Evaluation of tree T-PEEs for freeze protection in young citrus

By Kelly T. Morgan and Stephen J. Futch

Water has been used for cold protection in past freezes with mixed success. Low dew point temperatures and high winds can promote evaporative cooling when insufficient amounts of water are used.

Various methods have been used to protect young citrus trees from frost and freeze conditions. Among these, the use of covers and other structures to restrict water to the relatively small canopies of young trees (1 to 2 years of age) have been tested. Recent research has indicated that the restriction of water and fertigation to small areas directly under young trees aids in improved tree growth by reducing potential loss of nutrients applied outside the tree root zone, leading to larger trees and earlier fruit production.

A field trial was established in October 2014 and completed in June 2016 to examine and determine advantages and/or disadvantages provided by the tree T-PEE in a commercial citrus grove in Florida. Current production methods consist of a single emitter placed adjacent to the tree and a plastic wrap placed around the lower 1 foot of the tree trunk to minimize sprouting and potential herbicide injury. It has been suggested that trees grown using a cone-shaped tree T-PEE grow larger faster, use less water and fertilizer, and receive greater freeze protection as compared to standard production systems. The objectives of this project were to determine if the tree T-PEE: 1) elevates air temperatures around the young citrus trees above damaging levels during freeze events, 2) increases soil moisture in the irrigation zone to a greater depth than standard micro sprinkler emitters and 3) accelerates young tree growth.

STUDY SITE

The study site was two rows of Valencia trees planted in a commercial grove in the fall of 2014. Treatment plots of five

trees were arranged in a randomized complete block design and replicated four times to provide sufficient replication to evaluate effects of the tree T-PEE using the following methods.

Each citrus tree was irrigated by the grove irrigation manager with a single micro sprinkler delivering either 5, 7.5 or 10 gallons per hour with a standard full-circle spray pattern, 45 degree downward spray and a full-circle spray with a tree T-PEE installed (see Table 1, page 18). All trees were irrigated for the same amount of time regardless of the emitter output rate because the emitters were all supplied by a single irrigation tubing line.

Air temperature was recorded at a 6-inch height inside the tree T-PEE and 18 inches above the ground but inside the canopy of trees with tree T-PEEs installed. The thermocouples measured air temperatures near the tree trunk and main stem and were secured to the trees by tape.

Soil moisture was measured at three depths (6, 12 and 18 inches below the soil surface) 8 inches from the tree trunk using capacitance soil-moisture sensors recorded by a data logger every 30 minutes. Tree-trunk diameter measurements were made at 3 inches above the bud union at the beginning of the study and twice during the study period because trunk diameter is the best indicator of growth for young citrus trees. Canopy volume estimates were also made at the same time that trunks were measured. Canopy volume was estimated using average canopy diameter and height assuming a spheroid shape.

RESEARCH RESULTS

Air Temperatures

During freeze events. Air temperatures not influenced by the irrigation system were recorded by the Florida Automated Weather Network (FAWN) Joshua weather station less than two miles from the project site. One freeze night was recorded at the FAWN site with a minimum temperature of 29.7°F on February 20, 2015, and no freeze events were recorded in 2016. During the single freeze event, average temperature at the 6-inch height above the ground increased inside the tree T-PEE to 56°F for the black emitter and 53°F for the orange emitter. Temperatures outside the tree T-PEE at the 18-inch height above the ground dropped to 34°F for both the blue and orange emitter trees. No increase in temperatures was observed for two dates that air temperatures dropped to approximately 35°F and irrigation was not used.

During non-freeze period. No differences in mean monthly air temperature were measured at both 6-inch and 18-inch heights for trees with tree T-PEEs and without tree T-PEEs. However, as one would expect, maximum temperatures were significantly higher for trees without tree T-PEEs in March, April and May at the 6-inch height compared with the same height inside the tree T-PEEs (see Tables 2 and 3, page 14).

Soil Moisture Measurements

Soil moisture increased greatly for all sites at all depths on the evening that irrigation ran for freeze protection because of the extended duration compared with typical irrigation events. Soil moisture increased for trees with and without tree T-PEEs at the 6- and 12-inch depths below the soil surface during irrigation events. However, soil moisture under trees without tree T-PEEs did not increase at the 18-inch depth for the black and blue emitters and increased only slightly at the 18-inch depth for the orange emitter. Substantial increases in soil moisture were observed at the 18-inch depth for all three treatments with tree T-PEEs installed.

These measurements indicate that irrigation was concentrated within a smaller area at the base of each tree with a tree T-PEE installed and that less time is needed to fill the limited area irrigated under the tree T-PEE compared with the larger areas irrigated by the unrestricted emitters.

Tree Growth

Significant differences were found among treatments in tree diameter at

the beginning of the study (October 17, 2014). Greatest trunk diameters were measured for trees with orange emitters and tree T-PEEs installed. Smallest trees were found in plots with black emitters with a 45 degree down-spray pattern.

The differences were not related to treatments, as the treatments had begun only recently. Similar significant differences were found in trunk diameter on January 21, 2016, and June 10, 2016. Tree heights, tree canopy widths and canopy volumes were not significantly different among treatments at any measurement date.

CONCLUSIONS

Only one freeze event occurred during the two winters of this study. Air temperatures measured during the freeze event indicate that installation of tree T-PEEs significantly increases air temperatures at 6 inches inside the tree T-PEE by 18°F to 21°F. However, air temperatures at the 18-inch height above the tree T-PEE dipped to the same air temperature as trees without the tree T-PEE.

Soil-moisture measurements

Table 1. Project treatments describing three emitter outputs in gallons per acre, used to evaluate the efficacy of tree T-PEEs in improving freeze protection and water conservation.

Emitter type	Jet color	Distribution pattern	Flow rate
Maxi Jet	Black	360 degrees x 14 filled-in streams	5.6
Maxi Jet	Orange	360 degrees x 14 filled-in streams	7.7
Maxi Jet	Blue	360 degrees x 14 filled-in streams	10.5
Maxi Jet	Black	45 degrees downward fan	5.6
Maxi Jet	Orange	45 degrees downward fan	7.7
Maxi Jet	Blue Max Cone	45 degrees downward fan	10.5
Maxi Jet	T-Pee Black	360 degrees x 14 filled-in streams inside tree T-PEE	5.6
Maxi Jet	T-Pee Orange	360 degrees x 14 filled-in streams inside tree T-PEE	7.7
Maxi Jet	T-Pee Blue	360 degrees x 14 filled-in streams inside tree T-PEE	10.5

Table 2. Summary of air temperatures recorded at 6- and 18-inch heights from January to May 2015.

	6-INCH AIR TEMPERATURES (°F)					18-INCH AIR TEMPERATURES (°F)				
	January	February	March	April	May	January	February	March	April	May
Trees without T-PEEs										
Mean	58.3	61.3	73.1	78.8	76.9	56.7	61.5	74.2	78.7	78.2
Standard Deviation	12.8	13.1	13.5	14.1	13.9	12.9	13.4	13.7	13.2	12.3
Maximum	83.2	94.9	113.4	118.8	121.3	73.6	97.8	120	120	116.3
Minimum	45.2	33.7	43.9	57.6	62.3	7.8	33.5	44.3	73.9	72.6
Trees with T-PEEs										
Mean	56.7	62.9	73	77.8	80.3	58.9	62.9	74.5	79.2	85.3
Standard Deviation	11.3	10.9	9.5	10.9	10.8	11.8	13	11.9	12	11.6
Maximum	81.6	88.7	103	104.5	118.3	83.2	102.9	109.6	114.2	116.9
Minimum	46.2	37.3	46.8	58.5	62.8	48.6	35.1	45.6	59.4	60.3

Table 3. Summary of air temperatures recorded at 6- and 18-inch heights from January to May 2016.

	6-INCH AIR TEMPERATURES (°F)					18-INCH AIR TEMPERATURES (°F)				
	January	February	March	April	May	January	February	March	April	May
Trees without T-PEEs										
Mean	53.4	64.6	72.1	79.3	74.5	59.3	63.8	76.1	75.8	75.4
Standard Deviation	11.8	16.1	12.7	12.3	16.3	11.3	12.5	11.2	11.3	11.7
Maximum	85.3	91.4	102.5	105.4	109.4	72.7	99.2	115.6	116.4	113.5
Minimum	42.6	35.6	47.4	59.8	66.4	45.3	35.6	46.8	78.4	76.7
Trees with T-PEEs										
Mean	54.6	61.8	72.6	73.5	82.4	56.9	65.9	79.7	76.3	89.2
Standard Deviation	11.8	9.6	9.9	11.9	10.6	10.9	11.6	10.3	11.5	13.7
Maximum	83.5	83.6	106.3	107.3	123.5	87.3	106.7	119.5	118.4	118.6
Minimum	46.8	38.4	47.9	56.3	64.6	49.8	38.3	48.7	62.5	63.7

at 6- and 18-inch depths were consistently higher under the tree T-PEEs compared with treatments without tree T-PEEs. These higher soil-moisture measurements indicate that the irrigation schedule used in this study would have resulted in leaching of nutrients below the root zone of the trees. These results would also indicate that irrigation water savings could have resulted from reduced irrigation of trees with tree T-PEEs installed.

Tree-trunk diameter is the best indicator of growth for young citrus trees. Trunk diameters were significantly greater at the beginning of this study for one of the treatments with tree T-PEEs installed. These trees maintained the size advantage throughout the study. Tree heights, canopy widths and canopy volumes were not significantly different among treatments at any measurement date.

The results described above report findings from the 18 months of this study. However, long-term use of tree T-PEEs must be investigated to evaluate the effect of the restricted irrigation zone under the tree T-PEE on tree growth beyond 18 months after installation. Additionally, the cost of and installation may be greater than grower budgets allow, unless tree T-PEEs are reused by moving them to newly planted trees after two to three years.

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