

# CITRUS COLD PROTECTION PRACTICES

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**T**his time of year Florida citrus growers become more concerned with the threat of freezing temperatures. Citrus trees with good acclimation to cold can survive many of the freeze events that occur.

Freeze survival and profitability don't necessarily always go hand in hand. In many marginal freeze events, a benefit of just a few degrees in air temperature can determine the difference between making a profit or having a loss.

It is documented that citrus foliage (of the most cold-tolerant cultivars) having acclimated to winter temperatures can survive freezes as low as 14°F. The degree of acclimation is variable and directly related to citrus variety and minimum air temperatures during the previous two weeks. Over the last few winters these critical leaf freezing temperatures for mature orange tree leaves have ranged from 18°F to 24°F. Unfortunately, citrus fruit are not as tolerant to freezing conditions as the foliage or the tree. Freeze damage in citrus fruit is related not only to the variety, but also the

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minimum temperature and duration of these low temperatures.

When talking about cold protection practices in Florida citrus, we divide these into two categories: passive and active.

## PASSIVE PROTECTION

Passive practices of cold protection are those that do not require the grower to actively participate in cold protection during a freeze. These practices include site selection, cultural practices and horticultural selections.

Site selection can have a dramatic effect on the occurrence of freezing temperatures. Generally, the further south in Florida you go, the warmer the winter temperatures become and the fewer the freeze events that occur. This may not always hold true, and growers looking at new or existing grove land should have information on historical minimum temperatures for

that specific location.

Lower elevations are generally colder than higher locations during radiation (calm wind) freezes. Elevation during an advective (windy) freeze generally has little or no effect. Properly designed windbreaks can significantly reduce wind speed during an advective freeze. The slowing of wind speed helps to retain natural heat stored in a grove from being blown out. During a radiation freeze, a windbreak will have little effect on minimum temperatures. When winds blow from the north or northwest, groves located close to large bodies of water or located on the south or southeast side of lakes are generally warmer during all types of freezes in Florida.

Certain cultural practices can have a pronounced effect on the ability of citrus trees to survive freezing temperatures. Oftentimes, a small change in air temperature can result in significant differences in the amount of freeze damage.

Soil moisture can influence minimum temperature in a citrus grove. Soils with higher water content will be warmer than soils with lower water content. In the past, growers with overhead irrigation would wet the soil prior to a freeze to increase soil moisture content. This increased the capacity of the soil to store heat during the day. Precipitation associated with the passage of cold fronts prior to a freeze will provide the same effect. Conversely, lighter, drier soils can be colder in a radiation freeze. During advective freezes, soil moisture has less of an effect on grove temperature.

Row middle management can also affect the microclimate of a citrus grove. Cultivated or closely mowed row middles (Figure 1, page 8) have been shown to be a little warmer than groves where weeds are allowed to become excessively tall. Excessive weed growth acts as an insulator, preventing sunlight from reaching the soil surface during the day. Rank weed growth can also impede cold air drainage out of the grove during radiation freezes.

Citrus nutrition can also influence a citrus tree's ability to survive freezing temperatures. Previously, researchers have tried to isolate what specific

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mineral nutrients had the greatest impact on freeze damage to citrus trees. A summary of the research data indicates that there is no single nutritional element that will increase the cold tolerance of citrus to freezing temperatures. Although it is extremely important to maintain adequate mineral nutrition in citrus trees during the winter, trees that are stressed due to lack of proper nutrition will often be more susceptible to — and damaged more — by freezing temperatures.

Citrus irrigation and tree water status also play an important role in the susceptibility of citrus trees to freezing temperatures. Although difficult to quantify, indications are that excessive irrigation during the winter can result in an increase in “free water” in the tree. This “free water” between plant cells is more susceptible to freezing at temperatures closer to 32°F than water contained in plant cells. A reduction in irrigation during the winter has resulted in less freeze damage of trees, compared to



**Figure 1.** Groves can be made warmer during the winter with cultivated or closely mowed row middles.

trees receiving excessive irrigation during the winter. Realistically, growers have little control over rainfall, but can have an effect on the amount of irrigation water applied. Irrigation should only be scheduled during the winter to prevent fruit drop and excessive tree water stress.

The selection of rootstocks and varieties influence the susceptibility of citrus trees to freeze damage. Citrus rootstock selection can often result in

success or failure of a citrus grove in a particular location. Generally, the more vigorous the rootstock selection, the more susceptible the tree will be to freeze damage. It was not unusual to see groves of rough lemon and sour orange growing side by side when the severe freezes of the 1980s occurred. In these situations, trees on rough lemon were killed to the ground while trees on sour orange received damage, but did recover in some areas. It should be noted that if the

freeze is severe, all unprotected citrus rootstock varieties are susceptible to damage as we have seen in the areas of north central Florida in the 1980s. 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.



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**Figure 2.** Wind machines can be helpful in increasing grove temperature.

The time of fruit maturity can 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 freeze damage to fruit. Citrus tree stress associated with a large crop load during the winter can influence cold tolerance. Pineapple oranges and Murcott tangerines with excessive crop loads have been shown to be more susceptible to tree freeze damage. Post-harvest tree stress in the days following harvest can render citrus trees more susceptible to cold temperatures. This condition usually subsides in three to 10 days.

There are a number of passive practices or decisions growers can make to ensure the success of a grove in surviving freezing temperatures. Some of these would be done prior to planting, but some can be incorporated into existing grove operations.

### ACTIVE PROTECTION

Active practices are those used by growers during a freeze to reduce the freeze damage to citrus trees. These include wind machines, low-volume irrigation and tree wraps for young citrus trees.

Wind machines are used extensively in what are called cold pockets. These cold pockets are located in depression areas of the “ridge” production area where dense cold air will drain on radiation freeze nights. Wind machines need a strong temperature inversion

at the level of the machine (around 30 feet above the ground) in order to be effective. These 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 (Figure 2), increasing grove temperature to an average of the volume of air mixed. The development of inversions can be monitored for FAWN (Florida Automated Weather Network) tower locations by comparing the 2-foot and 30-foot temperatures shown. This FAWN data can be accessed by telephone or online with a computer that has Internet capabilities at <http://fawn.ifas.ufl.edu>.

Low-volume irrigation using microsprinklers is the most widely used method in the Florida citrus industry to protect citrus trees from freezing temperatures. Early attempts to use overhead irrigation in the 1962 freeze resulted in widespread damage to trees due to insufficient volumes of water being applied for the freeze conditions. This resulted in growers becoming very reluctant to use irrigation for cold protection until the early-to mid-1980s.

Widespread use of microsprinklers in the mid-1980s allowed growers to apply sufficient volumes of water directly under and on the lower portions of citrus trees (Figure 3), resulting in protection of these trees from cold damage. Irrigation used for freeze protection is based on a few simple principles. First, there is benefit from the sensible heat of the irrigation water that is released when water hits

the tree. This sensible heat is due to the actual temperature (about 68°F) of well water. Second, there can also be some additional benefit if this micro-sprinkler irrigation can saturate/humidify the air, causing the formation of fog in the grove. This saturation of the air will reduce the rate of temperature fall during the night (this is highly dependent on the dew point and air temperature). Third is the process of water freezing to ice (called the latent heat of fusion) that will also add additional heat to the grove’s microclimate.



**Figure 3.** Ice formed from irrigation on the underside and lower portions of citrus trees offers freeze protection.

The formation of ice will also help insulate plant tissues, keeping them above critical temperatures. Current UF/IFAS recommendations call for water application rates of 2,000 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 some protection of the tree canopy from freeze damage. This modification of the tree microclimate (canopy density effect) decreases with height above the irrigation source and is significantly influenced by the presence

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or absence of wind. Microsprinkler irrigation under mature citrus trees will provide for only very limited protection of fruit on the exterior canopy of the tree. A recent study has demonstrated that a maximum 4°F increase in air temperature occurred within a citrus tree canopy with microsprinkler irrigation (2,363 gallons/acre/hour) during a radiation freeze event.

During advective freezes, mature trees may receive some limited benefit from irrigation, but this would be highly dependent on evaporative cooling and the amount of heat removed from the grove due to increased wind speeds.

Microsprinklers can provide excellent protection of young citrus trees from freeze damage. Microsprinklers should be located on the north or northwest sides of the tree no farther 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 microsprinklers on PVC stakes of 18 to 24 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 possible problems. Low-volume irrigation works as long as the heat added to the grove (sensible heat plus the heat of fusion) is greater than that which is lost. Heat losses from a grove when using irrigation will generally come from evaporative cooling. This process occurs when dew points are low and evaporation of ice exceeds that of ice formation. It takes 7.5 gallons of water freezing to equal the heat lost in one gallon of ice evaporating. This demonstrates the importance of knowing the effect of dew point and wind speed on the effectiveness of microsprinkler irrigation.

Another consideration is the power source of the irrigation system. Growers using electricity to power their irrigation systems should exercise caution. If water flow ceases, ice will rapidly form in irrigation tubing, preventing flow should water flow resume. In past freezes, rolling power outages during peak demand have resulted in dam-

age to citrus groves due to irrigation plugging caused by iced-up emitters. Growers in this situation need to evaluate contingency plans for back-up power sources.

Growers need to determine a critical temperature start time if microsprinkler irrigation will be used for cold protection. This start time needs to occur prior to the formation of ice in the irrigation tubing. The FAWN system at <http://fawn.ifas.ufl.edu> has several tools available for citrus growers to use when making cold protection decisions. One of these tools is a “Text Message Freeze Alert System” that will alert your email or cell phone when a critical temperature occurs in your area which may trigger a cold protection action on your part.

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 under the wrapped trunk of young citrus trees. This reduction in the rate of temperature drop prevents the citrus tree trunk from reaching the critical minimum temperature at which injury occurs. There are many different styles of tree wraps available on the market today. Research has shown that some very poor insulating wraps can cause temperatures under the wrap to be lower than air temperatures. 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 15 years. Young citrus trees are more susceptible to freezing temperatures than mature trees, and wraps could be an attractive and effective supplement to entire grove irrigation when protection is needed for only young trees.

In closing, growers are all too fully aware of the detrimental effects of freezing temperatures to Florida citrus. In mitigating these potential adverse effects, growers should consider all the available methodologies — including passive and active cold protection practices — because a few degrees temperature can have a significant effect on freeze damage and grower profitability.

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