties. Seeds: 0-10 per fruit.

Bearss lime or Sicilian lemon

Harvest July to December

Trees are very vigorous, thorny, and sensitive to cold. Continuous growth makes it difficult to control tree size. Seeds: 1-6 per fruit.

Miscellaneous

Calamondin

Harvest November to April

This acid fruit flavors drinks, marmalades and jellies. Popular in landscapes and ornamental containers, rooted cuttings of this cultivar are also widely marketed as “miniature oranges” for use as a winter houseplant. While rooted cuttings grow like shrubs, budded trees can reach 15 – 20 feet and are cold-hardy. Seeds: 3-5 per fruit.

* Nagami kumquat

Harvest November to April

This oblong or egg-shaped fruit has an acid taste and bright-orange color. Cold-hardy trees are used in home and commercial landscaping. An ornamental, variegated Nagami kumquat, Centennial, is available. Seeds: 0-3 per fruit.

* Meiwa kumquat

Harvest November to April

The peel and pulp of these large, round fruit have a pleasant spicy-sweet taste, and are used for preserves and candied fruit. Tree is compact, foliage dark green. Trees are used in home and commercial landscaping and are quite cold-hardy. Seeds: 1-6 per fruit.

Limequat³

Harvest November to March

Eustis, Lakeland, and Tavares limequats, hybrids of kumquats and the West Indian or key lime, all resemble the key lime in size, form and composition and are commonly substituted for key lime. Eustis and Lakeland kumquats are similar in color to the key lime where as the Tavares limequat has more orange color. Eustis and Lakeland are sister hybrids of the West Indian or key lime and the round or Meiwa kumquat. Tavares is a hybrid of key lime with the oval or Nagami kumquat. All limequat are more cold resistant than key limes but less cold resistant than kumquats.

Promising New Cultivars

The University of Florida and other universities and research agencies have recently released a number of promising new cultivars. However, these new cultivars are still being tested in commercial groves and may not show up in garden stores for some time. Early and mid-season oranges include cultivars that mature earlier or later than Hamlin oranges, have better flesh color or flavor than Hamlin, with one selection, Jin Cheng, having egg-shaped rather than round fruit. A new Murcott and Clementine cultivar will also be available. Look for them in the future.

Appendix B. Rootstock Characteristics

Rough Lemon

Rough Lemon recommended for Valencias and other round oranges in warm areas

- adapted to deep, coarse sandy soils
- cold-sensitive, not recommended in chronically cold areas, but rootstock vigor promotes rapid recovery
- produces large, vigorous trees that may grow too large for dooryard sites
- produces high yields and large fruit with relatively thick peel and poor juice except perhaps Valencia orange

Milam Lemon

Milam Lemon recommended for Valencia orange in warm areas

- similar to rough lemon for tree growth, productivity, fruit characteristics, and cold tolerance
- adapted to deep, coarse sandy soils
- resistant to burrowing nematode
- additional care needed for young trees during first few years

- susceptible to *Phytophthora* foot rot
- susceptible to citrus blight

Rangpur

Rangpur recommended for Valencia orange

- similar to rough lemon in tree vigor, tree size, cold tolerance, high yields, large fruit size
- juice quality slightly better than rough lemon
- very salt tolerant
- susceptible to *Phytophthora* foot rot

Palestine Sweet Lime

Palestine sweet lime satisfactory for Valencia orange in warm areas

- well-adapted to deep, sandy soils
- equals rough lemon in cold tolerance, tree vigor and size, depth of rooting, fruit quality
- fruit size is unusually large
- possible use for self-incompatible mandarin hybrids such as Orlando tangelo that can set crops of parthenocarpic fruit and to induce maximum size in mandarin cultivars with small size

Volkamer Lemon

Volkamer lemon useful for warm sites with orange cultivars used for juice

- similar in behavior to rough lemon but juice quality superior
- adapted to a wide range of soils
- maximum productivity in short periods of time

Citrus Macrophylla

Citrus macrophylla used for Tahiti lime:

- maximum productivity in short periods of time

- large fruit size
- fruit does not store well on tree
- cold-susceptible
- resistant to *Phytophthora* foot rot
- salt tolerant
- poor juice quality
- susceptible to blight
- susceptible to tristeza

Cleopatra Mandarin

Cleopatra mandarin used for Hamlin and Pineapple oranges more than Valencia good for mandarin cultivars large enough to tolerate the reduction in fruit size.

- fruit quality is excellent and fruit stores well on tree
- a “lazy” rootstock, growing well but fruiting poorly until 10 to 15 years old
- produces moderate to large tree
- induces maximum cold-hardiness in the scion
- susceptible to blight
- susceptible to *Phytophthora* root rot in poorly drained sites
- highest salinity tolerance among commercial rootstocks

Sour Orange

Sour orange excellent for Hamlin, navel orange, and grapefruit

- produces tree of moderate vigor and size
- good yields on fertile soils
- produces good juice quality and good fresh fruit
- induces maximum cold-hardiness

- extremely susceptible to tristeza
- tolerant to *Phytophthora* foot rot but less so to root rot

Trifoliate Orange

Trifoliate orange used for satsuma tangerines, orange cultivars, and grapefruit:

- not used for mandarin hybrids because of bud union incompatibilities
- produces moderate-size trees on clay and loam soils; trees do not grow rapidly
- produces small fruit with some scions because of heavy fruit set
- fruit holds well on tree, except satsuma tangerines
- juice color excellent
- cold tolerant when maximum cold-hardiness is developed, but can be more susceptible to cold than sour orange or Cleopatra mandarin unless acclimatized to cold
- seedling tree, so thorny it can be used as a protective hedge; produces inedible seedy fruit
- deciduous as a seedling tree
- susceptible to blight + resistant to *Phytophthora* foot rot
- Flying Dragon is a trifoliate orange selection, the stem of which has an interesting curving pattern, along with re-curved thorns.

Carrizo Citrange

Carrizo citrange used for sweet orange, grapefruit, and mandarin types:

- a hybrid of sweet orange and trifoliate orange
- produces large, vigorous trees
- excellent growth in all soils except those with high calcium levels

- often displays symptoms of zinc, iron
- or manganese deficiency in spring flush

Swingle Citrumelo

Swingle citrumelo superior rootstock for grapefruit and navel orange:

- tree vigor and size vary according to scion
- cold tolerance equal to that of sour orange and Cleopatra mandarin
- suitable for most soils except highly calcareous soils.

⁴ See footnote

Appendix C. Recommended Scion/Rootstock Combinations

See Table 1.

Appendix D. Florida Citrus Harvesting Periods

See Table 2.

Fruit Characteristics

Citrus fruit matures slowly and does not ripen after harvest, unlike peaches or pears. Changes in juice content, sugar, and acid levels determine fruit maturity, with the acid content decreasing and the sugar content increasing as fruit matures. Commercial growers take fruit samples for analysis to determine if legal maturity standards have been reached, but homeowners can taste fruit to determine fruit maturity.

Citrus fruit may be stored on the tree long after it reaches maturity. Fruit usually improves in taste until the flesh begins to dry and the fruit drops. However, severe rust mite damage may hasten fruit dehydration and seed may germinate within grapefruit held on the tree too long. Grapefruit from the same bloom can usually be harvested from October through May or later. Fruit of orange cultivars cannot be held on the tree as long; mandarin cultivars can be

held an even shorter time because they become puffy. Lemons and limes can be used whenever they have enough juice.

Ease of peel removal varies among cultivars.

Loose-skinned mandarin types are the most easily peeled. Navel, Ambersweet, and Temple cultivars peel more easily than oranges. Seed content varies from fruit to fruit on the same tree. However, fruit with 0-6 seeds are regarded as commercially seedless. The seed content of most cultivars is increased with cross-pollination.

Cold tolerance differs in the trees of various cultivars. Mandarin cultivars are the most cold tolerant, with the exception of Temple and Fallglo. Sweet oranges rank next in cold tolerance, closely followed by grapefruit. Lemons and limes are far less cold tolerant. In general, citrus trees are more cold tolerant after the crop has been harvested because the canopy is more compact and retains more heat during freezes. Cold tolerance of fruit differs from the cold of trees and is related to peel thickness and larger fruit, because of their greater mass, are usually more cold tolerant than smaller fruit. Grapefruit is usually the most cold tolerant because of its thick peel, followed by oranges, mandarins, lemons and limes. Most frozen fruit will drop within a few days after a freeze. Fruit remaining on the tree will dry out with time, with the degree of juice loss being related to cultivar, severity, and duration of freezing temperatures. If harvested within several days after a freeze, such fruit can still be salvaged for juice. Slightly damaged 'Valencia' fruit will often recover some juice content if the freeze occurs before the end of January.

Cool fall and winter temperatures intensify peel color, which is closely related to eating quality. Fruit sometimes will not develop the desired color in Florida and in tropical areas with mild climatic conditions. Mandarin cultivars vary widely in color, with some being dependent on low temperature for color development than others. Grapefruit develops an excellent peel color even in the hottest climates, but the green color changes to yellow earliest in cooler climates. Lemons are usually de-greened with ethylene to develop yellow color. Limes are not temperature dependent with regard to color. Flesh

color is similarly affected but to a lesser degree. Early-maturing cultivars generally are not as well colored as mid- and late-season ones, and the better-colored, late-maturing cultivars may actually re-green to some extent if held on the tree until late in the season. Fruit grown in cooler climates usually contains more acid.

Adapted from *Florida Citrus Varieties*, D.P.H. Tucker, C.J. Hearn, and C.O. Youtsey. Fla. Coop. Ext. Ser. Bul. SP 102.

Glossary

BUDDING Budding is a type of grafting where the scion consists of a single bud attached to a piece of bark with a thin sliver of wood underneath. The inverted T-bud and the chip bud are budding methods most commonly used in Florida.

CULTIVAR A cultivar is a horticultural variety that has originated and persisted under cultivation (not necessarily referable to a botanical species) and of botanical or horticultural importance, requiring a name. Single quotation marks are usually placed around the name of the cultivar as in 'Hamlin' oranges.

DOLOMITE A material used for liming soils in areas where magnesium as well as calcium are needed. Dolomite is made by grinding dolomitic limestone which contains both magnesium carbonate, $MgCO_3$ and calcium carbonate, $CaCO_3$. In strict chemical terminology, lime refers only to calcium oxide (CaO) but the term "lime" is commonly used to refer to all limestone-derived materials applied to neutralize acid soils.

GRAFTING Grafting is a specialized type of plant propagation wherein part of one plant (the scion) is inserted into another (the rootstock) so that they unite and grow as a single plant.

MANDARIN Sometimes used synonymously with "tangerines," are loose-skinned citrus of small to medium size. They have an open core in the fruit, a distinctive flavor and aroma, with considerable cold tolerance.

POTASH This term generally refers to potassium oxide (K_2O). Wood ashes are also a source of potassium.

PROPAGATION Plant propagation is the art and science of reproducing plants while preserving the unique characteristics of that plant from one generation to the next.

QUIESCENCE A period of non-apparent growth that citrus trees in northern and central Florida experience as cooler temperatures occur. In the warmer areas of southern Florida, in Central and South America, citrus trees seldom become completely quiescent.

Additional Notes:

3. Recommended reading: Florida Citrus Varieties, Bulletin SP102, by D.P.H. Tucker, C.J. Hearn, and C.O. Youtsey, University of Florida, Institute of Food and Agricultural Sciences.
4. For additional information, see Rootstocks for Florida Citrus, Bulletin SP42, by W.S. Castle, D.P.H. Tucker, A.H. Krezdorn, and C.O. Youtsey. University of Florida, Institute of Food and Agricultural Sciences.

Table 1. Recommended scion/rootstock combinations.

Location in Florida	Scion/Rootstock	Primary/Secondary Use
North	sweet orange/Cleopatra mandarin	juice/fruit
	mandarins/Cleopatra mandarin	fruit
	grapefruit/sour orange	fruit/juice
	navel orange/sour orange	fruit
	Hamlin orange/sour orange	juice/fruit
	satsuma tangerine/trifoliate orange	fruit/juice
	sweet orange/trifoliate orange	juice/fruit
	grapefruit/trifoliate orange	fruit/juice
	grapefruit/Swingle citrumelo	fruit/juice
	navel orange/Swingle citrumelo	fruit
Central	Valencia/rough lemon	juice/fruit
	Valencia/Milam lemon	juice/fruit
	Valencia/Rangpur lime	juice/fruit
	sweet orange/Cleopatra mandarin	juice/fruit
	mandarin/Cleopatra mandarin	fruit
	grapefruit/sour orange	fruit/juice
	navel orange/sour orange	fruit
	Hamlin orange/sour orange	juice/fruit
	satsuma tangerine/trifoliate orange	fruit/juice
	sweet orange/trifoliate orange	juice/fruit
	grapefruit/trifoliate orange	fruit/juice
	sweet orange/Carrizo citrange	juice/fruit
	grapefruit/Carrizo citrange	fruit/juice
	mandarin, mandarin types/Carrizo citrange	fruit/juice
South	Valencia/Palestine sweet lime	juice/fruit
	mandarin/Palestine sweet lime	fruit
	mandarin types/Palestine sweet lime	fruit
	sweet orange/Volkamer lemon	juice
	Tahiti lime / <i>Citrus macrophylla</i>	juice
	sweet orange/Cleopatra mandarin	juice/fruit

Location in Florida	Scion/Rootstock	Primary/Secondary Use
	mandarin/Cleopatra mandarin	fruit
	grapefruit/sour orange	fruit/juice
	navel orange/sour orange	fruit
	Hamlin orange/sour orange	juice/fruit
	satsuma tangerine/trifoliolate orange	fruit/juice
	sweet orange/trifoliolate orange	juice/fruit
	grapefruit/trifoliolate orange	fruit/juice
	sweet orange/Carrizo citrange	juice/fruit
	grapefruit/Carrizo citrange	fruit/juice
	mandarin hybrid/Carrizo citrange	fruit/juice

[illegible]

Table 2. Florida citrus harvesting periods.

[illegible]