Proc. Fla. State Hort. Soc. 97: 25-27. 1984.

LOW VOLUME IRRIGATION AND TREE WRAPS FOR COLD PROTECTION OF YOUNG HAMLIN ORANGE TREES[1]

F. S. Davies, L. K. Jackson, and L. W. Rippetoe
Department of Fruit Crops, University of Florida, Gainesville, FL 32611

Additional index words. freeze, frost, *Citrus sinensis.*

Abstract. **A combination of low volume under-tree irrigation (22 gal/hr) applied with 90° microsprinklers and 5 different types of tree wraps (Reese, fiberglass, polyurethane foam, aluminum foil, Tree Guard) were used for cold protection of 1-yr-old 'Hamlin' orange (*Citrus sinensis* (L.) Osbeck) trees on sour orange (*Citrus aurantium* L.) rootstock. Trunk temperatures were monitored above and under the wraps and % survival determined following the severe freeze of 24-26 December 1983 and the moderate freeze of 29 February 1984. Nighttime trunk temperatures were similar for wrapped and unwrapped trees when irrigation was applied; however, Reese, fiberglass and aluminum wraps prevented large fluctuations in daytime temperatures which occurred under Tree Guard wraps. Reese, foam and fiberglass wraps maintained trunk temperatures near 32°F for 4 hr after the irrigation system broke down 26 December; whereas, trunk temperatures under other wraps fell to those of unwrapped trees. Recovery and regrowth was best for Reese, Tree Guard, and fiberglass, and poorest for aluminum foil. The combination of certain types of wraps with low volume irrigation directed at the trunk gave better cold protection than irrigation alone.**

Severe freezes of 1980, 1981 and 1983 have been responsible for extensive losses of young citrus trees throughout Florida. Over 6 million young trees have been planted in each of the past 2 yr (C. Youtsey, personal communication), with indications that many more will be planted in the next few years. Costs of bringing a citrus tree into production range from $18 to $42 per tree (6); consequently, growers are interested in finding methods of protecting their investment from cold damage.

Traditionally, young trees have been protected using soil banks (3, 5), or tree wraps (4, 5, 8). Tree wraps provide 1 to 5°F protection under most circumstances (4, 8) but are less effective than soil banks which provide 12-15°F protection (5). Nevertheless, banks are costly to construct and maintain and may cause damage to the tree trunk (5).

Recently, low volume irrigation has been used effectively for cold protection of young citrus trees (7); however, in some instances damage has occurred due to irrigation. Moreover, little is known about irrigation rates, nozzle sizes and types, and environmental conditions which may alter effectiveness.

Our objectives were to combine tree wraps with low volume irrigation for protection of young 'Hamlin' orange trees. We were also interested in monitoring changes in wind speed and net radiation during both advective and radiation freezes to determine optimum operating conditions for this system.

Materials and Methods

One-yr-old 'Hamlin' orange trees on sour orange rootstock were planted in June, 1983 in a 1-acre block near Gainesville, Florida. Trees were set at a 20 by 20 ft spacing and received routine care during the first growing season. Nine blocks of 6 trees each were selected for the experiment in November, 1983. Trees in each block were randomly assigned one of 6 treatments: 1) unwrapped; 2) Reese wrap; 3) fiberglass wrap; 4) polyurethane foam wrap; 5) Tree Guard; or 6) aluminum foil wrap. Prior to wrapping, copper-constantan t-type thermocouples were attached to the trunk of each tree 8 inches above the soil surface. An additional thermocouple was placed in the canopy ca. 3 ft above soil level to monitor air temperature.

All trees were irrigated using 90° Maxijets which delivered 22 gal/hr at 20 psi. Trunks were irrigated from ground level to a height of about 1.5 ft. Irrigation was run on 24-26 December 1983 and temperatures monitored every half hour using a Doric Digitrend 235 datalogger. Data were stored on a magnetic disk and means and standard deviations determined for each set of readings.

Additional environmental measurements were made during minor freezes of 1, 6, 7, 28 and 29 February 1984. Net radiometers were placed in irrigated and unirrigated blocks and both nighttime and daytime measurements made along with temperature measurements. Net radiometers were positioned using a metal stand at a height of 5 ft above the soil surface. Wind direction and speed were monitored with a Gill microvane and 3-cup anemometer. All readings were monitored at half hour intervals by the Doric 235 datalogger. In addition, net radiation from individual trees was monitored for blue base 360° (10 gal/hr) and red base 90° (22 gal/hr) Maxijets during a radiation freeze of 7 February.

Shoot regrowth and tree survival were determined on 5 April 1984. Trees were cut-back to live wood on 5 April and recovery followed until mid-July, 1984.

Results and Discussion

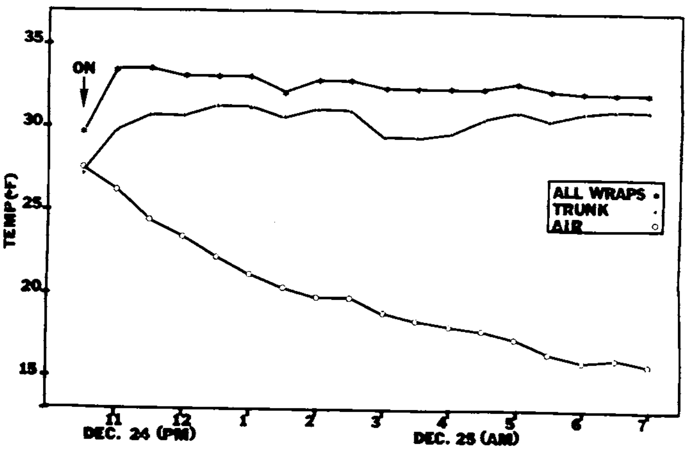

Fig. 1. Effects of low volume irrigation (22 gal/hr 90° jets) and tree wrap combinations on trunk temperatures of 1-yr-old 'Hamlin' sweet orange trees, 24-25 December 1984. Trunk and air temperatures at each time are means of 9 measurements. Temperatures were similar for all tree wraps, therefore data were combined, n = 45.

Low volume under-tree irrigation maintained trunk temperatures above or near 30°F while air temperature reached a minimum of 15°F on the morning of 25 December 1983 (Fig. 1). Trunk temperatures were slightly higher for the wrap-irrigation combination than for irrigation alone on the night of 24 December and the morning of 25 December (Fig. 1); however, temperatures were similar for all

[1]Florida Agricultural Experiment Stations Journal Series No. 6058.

treatments for the night of 25 December and morning of 26 December (Fig. 2). Irrigation lines broke on the morning of 26 December at 4:30 AM causing trunk temperatures for trees with no wraps and those protected by aluminum foil alone to drop from 35° to 25°F within 4 hr (Fig. 2). Temperatures under Tree Guard fell to 28° while those under Reese, fiberglass or foam remained fairly constant at 32°. The temperature stability provided by the wraps after the irrigation was discontinued was related to the insulating value of the wrap even though all trees were covered by a thick blanket of ice.

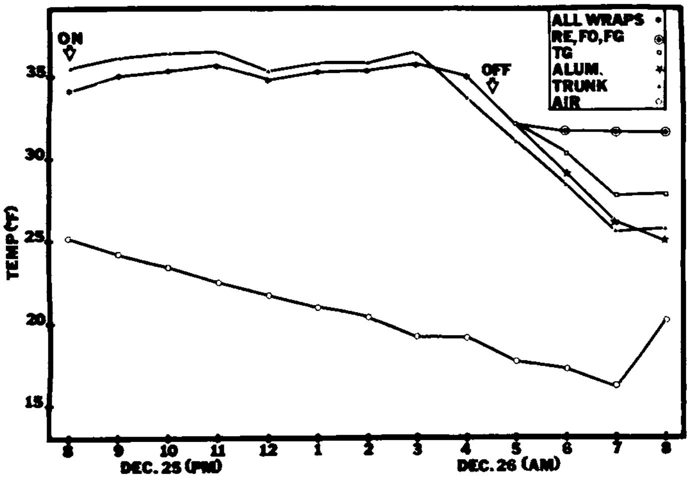

Fig. 2. Effects of low volume irrigation (22 gal/hr, 90° jets) and tree wrap combinations on trunk temperatures of 1-yr-old 'Hamlin' sweet orange trees, 25-26 December 1984. Trunk and air temperatures at each time are means of 9 measurements. Temperatures were similar for all tree wraps, therefore data were combined, n = 45. Irrigation was discontinued at 4:30 AM and data were combined for Reese, foam and fiberglass (RE, FO, FG) n = 27. TG = Tree Guard; ALUM. = aluminum foil wraps.

We did not observe evaporative cooling after the system was shut down even though wind speed was in excess of 20 mph. Trunk temperatures under the ice blanket without wraps were actually 6° to 9°F higher than air temperatures. The extensive blanket of ice surrounding the trunk undoubtedly was responsible for the lack of evaporative cooling. Evaporative cooling of 7-8°F occurred during windy conditions in 1981 when insufficient irrigation was provided (Davies, unpublished). However, other studies indicate that evaporative cooling is rarely a problem during radiation freezes (2).

Daytime temperatures varied for irrigated trees depending on the type of wrap. On 25 December when air temperatures never reached above 33°F all wraps except Tree Guard maintained trunk temperatures below those of unwrapped trees (Fig. 3). Similarly, when no irrigation was applied during the day on 1 February, only trunk temperatures beneath Tree Guard were above those of unwrapped trees (Fig. 4b). Reese wraps maintained temperatures as much as 20°F below unprotected trunk and 7°F below air temperatures (Fig. 4b). Generally, trunk temperatures were from 7.5° to 13.5°F higher than air temperatures during the day. The increase in trunk temperatures under the wraps closely paralleled the increase in net radiation (Fig. 4a).

Nighttime temperatures varied with type of tree wrap when no irrigation was provided on 26-27 December. Trunk temperatures under Reese wraps were as much as 5°F higher than those of unwrapped trunks, while temperatures under foam and fiberglass were generally 2 to 3°F higher (Fig. 5). Tree Guard provided 1 to 2°F protection while trunk temperatures under aluminum foil were similar to or slightly lower than those of unwrapped trunks. These values are similar to those reported by others for the same wraps

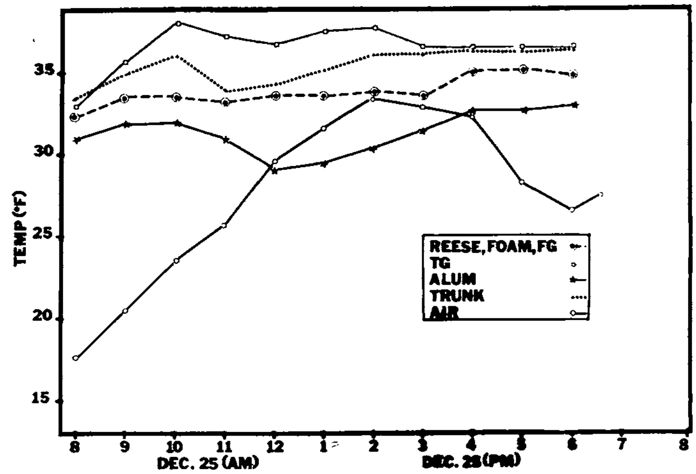

Fig. 3. Daytime trunk temperatures of 1-yr-old 'Hamlin' trees under various tree wraps, 25 December 1984. Temperatures at each time are means of 9 measurements for Tree Guard (TG), aluminum foil (ALUM), trunk and air temperatures. Data for Reese, foam and fiberglass (FG) were combined, n = 27.

during previous freezes (4, 5, 8). The amount of temperature increase over unwrapped trunks again reflected the insulating value of each wrap as seen in Fig. 2.

Shoot regrowth following the freeze of 1983-84 was greatest for Reese wraps, intermediate for Tree Guard, foam and fiberglass wraps, and lowest for unwrapped and aluminum foil wraps (Table 1). Percent tree survival was best for Reese, Tree Guard and foam, intermediate for fiberglass and unwrapped, and lowest for aluminum where no trees survived as of May, 1984. Similarly, Jackson et al. (4) observed no difference in tree height (another measure of survival) after a freeze for Reese, foam or fiberglass. They did not use Tree Guard or aluminum foil as wraps.

Survival is not entirely related to the cold protection capabilities of the wrap. Sprouts began to form in early February under Reese, Tree Guard and fiberglass wraps. Shoots, 3-6 inches in length, were produced under Reese and Tree Guard by mid-February. This is interesting since trunk temperatures under these wraps varied considerably. Early sprouting seems likely under Tree Guard due to high daytime trunk temperatures. In contrast, sprouting under Reese wraps may have resulted from high evening or nighttime temperatures (Fig. 4). Trunks rotted under aluminum foil due to lack of sufficient ventilation. Consequently, the

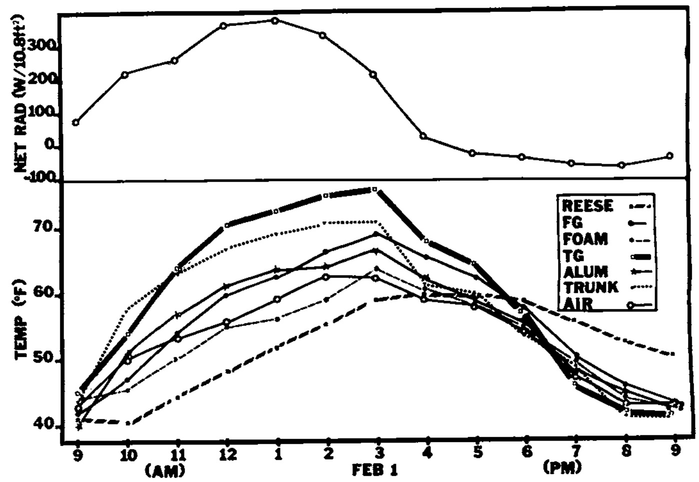

Fig. 4. Daytime net radiation from around 1-yr-old 'Hamlin' orange trees, 1 February 1984 (top). Daytime trunk temperatures under various tree wraps and air temperatures (bottom). Temperatures at each time are means of 9 measurements. FG = fiberglass, TG = Tree Guard ALUM = aluminum foil wraps.

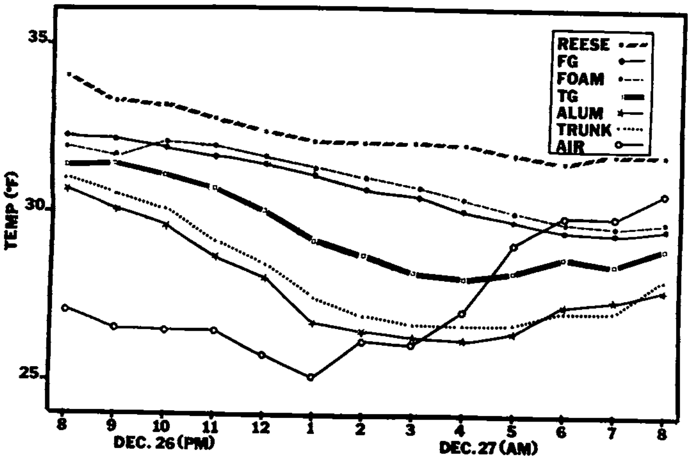

Fig. 5. Effects of tree wraps on nighttime trunk temperatures of 1-yr-old 'Hamlin' trees, 26-27 December 1984. Temperatures at each time are means of 9 measurements. FG = fiberglass, TG = Tree Guard, ALUM = aluminum foil wraps.

Table 1. Effect of tree wrap-irrigation combinations on survival and regrowth, of 'Hamlin' sweet orange following freezes of 24-26 December 1983 and 29 February 1984.

Tree wrap[z]	Survival (%)	Regrowth[y] (inches)
No wrap	89	3.1
Reese	100	11.4
Tree Guard	100	7.2
Fiberglass	89	5.2
Polyurethane foam	100	4.2
Aluminum foil	45[x]	0.0

[z]All treatments received irrigation with 90° Maxijets at 22 gal/hr on 24, 25, 26 December, but were not irrigated on subsequent freezes.
[y]Mean shoot regrowth and survival as of 5 April 1984.
[x]All aluminum foil wrapped trees were dead as of May, 1984.

poor performance of the foil cannot be attributed entirely to a lack of cold protection.

Low volume irrigation creates a fog under some conditions which may interrupt radiation losses from the soil. Our preliminary studies, however, indicate that amount and pattern of water applied had little effect on net radiation of young 'Hamlin' trees on the night of 7 February. Values averaged –61.3 w/10.8 ft^2 for the red (22 gal/hr) 90° jets compared with –53.1 for blue (10 gal/hr) 360° jets. Previous studies by Buchanan et al. (1) also suggest that fog or mist is not responsible for temperature increases in mature groves unless droplet size is much smaller than that produced by these types of systems. Moreover, Wilcox and Davies (9) found that leaf temperatures decreased considerably from the bottom to the top of the tree even when a heavy fog was produced, suggesting there is little effect of mist on radiation losses.

The combination of low volume under tree irrigation (90° at 22 gal/hr) with Reese, polyurethane foam, fiberglass or Tree Guard wraps effectively protected trunks of young 'Hamlin' trees from severe freeze damage in 1983-84. The combination proved effective even during the severe advective freeze of 24-26 December 1983 when temperatures reached as low as 13°F and wind speeds reached 20-25 mph. Moreover, presence of tree wraps with high insulating properties may provide insurance if irrigation systems should be shut-off during a freeze.

Acknowledgement

The authors are grateful for support from Tom Thayer of the Maxijet Corp. and Dwayne Hamlin of Tree Guard for their equipment and financial support.

Literature Cited

1. Buchanan, D. W., F. S. Davies, and D. W. Harrison. 1982. High and low volume under-tree irrigation for citrus cold protection. Proc. Fla. State Hort. Soc. 95:23-26.
2. Davies, F. S. 1980. High volume under-tree sprinkling for citrus cold protection. Proc. Fla. State Hort. Soc. 93:1-2.
3. Hume, H. H. 1907. Citrus fruits and their culture. Orange Judd Co., NY.
4. Jackson, J. L., Jr., D. P. H. Tucker, and A. J. Rose. 1981. Evaluation of several tree wraps on Citrus. Proc. Fla. State Hort. Soc. 94:63-65.
5. Jackson, L. K., D. W. Buchanan, and L. W. Rippetoe. 1983. Comparisons of wraps and banks for citrus cold protection. Proc. Fla. State Hort. Soc. 96:29-31.
6. Muraro, R. 1982. Four year costs for planting and maintaining a reset citrus tree. Citrus & Veg. Mag. 46(1):52-53.
7. Parsons, L. R., T. A. Wheaton, and J. D. Whitney. 1981. Low volume micro-sprinkler undertree irrigation for frost protection of young citrus trees. Proc. Fla. State Hort. Soc. 94:55-59.
8. Rose, A. J. and G. Yelenosky. 1978. Citrus trunk wrap evaluations. Proc. Fla. State Hort. Soc. 91:14-18.
9. Wilcox, D. A. and F. S. Davies. 1981. Modification of air temperature and citrus leaf temperature with high volume under-tree sprinklers. Proc. Fla. State Hort. Soc. 94:59-63.