Microsprinkler irrigation for COLD PROTECTION of Florida citrus

By L.R. Parsons
and B.J. Boman

Millions of boxes of fruit and thousands of acres of citrus trees have been lost in freezes and frosts. Oranges are usually damaged when the fruit are exposed to temperatures of 28°F or lower for four hours or more. As the temperature gets colder or durations below 28°F get longer, damage to fruit, leaves, twigs, and eventually large branches increases.

Low volume undertree microsprinkler irrigation has proven effective during several freeze nights in Central Florida tests. In addition to frost protection, microsprinklers can provide effective year-round irrigation. Microsprinklers, or spray jets, are small, low-volume irrigation sprinklers that discharge five to 50 gallons/hour. In citrus groves, the most commonly used spray jets discharge from five to 25 gallons/hour and cover a diameter of five to 21 feet. Usually one or two microsprinklers per tree are installed at the ground level or on short risers. Microsprinklers do not commonly wet leaves and branches above a height of about 3 feet.

EFFECTIVENESS

Microsprinkler irrigation is more effective for cold protection when high volumes of water are used. A system that delivers the maximum amount of water per acre and is practical or affordable is best for frost protection. Irrigation rates of 2000 gallons/acre/hour or 33.3 gallons/acre/minute are recommended. This can be accomplished with one 20 gallon/hour jet or two 10 gallon/hour jets per tree in a grove with 100 trees/acre. If there are 200 trees per acre, then one 10 gallon/hour jet is adequate. Rates below this level will provide some protection, but not as much as higher rates. Application rates of 3000 gallons/acre/hour or more are more effective at lower temperatures.

At high application rates, average warming with spray jets at a 4-foot height is only 2-3°F. Spot readings have occasionally shown temperature increases of 4°F or more, but 1°F or less is also common during freeze nights. At heights greater than 8 feet, warming is usually less than 1°F. When compared to a non-irrigated area, lower volume systems provide slight warming, but higher volume systems (2000 gallons/acre/hour) provide more warming.

Low irrigation rates can provide some, although not much, protection on calm frost nights. While a small amount of water can provide a little protection, it is generally best not to go below 10 gallons/hour/tree. Emitters that put out less than 10 gallons/hour usually have small orifices that can plug easily. If a jet next to a tree is plugged, that tree will suffer more damage or may be killed.

Microsprinklers can provide some protection to leaves and wood, particularly on the lower and inner part of the canopy. A dense canopy tends to retain heat from the soil and provide better protection than a thin canopy. Damage will commonly be seen on the outer and upper parts of the tree after severe freezes. Since fruit is more sensitive to cold temperatures than leaves or wood, microsprinklers generally do not protect the fruit. At higher volumes, spray jets will help protect fruit a little better than no irrigation, but generally microsprinkler irrigation is best for tree protection rather than fruit protection.

There is a limit to the effectiveness of microsprinklers. Factors such as tree health, rootstock, and cold acclimation affect tree survival. Depending on volume of water applied, the lower limit of effectiveness for microsprinkler irrigation is around 17°F. The lower parts of young trees have been protected to even colder temperatures, but damage usually increases as it gets colder.

YOUNG TREE PROTECTION

Microsprinklers have been effective in protecting the bud union and lower portion of young trees. In young trees, the microsprinkler protects the lower trunk by the direct application of water. When water freezes, it releases heat. If the application rate is high enough, the freezing water will maintain the trunk at a temperature near 32°F.

The spray jet must be close enough to the young tree so that water sprays directly on the trunk and lower part of the tree. Recommended distances between the trunk and the jet are 1 to 2.5 feet. If the jet is too far away from the young tree, wind can blow the water away. If the water freezes before it hits the tree, milky white ice can form on the tree. Protection under milky ice is usually not as good as under clear ice.

During most Florida freeze nights, the wind comes from the north or northwest, making it best to put the jet on the north or northwest (upwind) side of the tree. In this position, the wind will carry the water into the tree and not away from it.

Seeing protection only in the iced zone on young trees is common. Damage commonly occurs, particularly in severe freezes, above the iced zone or where no water was run. Young trees are usually more sensitive to cold and do not retain heat as well as mature trees. Therefore, protection down to 17°F cannot always be assured even if the tree is in good health.

Insulating tree wraps placed around the trunks of young trees slow the rate of temperature fall. Tree wraps alone provide some trunk protection. Tree wraps in combination with microsprinkler irrigation provide even better cold protection insurance. If the irrigation system fails during the night, the tree wrap (particularly if it is a good insulator or has enclosed water pouches) can slow the temperature drop and protect the tree longer.

OPERATION OF MICROSPRINKLERS ON FREEZE NIGHTS

For cold protection, a microsprinkler system must be designed to provide water to the entire block or grove all at once. An irrigation system that can apply water only to smaller zones is not satisfactory for freeze protection. Hence, a system designed for freeze protection is initially more expensive to install because it handles a larger volume of water.

Compared to higher pressure overhead systems, microsprinklers operate at relatively low pressures of 20 to 25 psi. Because of this low pressure and the small openings in the emitters, spray jets can freeze up if

they drop below 32°F before the water is turned on. Hence, the water should be turned on before the temperature reaches 32°F so the jets do not freeze. On frost nights, it is recommended that microsprinklers be turned on when the air temperature reaches 36°F. Be careful of thermometer placement, because in low-lying cold pockets, the ground surface can be below 32°F when it is 36°F at the thermometer location. When spray jets ice up, they are very difficult to thaw and usually the emitters must be replaced in the field.

Once the microsprinklers are turned on, the system must keep running all night. If the system stops or fails when the temperature is below 32°F, it will be very difficult to restart the system because the emitters can rapidly freeze up. The situation becomes especially critical for young trees if the system fails when the temperature is below freezing.

If the irrigation system stops, the trunk can rapidly drop below the actual air temperature by evaporative cooling. Thus, more tree damage can occur than if the jets were never turned on. Even if the system has only stopped for a short time, many of the emitters probably will have frozen and getting the entire system fully operational again will be difficult. Because of evaporative cooling, damage can be greater to trees in the area where a system stopped during a freeze night than where the system kept operating continuously.

Do not turn off a system when the temperature is near the critical tree killing temperature. If the pumping system is unreliable or if the pump is electrically driven in an area that commonly has electrical interruptions on freeze nights, it may be wise to convert to a more reliable system.

In the morning, when the temperature warms up, waiting until all the ice has melted before turning off the system is not necessary. Generally speaking, if the air temperature (dry bulb) has risen to 40 or 45°F, the irrigation system can be turned off safely. If the grove contains only mature hardened off trees, the system can be turned off at 40°F.

Under the most adverse conditions of low dew point and high wind, the grower may want to wait until the temperature is above 45°F. If it is a two-night freeze and the daytime temperature never gets above 40°F, then the system should be run continuously throughout the day and into the second night. If drainage or water conservation is of major concern, the system can possibly be turned off slightly before 40°F under less severe non-windy conditions, but that increases the freeze damage risk.

OPERATION ON WINDY NIGHTS

Like other methods used for citrus cold protection, microsprinklers are less effective during windy or advective freeze nights. They provide little or no protection to mature trees. There is a risk when using water during windy or low humidity freezes. When dew point temperatures are low and winds are high, high evaporation rates can occur and cool the wetted part of a tree below the air temperature. This happened in the windy 1962 freeze. Where overhead sprinklers were used, evaporative cooling occurred and trees were killed.

The irrigation application rate on the wetted area influences the level of protection. A higher application rate can protect trees to lower temperatures. One way to increase the application rate is to reduce the spray pattern size. This can be done by changing a 360° full circle spray pattern to a half circle (180°) or quarter circle (90°) pattern. This essentially doubles or quadruples the application rate by concentrating the amount of water on a smaller area. With a higher application rate, the protection level is better. Because of changing winds, a half-circle cap may do a better job of directing water into the young tree than a quarter-circle cap.

SUMMARY

Undertree microsprinkler irrigation is an affordable alternative to other forms of cold protection. It does not provide complete protection and generally will not protect fruit. Weak trees will receive little or no protection. On calm nights, microsprinklers have given partial protection to healthy and well-hardened trees down to 17°F. On windy severe freeze nights, little if any protection will be provided for mature trees, and only higher volume systems will provide protection for the lower portion of young trees.

This article is composed of excerpts from a University of Florida-IFAS document of the same name. The full article, published in 2003, may be found on the UF-IFAS EDIS web site at http://edis.ifas.ufl.edu/CH182