North Florida Research and Education Center
Suwannee Valley

Effect of Drip Irrigation Alone on Freeze Protection in Transplanted Watermelon Grown with Plasticulture

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The Suwannee Valley in Florida is a region that has a wide variety of vegetable crops grown. The major crops include: watermelon, potato, sweet corn, snap bean, cucumber, pepper, tomato, squash, and greens (collard and turnip). Production systems vary by crop, for instance; potato, sweet corn, snap bean, mustard, and pickling cucumber are usually grown on open ground culture with overhead irrigation; but watermelon, pepper, tomato, and slicing cucumber are almost always grown with plastic mulch and drip irrigation. Other crops, such as squash and greens, are produced on both systems in the Suwannee Valley.

The adoption of plastic mulch and drip irrigation in the Suwannee Valley began in the late 1980s and became the standard for watermelon, pepper, tomato, and slicing cucumber by the mid 1990s. The adoption of plastic mulch has led producers to plant somewhat earlier due to the warming effects of black plastic mulch. The small market window in the spring season in North Florida results in producers taking early planting risks to meet the generally higher market prices early in the season. Along with the benefits of earlier market prices, comes the higher risk of freeze/frost damage during the early planting season. Freeze protection can be accomplished with overhead irrigation, row covers, or other cover methods such as styrofoam cups. Overhead irrigation is commonly used to protect strawberries, but is not frequently used in North Florida for other vegetable crops. Row covers are often used by small farmers who intensively produce high value specialty crops sold in direct-to-consumer markets. Watermelon producers in the Suwannee Valley have become fewer in numbers and are generally on larger acreages (50-300 acres). Essentially all watermelons in this region are grown with plastic mulch and drip irrigation and the producers do not have solid set irrigation systems for freeze protection. Very few large producers have implemented row covers or other plant covering materials due to the cost and labor demands. Freeze events in North Florida are hard to predict in the early spring. Early March transplanting dates are usually high risk with at least 1 to 6 freeze, or near freeze events expected in March.

Because producers have no real means to protect early transplanted crops, such as watermelon, some have run the drip irrigation systems during freeze events in hopes of some protection. A significant research effort was provided by George Hochmuth and others at the University of Florida in the late 1980s to test several freeze protection methods on strawberry (Hochmuth et al., 1986 and Hochmuth et al., 1993). These trials showed the effectiveness of row covers, sprinkler irrigation, and the combination of row covers and sprinkler irrigation. However, in these same trials conducted in Gainesville and Plant City, results showed running drip irrigation under plastic mulch alone provided the strawberry crop no protection from freezes. The addition of drip irrigation in conjunction with row covers showed no additional protection

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above the row covers alone. These results were consistent during 13 freeze events at Gainesville and 4 freeze events at Plant City during the winter of 1985-86.

Some vegetable producers in North Florida have still tended to use drip irrigation on freeze events because of their hopes it may still help and also they viewed the relative costs to run the drip irrigation system as low. The relative low cost, however, has changed dramatically in the past few years as it relates to high fuel costs to pump water, and the demonstrated high risk of leaching expensive preplant fertilizers. Recent efforts to demonstrate Best Management Practices (BMP) has shown the high risk of leaching fertilizer during long drip irrigation events early in the season. This has been demonstrated by injecting soluble blue dye into the drip irrigation system to show the movement of the dye (and fertilizer) after single lengthy irrigation events of three hours or more (Hochmuth et al., 2006; Simonne et al, 2003; 2004; 2005). The concern of growers regarding the real benefit of using drip irrigation for freeze protection in comparison to the actual costs resulted in on-farm trials in a transplanted watermelon crop in March 2008 near Live Oak, Florida.

Temperature probes (Campbell Scientific Inc. 109-L) were installed in a commercial watermelon field shortly after transplanting and prior to several anticipated freeze events. This temperature probe is reported to have an accuracy of about 0.5 deg F. No radiation shield was used in the installation. The temperature data were recorded at 15 minute intervals. A max/min thermometer was also installed at the edge of the field to assess air temperature away from the plastic mulch. .

The temperature probe used was a device about the diameter of a pencil, and 2" long. The temperature was measured with the sensor laying on top of the watermelon plant leaf directly above the transplant hole in the plastic (Figure 1).

Irrigation shutoff valves were used in 3 beds in the middle of a 38-acre watermelon field. Leaf canopy temperatures as recorded for one plant within this area of three beds with no drip irrigation, and from nearby beds where drip irrigation was operated overnight.

The comparison of the low temperatures recorded outside the watermelon field and the leaf canopy above the hole in the plastic mulch for two events is shown in Table 1. This leaf canopy temperature is shown for the beds not receiving drip irrigation. This showed the heat retention properties associated with the plastic mulch. The leaf canopy temperature was recorded with only one temperature probe in one plant on an irrigated bed, and one probe on a non-irrigated bed.

Table 1. Low temperature recordings taken from outside the watermelon field and from within the field in the leaf canopy.

Date	Low temp (°F)	Leaf canopy Temp (°F)
Feb 27-28	22.0	25.0
Mar 8-9	28.0	32.0

Leaf canopy temperature measurements for the event of February 27-28 are shown in a graph on Fig 2. There was no apparent variation between the drip irrigated and non-irrigated treatments. The overnight low temperature measured at the leaf canopy was 25.0 deg. F. Temperatures below 32.0 deg F. were sustained for eight hours. This event resulted in total crop loss to freeze damage, and subsequent replanting. There was no difference between the temperatures recorded with and without drip irrigation.

Measurements recorded during the events of March 8-9 and 9-10 are shown in Fig 3. The overnight low temperature measured at the leaf canopy on the morning of March 9 was 32.0 deg. F, and 37.0 deg F. on the morning of March 10. No plants were damaged during this event. Higher temperatures were recorded overnight where irrigation was not utilized. The variation between irrigated and not irrigated was about 1.0 deg F.

Conclusion:

The results of this on-farm trial on three cold nights indicated that running drip irrigation under plastic mulch as an attempt to freeze-protect the crop had no effect on the temperature in the watermelon plant canopy. This result is the same found in the strawberry trials conducted in 1985-86 (Hochmuth et al., 1986 and Hochmuth et al., 1993). In addition, no differences were found in freeze damage to the plants on any of the cold nights in 2008.

This result is also an important finding related to best management practices. Long drip irrigation events, like those used in this trial, leach nutrients from the soil under the plastic. These long irrigation events, if not effective as freeze protection, should not be used because of the risk of leaching valuable nutrients and the expense of the fuel to run the irrigation system.

Perhaps the best means of preparing for a freeze event would be to adequately, but not excessively, irrigate the beds on the day leading up to the freeze. This may help by allowing the solar energy to be collected by the plastic mulch and transferred to a moist bed. The moist bed will hold more heat than a dry bed as water has a higher capacity to store heat than air. Additional research is needed to further explain the effect of drip irrigation on the soil temperature within the beds.

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Fig 1. Temperature sensor placement in crop canapy.

Fig 2. Plant canopy temperatures recorded with vs. without drip irrigation during freeze event on 27 & 28 Feb 2008.

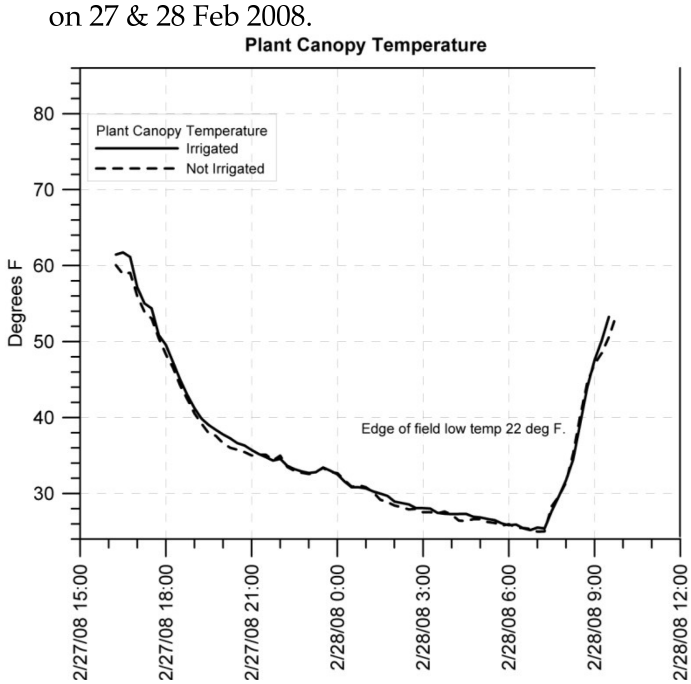

Fig 3. Plant canopy temperatures recorded with vs. without drip irrigation during freeze events on 8 -10 Mar 2008.