Understanding citrus cold-hardiness development for making management decisions

By Chris Oswalt and Timothy M. Spann

Cold hardiness in citrus is highly dependent on the vigor of the rootstock/scion combination, crop load, susceptibility of plant tissue, tree water status, nutrition and other cultural practices that affect tree vigor. These represent a combination of factors and interactions that are difficult to identify and quantify. Over the years, a number of methods to measure citrus cold hardiness have been developed, including freezing detached leaves, direct measurement of leaf cellular solute concentrations and leaf cellular leakage — all in an attempt to better predict citrus' response to freeze events so that wise management decisions can be made.

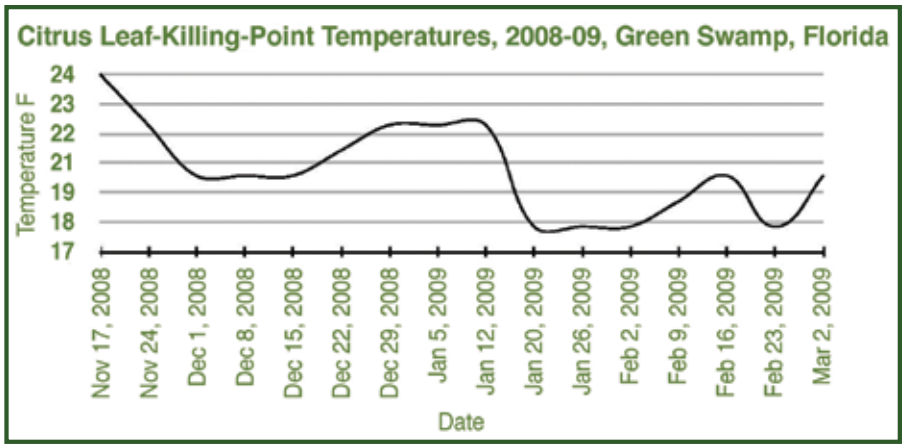

Figure 1. *Citrus leaf-freezing-point temperatures for the 2008-09 winter for sweet oranges in the Green Swamp.*

DETERMINING LEAF-FREEZING TEMPERATURES

Early studies on measuring citrus acclimation involved the freezing of detached leaves in a freeze chamber. This procedure used small temperature probes called thermistors attached to the leaf surface. The freeze chamber temperature was slowly dropped below freezing until an increase in leaf temperature was measured. This increase in leaf temperature is called an exotherm. An exotherm is a measurable increase in temperature as water freezes to ice. These exotherms in the test chamber were produced by heat given off when cellular water froze. The temperature at which this exotherm occurred was considered the citrus leaf-freezing-point temperature. This method was found to produce mixed results, and the process has since been modified to produce a more accurate evaluation of acclimation in citrus leaves.

In the mid-1980s, researchers in

Florida developed a new methodology to more accurately determine citrus leaf-freezing-point temperatures. This methodology used the measurement of cellular leakage to determine the leaf-freezing-point temperature. The process was further modified in the mid-1990s, and this procedure is the basis of how leaf-freezing-point temperatures are determined today.

Citrus leaves are harvested weekly from a set of trees that are randomly selected at the start of the season. Sets of trees of different rootstock and scion varieties and in different locations are used. The leaves are delivered or shipped to the lab for freeze-temperature analysis. Leaf disks are punched from these leaves using a paper hole punch, and five disks are placed in individual test tubes. The test tubes containing the leaf disks are placed in an ethylene glycol freeze bath. The temperature of the freeze bath is set at 28°F, and the disks are held for one hour. After the first hour, a subset of the samples is removed. The temperature of the freeze bath is then lowered by 2°F, and held for another hour, after which another subsample is removed. This procedure continues in 2° increments down to the last temperature of 16°F.

De-ionized water is added to each test tube containing the leaf disks after they are removed from the freeze bath. The samples are held overnight to allow for the contents of damaged cells to leak into the de-ionized water. The following day, the electrical conductivity of the solution containing the disks is measured and recorded for each test temperature, after which the samples are autoclaved and allowed to rest overnight. The following day, the electrical conductivity is remeasured on the autoclaved samples, representing 100 percent cellular damage. The post-freezing values are divided by the post-autoclaving values for each sample to determine percent freeze damage at each temperature. Graphs are plotted using percent damage and test temperature. The citrus leaf-freezing-point temperature is determined where the test temperature and 50 percent damaged value meet. The value of 50 percent has been shown to be the point where citrus leaf cells are damaged to the point of tree defoliation. This method has been consistent with field observations made after freeze events.

USING CITRUS LEAF-FREEZING-POINT TEMPERATURES

Determination of the critical temperature at which citrus leaves freeze

Stakeholders, Regulators Worked Together to Formulate CBS Rules

By Michael W. Sparks

When state inspectors discovered Citrus Black Spot (CBS) earlier this year in Southwest Florida, it was quite a shock to our industry, particularly fresh-fruit shippers.

Re-tooled canker regulations were only a year old, and all of a sudden, we were again facing a disease that could devastate our fresh-fruit industry.

But through the diligent effort of many people over the past 10 months, federal regulators recently issued the new CBS rules. Neither California, Texas, nor Florida are completely satisfied with the rules, but all parties concerned can live with them. I guess that makes it a good compromise.

The rule provides a marketplace for our fresh fruit from the regulated areas and will remain in place until CBS research (and peer review) can justify a rule revision.

I think the whole process is proof of what the various citrus-producing states and regulators can do when we all work together and communicate clearly.

As part of the rule, quarantines have been established in areas within an 8-mile radius of a CBS find. The two-tiered plan creates quarantine areas (1 mile from detection) and regulated areas (an additional 7 miles outside of the quarantine area).

Fresh-fruit shipments have to meet certain conditions, including packinghouse inspections and compliance agreements, disinfecting process protocols and transport in tarped vehicles.

Fruit from within the "quarantine" area will only be eligible for movement to non-commercial citrus-producing states east of the Mississippi River. Fruit from a "regulated" area will be eligible for movement to states other than commercial citrus-producing states.

Fresh fruit outside the quarantine and regulated areas may be shipped with no restrictions.

To view the entire order, visit www.flcitrusutual.com and go to the "Pest and Disease" page. Go to http://www.doacs.state.fl.us/pi/enpp/pathology/citrus-black-spot.html for maps.

I would like to offer a sincere thank you to the USDA's Animal Plant Health Inspection Service (APHIS), the Florida Department of Agriculture and Consumer Services (FDACS), grower Dan Richey, the Florida Citrus Packers and Mutual's counterparts in Texas and California for collaborating and expeditiously putting the CBS rule together. This took a lot of hard work to put the rule in place in time for the fresh season and everyone involved should be commended.

Michael W. Sparks is the Executive Vice President/CEO of Florida Citrus Mutual, the state's largest citrus grower organization.

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is an important factor when making cold-protection management decisions. The information can be used to measure citrus acclimation, amount of flower bud induction and the evaluation of cultural practices.

The citrus leaf-freezing point can be used to determine the amount of acclimation that has occurred during the winter. This can give growers an idea if or when cold-protection practices should be implemented. The change in citrus leaf-freezing-point temperatures during the winter [Figures 1 (page 10) and 2] can be used to help make these cold-protection decisions.

It is important that freezing-point temperatures be determined each season, and for each week during the season since the freezing-point temperature varies from season to season and throughout a season, depending on weather conditions (Figures 1 and 2). Citrus trees acquire a greater level of acclimation or depression in the leaf-freezing temperature through exposure to cool winter temperatures. The more hours of exposure to cool temperatures, the more quiescent the trees become and the lower their freezing point.

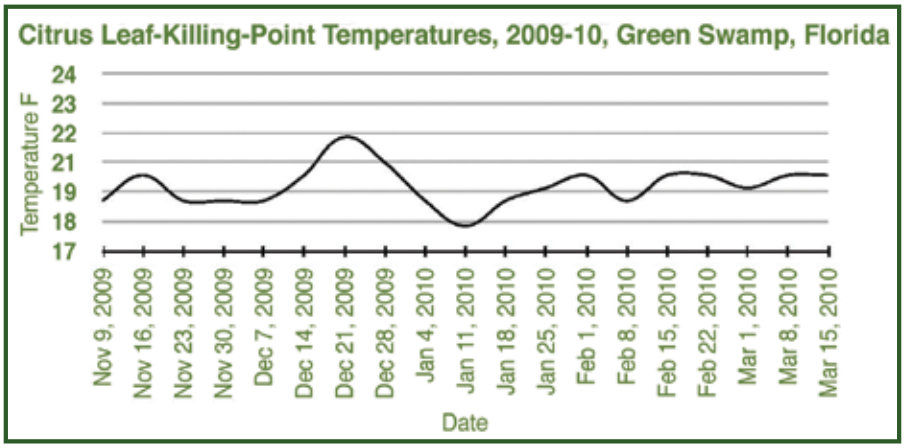

Figure 2. *Citrus leaf-freezing-point temperatures for the 2009-10 winter for sweet oranges in the Green Swamp.*

Citrus leaf-freezing points can be used as a guide for citrus growers in evaluation of winter cultural practices.

Reduced irrigation during the fall and winter enhances the formation of citrus flower buds in Florida and increases the cold hardiness of citrus trees. Studies have demonstrated that moderate water stress during the winter has resulted in a decrease in the amount of freeze damage to citrus trees as compared to trees that were well-watered or over-irrigated. Although studies analyzing the effects of mineral nutrition on the cold hardiness of citrus trees have not demonstrated a direct relationship, citrus leaf-freezing-point temperatures can provide insight into possible changes in acclimation brought on by fall and winter fertilization practices.

IRRIGATION FOR COLD PROTECTION

Today the preferred method for Florida citrus cold protection is microsprinkler irrigation. This methodology uses the heat released from the phase change of water to ice. The release of this heat and the insulating properties of ice protect citrus trees from freeze damage. Microsprinklers are very effective on young and moderately sized trees. The effect of microsprinklers for cold protection is reduced when used on large mature citrus trees. This is due to the limited amount of water applied and the volume of citrus tree canopy needing protection. Microsprinkler irrigation has a very limited effect on protecting citrus fruit up in the tree canopy. The majority of citrus fruit are located on the outer canopy of the citrus tree where microsprinkler irrigation will have a limited effect. Citrus leaves on mature citrus trees are also difficult to protect due to their location and small size.

The citrus leaf-freezing temperature can be used as a guide for determining the amount of cold hardiness or acclimation that has occurred in a citrus tree. Growers can use this

information in making decisions on whether or not to turn on their irrigation system for cold protection when predicted minimum temperatures are not forecast to reach the critical leaf-freezing temperature for their particular grove location. Accurate local forecast information is critical in making this determination. Growers should find a source of forecast information that they can have a high level of confidence in and fine-tune this forecast for their specific location. Citrus growers using this information can have a pronounced effect on the amount of water used for cold protection during the winter.

Conversely, knowing the critical temperature at which citrus leaves freeze will provide growers with the minimum temperature that leaves will survive. Once the wet bulb temperature exceeds the leaf-freezing-point temperature, the irrigation system can be turned off without causing leaf damage. Growers should determine a safety factor of a few degrees to account for variations in the citrus leaf-freezing-point temperatures due to differences in rootstocks, varieties and cultural practices. This information will allow citrus growers to timely turn off their irrigation systems, resulting in an additional water savings.

The authors would like to thank the Southwest Florida Water Management District for its funding of the citrus leaf-freezing-temperature determination project. During the winter, you can follow the citrus leaf-freezing temperatures at the FAWN Web site (http://fawn.ifas.ufl.edu/tools/coldp/crit_temp_select_guide_citrus.php).

Chris Oswalt is a multi-county citrus Extension agent based in Bartow, and Timothy M. Spann is a University of Florida-IFAS assistant professor at the Citrus Research and Education Center, Lake Alfred.

Nominees sought for Hall of Fame

Nominations for potential inductees to the Florida Citrus Hall of Fame are being accepted through Dec. 1. Nomination forms are available by visiting the Florida Citrus Hall of Fame Web site at www.floridacitrushalloffame.com or by contacting Florida Citrus Mutual at 863-682-1111.

Eligible nominees are those who have made significant contributions to the Florida citrus industry.

More information is available from John Jackson (jackson71344@yahoo.com) or Brenda Eubanks Burnette (bburne1003@aol.com).

FDOC Retail Programs Drive Orange Juice Sales

By Ken Keck

FDOC integrated marketing programs are designed to reach consumers at key touch points and make orange juice more relevant to their everyday lives. Supermarkets are a strategic location where up to 70 percent of purchase decisions are made. By focusing on the largest retailers that account for 75 percent of the total U.S. orange juice dollar volume, we can optimize limited dollars.

Our ongoing challenge is to deliver Florida citrus messages in the cluttered retail environment. We will execute some innovative marketing applications, combined with proven programs, to drive increased orange juice sales.

We'll use health and wellness messages to support and complement the new advertising campaign that helps people think about orange juice in new ways. As we try to inspire daily consumption by a younger consumer segment, "It's Just Juice & Families," we'll continue to reach and motivate our previous target of moderately health-conscious adults 35 years and older.

Today, more than half of all consumers plan ahead to save money when grocery shopping. FDOC will target Smart phone users as they search food, coupon and shopping lists sites with a strong call to action to purchase orange juice.

In more than 6,000 supermarkets, shoppers will hear a 30-second message on the in-store radio broadcast reminding them to pick up some orange juice.

FDOC will partner with 2,500 Wal-Mart stores to air Florida orange juice commercials on their in-store television screens up to 30 times per hour.

FDOC will also place informational messages on price tags at the point of purchase in select supermarkets. Descriptive tags will appear not only in front of orange juice, but also on complementary products such as cereal, and cold and flu items.

In 5,600 supermarket pharmacies, including 700 Publix stores, blood pressure machines will feature Florida orange juice signs and informational flyers.

To capitalize on the key cold and flu season, FDOC will offer collateral materials such as brochures, shopping lists and recipe cards to enhance retailers' flu shot programs.

Nationwide, FDOC will encourage retailers to distribute additional seasonal health and wellness brochures in front of orange juice displays, at customer service desks and in pharmacy departments.

Finally, we will generate excitement and drive multiple purchases of Florida orange juice by targeting consumers at the checkout. Shoppers who trade up to a purchase of two orange juice units can receive a free Florida Citrus cookbook.

Behind the scenes, our retail marketing team will continue to call on key personnel within top retailers and provide customized information to help each company grow their orange juice business versus the competition and to communicate Florida citrus information to shoppers.

These retail programs enable FDOC to reach millions of consumers nationwide with powerful orange juice messages. We will measure and evaluate retail marketing efforts to positively impact sales on behalf of Florida growers.

The mission of the Florida Department of Citrus is to grow the market for the Florida citrus industry to enhance the economic well-being of the Florida citrus grower, citrus industry and the state of Florida. Ken Keck, Executive Director, can be reached at 863-537-3999. For more information, visit www.FDOCGrower.com

Column sponsored by the Florida Department of Citrus
P.O. Box 9010, Bartow, FL 33831-9010