

2018–2019 Florida Citrus Production Guide: Citrus Cold Protection¹

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There has been no other single factor that has affected the historical distribution of Florida citrus other than freezing temperatures. Since the introduction of citrus by the Spanish in the 1500's freezing temperatures have dictated where the citrus production areas in Florida are located.

Early citrus production in Florida relied on principles of passive cold protection practices to mitigate freezing temperatures affects. Passive principles of cold protection are decisions that are made prior to planting the citrus trees. Site selection, horticultural selections, and cultural practices are considered passive methods. Another way to view these practices are those that do not require the grower to actively participate in cold protection of citrus during a freeze event.

Passive Methods of Cold Protection

Traditionally, site selection decisions that would result in a higher level of protection from cold would be planting on higher elevation ground to better facilitate cold air drainage. Selecting areas on the south and southwest side of lake and or large bodies of water as they are warmer during freeze events. Planting in close proximity to natural wind breaks can reduce wind speeds helping in retaining natural heat stored in the grove. Geographically areas further south along the Florida peninsula are warmer than locations

in north Florida. Soil texture can also affect minimum temperatures in a given grove and citrus freeze damage. For example, white colored lighter sand-sink soils are many times significantly colder on a given freeze night than other soil types.

Horticultural selection of citrus rootstocks and varieties can influence the susceptibility of trees to freeze damage. Citrus rootstock selection can often result in success or failure of a citrus grove in a particular geographical location. Generally, the more vigorous the rootstock, the more susceptible the tree will be to freeze damage. Rough lemon, Volkamer lemon, and Carrizo citrange are vigorous rootstocks and are more sensitive to freezing temperatures. Cleopatra mandarin and Swingle citrumelo are considered slower growing and therefore more cold tolerant. During the freezes of the 1980's, it was not unusual to observe the groves grown side by side, Rough lemon were killed to the ground while trees on Sour orange received some damage, but did recover. Having said this, if the minimum temperatures is critical or if the durations are significant, no rootstock is resistant to freeze damage, as it was observed in 1980's freeze in north and central Florida. The selection of citrus varieties used in a particular grove location should be influenced by the probability of freezing temperatures. Mandarin or tangerine trees are considered more cold tolerant than orange trees and orange trees are considered more cold tolerant than grapefruit trees. The time of fruit maturity can

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also have an effect on the profitability of a particular grove depending on the probability of freezing temperatures. Early maturing varieties that can be harvested before freezing temperatures can result in growers making a profit in areas where later maturing varieties would receive fruit damage. The crop load on trees during the winter can influence cold tolerance. Pineapple oranges and Murcott tangerines with excessive crop loads (on years) have been shown to be more susceptible to freeze damage.

Cultural practices can also provide some degree of cold protection. Practices such as increasing soil moisture during the day prior to the freeze can increase the thermal conductivity of the soil allowing for this stored heat to be released overnight. In addition, during the winter, tree water status should be maintained at a levels that reduce fruit drop and prevent water stress without stimulating vegetative growth. Citrus trees under drought stress are also more susceptible to freeze damage. Row middle management in the form of low growing turf, clean row middle management (by discing or by trunk to trunk herbiciding) can increase the solar interception of the soil, storing heat during the day. Tall growing weeds in row middles reduce the soil solar interception and may create cold air dams that impede the drainage of cold air from a grove. Nutritional status of the citrus tree can affect the susceptibility to freeze. No single nutritional element will affect the cold hardiness of citrus trees, although excessive nutrition and nutritional deficiencies can lead to an increase in freeze susceptibility.

Active Methods of Cold Protection

Passive cultural practices can only provide a certain level of protection. Active cultural practices are used by growers during a freeze to reduce the freeze damage to citrus trees. During the 1900s a number of these active cold protection practices were used by growers to reduce freeze damage to citrus trees. These practices included heating, wind machines, low volume irrigation, and tree wraps for young citrus trees.

Heating a citrus grove involves the use of grove heaters burning fossil fuel to prevent temperatures from reaching a critical temperature. Heating is very effective in protecting trees and fruit from freeze damage. Years ago this was one of the more common methods to protect citrus trees and fruit. Depending on the grove, usually 35 to 40 heaters per acre were used. These heaters would burn about 1 gallon of fuel oil per hour. This type of system is quite labor intensive and expensive due to the initial cost annually associated with setting out and picking up the heaters at the end of the winter. Additionally, refueling and lighting of heaters

before and during freeze events added to these costs. Environmental concerns such as fuel spills in and around the heaters and the need for infield refueling after a freeze. These problems, along with fuel costs and the fuel shortage of the 1970s, have resulted in the disuse of grove heaters in Florida citrus.

Wind machines are used extensively in 'cold pockets', which are depressed areas of elevation in the "ridge" production region where dense cold air drains on radiation freeze nights. One wind machine will protect about 10 grove acres if properly located. Wind machines need the development of a strong temperature inversion reversal at the height of the machine (about 30 feet above the ground) in order to be effective. Temperature inversions develop only during radiation type freeze events. Cold air at the surface cools and displaces warmer air to levels above the ground where the warmer air is mixed by the wind machine, increasing grove temperature to an average of the volume of air mixed. The development of inversions can be monitored with the Florida Automated Weather Network (FAWN) tower locations by looking at the difference between 2 foot and 30 foot temperatures. FAWN data can be accessed on the following website: <https://fawn.ifas.ufl.edu>.

Low volume microsprinkler irrigation is the most widely used method in the Florida citrus industry to protect citrus trees from freezing temperatures. Early attempts in 1962 to use overhead irrigation for freeze protection resulted in widespread damage to trees due to insufficient volumes of water being applied. This resulted in growers being reluctant to use irrigation for cold protection until the early to mid 1980's. Widespread use of microsprinklers in the early 1980's allowed growers to apply sufficient volumes of water directly under and on the lower portions of citrus trees resulting in protection of these trees from freeze damage. Irrigation used for freeze protection is based on a few simple principles. First, the benefit from the sensible heat of water that is released when water hits the tree. This sensible heat is due in large part to the actual temperature of well water (about 68°F). There may also be some additional benefit if irrigation can cause the development of fog in the grove that in turn will reduce the rate of temperature fall during the night (this is highly dependent on the dew point temperature). Secondly, the process of water turning to ice (called the latent heat of fusion) releases additional heat to the grove microclimate. The formation of ice also helps in insulating plant tissues above critical temperatures. Current recommendations call for application rates of 2000 gallons per acre per hour to protect trees from freezing temperatures. During radiation freezes,

water applied under the canopy of citrus trees modifies the tree microclimate resulting in limited protection of the tree and fruit from freeze damage. This modification of the tree microclimate decreases with height above the irrigation source. Generally, irrigation under mature trees will provide little protection of fruit on the exterior canopy of the tree, but may limit damage to fruit located closer to the microsprinkler. During advective freezes, mature trees may not typically benefit from irrigation but this would be highly dependent on evaporative cooling and the amount of irrigation heat removed from the grove due to increased wind speeds. Microsprinklers can provide excellent protection of young citrus trees from such freeze damage. Microsprinklers should be located on the north or northwest sides of the tree no further away than 2 to 3 feet. This will allow winds during an advective freeze to blow water at the tree. The type and pattern of emitter used is critical. Emitters should be the fan type, either a 90° or 180° pattern applying a uniform distribution of water at the tree. This condition should provide for excellent protection of young citrus trees. Another version of this system would be to elevate 360° fan type micro sprinklers on pvc stakes of 24 to 36 inches in length in the center (2 to 4 inches from the trunk) of young trees. The emitter tubing should be wrapped around the pvc stake to eliminate ice formation pulling down the elevated emitter. This system has been shown to provide additional protection to greater heights in young citrus trees. Before making a decision on using irrigation for cold protection, a grower must understand some of the potential issues. Low volume irrigation works as long as the heat added to the grove (sensible and the heat of fusion) is greater than that what is lost. Heat losses from a grove when using irrigation will generally come from evaporative cooling. This process occurs when dew point is low and evaporation of water exceeds the of ice formation. It takes 7.5 gallons of water freezing to equal the heat lost in one gallon of water evaporating.

This demonstrates the importance of knowing the effect of dew point and wind speed on the effectiveness of low volume irrigation. Another consideration is the power source of the irrigation system. Growers using electricity to power their irrigation systems should exercise caution. In past freezes, rolling power outages during peak demand have resulted in damage to citrus groves due to inadequate irrigation caused by iced plugging up emitters. Growers in this situation need to evaluate contingency plans for back up power sources. Growers also need to determine a critical temperature start time if micro-irrigation for cold protection. The start time needs to be prior to any

formation of ice in the irrigation tubing otherwise the freeze protection can get compromised.

Tree wraps are used to protect the trunk and bud union of young citrus trees recently planted in the grove. The effectiveness of tree wraps is directly related to the insulating properties of the wrap used. Tree wraps are designed to reduce the rate of temperature fall around the trunk of young citrus trees. This reduction in the rate of temperature drop allows for critical temperatures to be reached after sunrise past the time of minimum temperature. There are a number of tree wraps available in the market today. Research has shown that some very poor insulating wraps can cause temperatures under the wrap to be lower than air temperature. Care should be used when determining if the tree wrap chosen will provide for adequate protection of the tree trunk. Tree wraps with good insulating properties have been demonstrated to be quite effective, yet most growers have tended to rely solely on irrigation for freeze protection in the past 20 years. Young citrus trees are more susceptible to freezing temperatures than mature trees and wraps could be an attractive alternative to entire grove irrigation when protection is needed for only young trees.

To summarize, there are a number of citrus cold protection practices or decisions growers can make to insure the success of a grove in surviving freezing temperatures. Some of these would be done prior to planting, but there are additional practices that can be deployed in an established grove.