Proc. Fla. State Hort. Soc. 94:52-54. 1981.

OBSERVATIONS ON MICROSPRINKLER USE FOR COLD PROTECTION DURING 1981 FREEZE[1]

THOMAS W. OSWALT
University of Florida, IFAS, Cooperative Extension Service, Polk County, 1702 Hwy. 17 South, Bartow, FL33830

LARRY R. PARSONS
Agricultural Research & Education Center, 700 Experiment Station Road, Lake Alfred, FL 33850

Abstract. **The use of water for frost or freeze protection is not new to the Florida citrus industry, but after the December 1962 freeze the use of overhead sprinklers was generally abandoned. Recently, a number of growers have reported promising results when using microsprinklers during sub-freezing weather. This report is a compilation of paired groves having as similar a background as is possible in order to make comparison of the use of microsprinklers, the size of microsprinklers, the total gallons of water delivered per acre, minimum temperatures, topography, varieties and rootstocks. Observations are made comparing the number and size of microsprinklers with the amount of protection obtained. Observed effects ranged from very little improvement to noticeable improvement.**

The freeze which occurred on the mornings of Tuesday, January 13 and Wednesday, January 14 climaxed one of the most optimum pre-freeze conditioning sequences recorded since 1977. Typical of the conditioning citrus trees received in Bartow immediately prior to the freeze was the 34 out of 36 mornings on which the minimum temperature was below 55°F. In Bartow, temperatures in the 30's were recorded on 9 of the first 12 days in January, 1981.

Leaf freezing points determined from weekly samples of spring flush Valencia orange (*Citrus sinensis* (L.) Osbeck) trees also gave a strong indication of the tree conditioning. Samples of spring flush Valencia leaves indicated a consistent drop of leaf freezing temperatures for 4 weeks prior to the freeze. Leaf freezing points of Valencia dropped to the following temperatures: 21.3°F on December 16, 1980, 20.6°F on December 23, 1980, 19.3°F on December 30, 1980, and 19°F on January 6, 1981.

Data obtained in a survey of cold protection practices indicated a surprising increase in the acreage where irrigation was used for cold protection between 1979-80 and 1980-81. The change was from 1,695 acres to 4,996 acres. This was probably the greatest major shift in the concept of cold protection used in Polk County since the overhead irrigation method was literally abandoned after the December 13-14, 1962 freeze.

A concerted effort was made to document the effectiveness of microsprinkler systems for frost protection.

Materials and Methods

Tree response to microsprinkler irrigation during subfreezing temperatures were recorded on 35mm ASA 64 film using a polarizing and haze filter combination. Slides were taken at the grove site and from a fixed winged aircraft. On site photographs were also taken to provide simultaneous visual comparisons of protected and non-protected groves. In most cases, comparisons were made of similar varieties but under different management practices. Where adjacent grove middles were aligned, photographs were taken within one grove looking into the adjacent grove. Panoramic photographs were taken within one grove where rows did not line up properly. In several cases, where no similar groves were contiguous, individual photographs were taken on each site. All aerial photographs were taken at approximately 2000 ft. Sequential photographs were taken of each grove.

The Alturas area was photographed in February and again in April, 1981. The groves located in southern Polk, Osceola, and Manatee counties were photographed in February. The groves located in northern Polk and Hillsborough counties were photographed from late April through mid June, and aerial photographs were taken in April, 1981.

Slides of protected and non-protected trees were visually compared one with another and scored accordingly. Each site was visually compared with each remaining site. Ranking of sites was simply recording the times a given site was chosen as superior to all other sites. Once all the slides were compared, scores were tallied and ranked from lowest (most damaged) to best (least damaged).

Results and Discussion

Observations on the effects of microsprinkler systems following the January 1981 freeze included eight varieties of citrus, temperatures to 10°F, and irrigation rates from 480 gallons per acre per hour to 3,929 gallons per acre per hour. A wide variety of results were observed which could be partly attributed to the interaction of variety, temperature, and irrigation volume. Obviously, one must be cautioned not to conclude that the observed results could be explained entirely by microsprinkler operation during the freeze. A large number of variables such as age, management levels, rootstocks, different cultivar strains, and presence of pests and diseases are some parameters which were not measured. The goal was to observe a sufficiently large enough sample to identify trends.

Some of the differences were easily detected from the air such as in an area west of Alturas, Florida (Fig. 1). The dark colored groves were clearly different from the adjacent lighter areas. Slides of these areas taken on the grove sites demonstrated a marked difference where microsprinklers were used for cold protection.

Twenty-five paired observations were made of Pineapples, Hamlins, Valencias, Temples, and Jaffa oranges, and Marsh seedless grapefruit. The rankings were in order from zero (poorest) to 30 (best). Generally severe, almost total defoliation had occurred at or below the rating of 9. Defoliation was mostly confined to the upper periphery of the canopy where trees were ranked above 9.

An example of extensive defoliation and wood death was site 28 (rating = 0) which consisted of Pineapple on rough lemon rootstock compared to Site 29 (no irrigation), a similar variety and rootstock 25 feet away (Figs. 2 and 3). The irrigation rate applied to Site 28 was calculated at 1,304 gallons per acre per hour (gal/acre/hr) with a reported temperature of 12°F.

In the upper range, an example of peripheral defoliation was Site 41 consisting of Pineapples on rough lemon.

Much of the credit must go to Paul Huff, citrus consultant, Bartow, Florida and John Updike, Jr., Production Manager, Alcoma, Inc., whose urging was largely responsible for this report.

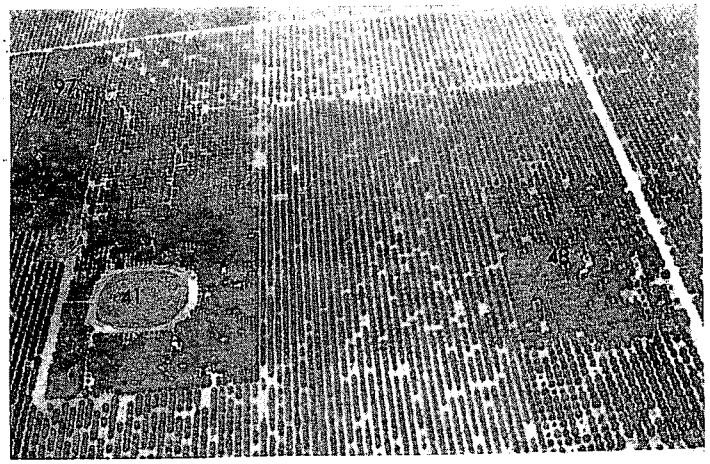

Fig. 1. Aerial photograph of grove sites #41, #48, #95 and #97 which were irrigated by micro-sprinklers on January 12-13 and 13-14, 1981. Adjacent blocks which were not protected photographed a lighter gray because of defoliation and dieback due to sub-freezing temperatures.

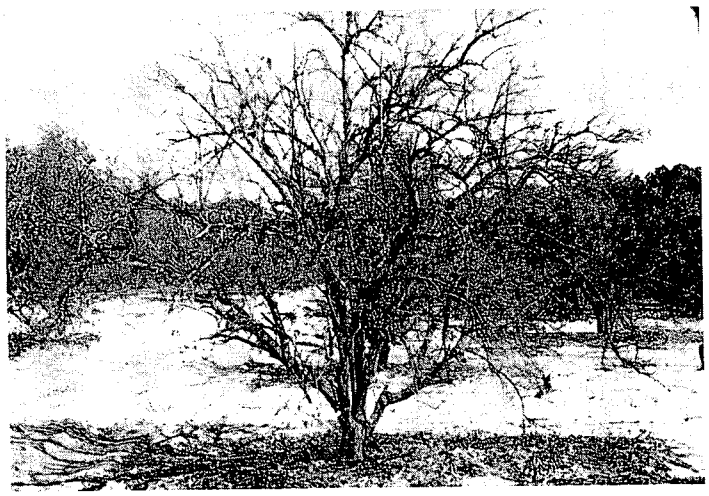

Fig. 2. Pineapple oranges at Site #28 irrigated on January 12-13 and 13-14 with 2 black micro-sprinklers per tree (est. 1,304 GPA/hr.). Minimum temperature 12°F. Comparative rank was the poorest at zero.

Fig. 3. Pineapple oranges adjacent to Site #28. No protection, minimum temperature 12°F.

Site 41 (rating = 16) was compared to adjacent Valencias on rough lemon (Fig. 4). The irrigation rate was estimated at 1,920 gal/acre/hr at a temperature of 16°F. A substantial amount of damage was avoided as compared to the adjacent and more cold hardy Valencias.

Fig. 4. Pineapple oranges at Site #41 irrigated on January 12-13 and 13-14 with 2 blue micro-sprinklers per tree (est. 1,920 GPA/hr.). Valencia oranges on the left were not protected. Minimum temperature estimated at 16°F. Comparative ranking was 16.

In the final example, Site 64 (rating = 18) consisting of Hamlins on trifoliata rootstock, was compared to a similar combination within the same block of trees, but without any form of protection (Figs. 5 and 6). The irrigation rate was estimated at 3,929 gal/acre/hr with a minimum temperature of 16°F. This was the highest volume observed in this study. The results indicated that substantial protection was provided by the microsprinklers.

Fig. 5. Hamlin oranges at Site #64 irrigated on January 12-13 and 13-14 with 2 red micro-sprinklers per tree (est. 3,939 GPA/hr.). Minimum temperature 16°F. Comparative ranking was 18.

Fig. 6. Hamlin oranges at Site #64 several rows north of the section photographed in Figure 5. No protection in this section. Minimum temperature 16°F.

In the comparison of Pineapples, the highest ratings generally paralleled warmer temperatures except where higher microsprinkler application rates were evident (Table 1). The most obvious example is Site 41 with an application rate of 1,920 gal/acre/hr with an estimated minimum temperature of 16°F compared to Site 26 at 20°F and 1,123 gal/acre/hr.

Table 1. A comparison of microsprinnkler systems as recorded in February 1981 by ranking of damage, irrigation rates, and minimum temperatures of Pineapple oranges. Highest ranking represents best protection.

Site	GPA/HR	Min. Temp. (°F)	Rank
28	1304	12	0
59	770	14z	5
30	1304	14z	6
25	529	19	7
26	1123	20	11
41	1920	16z	16

zUsing Pineapple oranges, grove temperature was estimated by comparing this grove with a grove at a higher temperature (less damage) and a grove at a lower temperature (more damage).

The Valencia sites were much like the trends mentioned for Pineapples. The higher rankings paralleled higher temperatures. The rankings continued to increase even where temperatures were lower only if the volume of applied water increased. In some cases, trees in colder locations appeared better than others at higher temperatures because of the greater water volume applied, e.g. sites 37 and 48 and 40 and 87 (see Table 2).

Table 2. A comparison of microsprinkler systems as recorded in February 1981 by ranking of damage, irrigation rates, and minimum temperatures of Valencias. Highest rank represents best protection.

Site	GPA/HR	Min. Temp. (°F)	Rank
32	480	12z	2
58	960	14	9
52	572	18z	11
34	960	16	13
37	480	18z	14
48	1144	16z	20
40	959	20	30
87	2496	16	30

zUsing Valencia oranges, grove temperature was estimated by comparing this grove with a grove at a higher temperature (less damage) and a grove at a lower temperature (more damage).

When the minimum temperatures were plotted against the gallons per acre per hour, it was possible to visualize a potential relationship to the amount of protection obtained (Fig. 7). Much more work must be completed before a meaningful relationship can be shown under a variety of horticultural and meteorological conditions. As mentioned earlier, ratings above 9 had little defoliation. Using this arbitrary division, it appears very likely with additional research or substantial field observations, a line of best fit could be developed that would establish a range of protection with a given volume of water. This range of protection would vary with changes in tree hardiness. The levels of protection differ between Pineapples and Valencias as would be expected. An effort to develop more information to substantiate this hypothesis could revolutionize our present concepts of cold protection costs and methods.

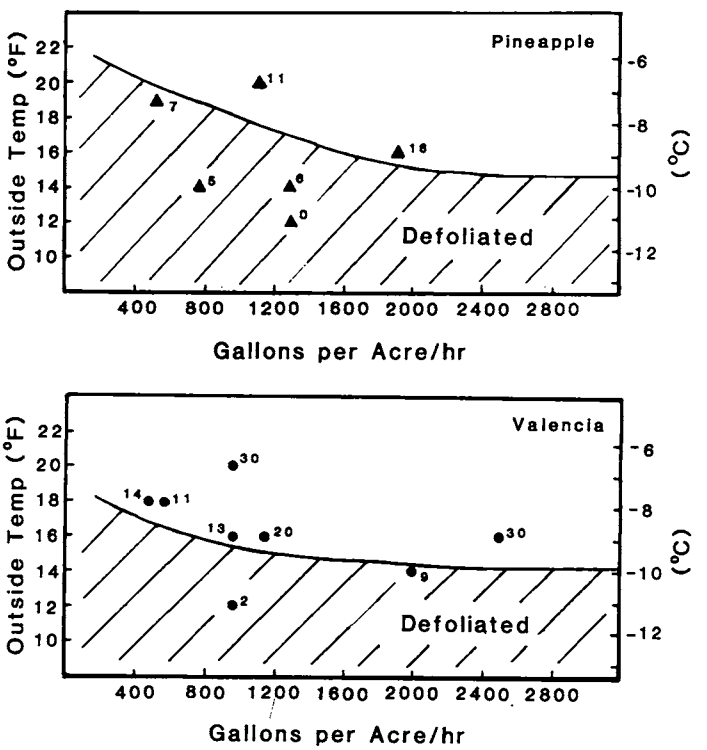

Fig. 7. Protection level provided for (a) Pineapple or (b) Valencia oranges by microsprinkler irrigation. Volume applied is compared with outside temperature in a non-irrigated adjacent block. The number by each data point indicates the damage rating. Trees with a rating of 9 of below were defoliated.