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Project Number: 82-M2

ANNUAL REPORT TO THE ALMOND BOARD OF CALIFORNIA

1982

Tree and Crop Research on Freeze Protection - Irrigation

by

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Objectives:

1. Identify how climatic factors are affected by the use of under-tree sprinklers.

2. Determine which factors have the greatest influence on freeze protection.

3. Study how growers can manage their under-tree sprinklers to maximize protection from freeze damage.

4. Investigate the interactive benefits of the combination of sprinklers and control of ice-nucleating bacteria on freeze protection.

5. Determine if the use of heaters in combination with under-tree sprinklers provides greater freeze protection.

Interpretive Summary:

Influence of ground sprinklers on the climate inside an almond orchard was studied in an orchard north of Chico during January, February and March, 1982. The air temperature within the orchard never fell below 28 F during this period, so we were unable to differentiate differences in protection resulting from application rates of 0.08 inch/hour and 0.12 inch/hour. There was a benefit from sprinklers relative to the control area where no sprinklers were operated.

Ground temperatures were raised from near 28 F to near 32 F in the plots that were sprinkler irrigated. Because the ground surface was warmer than in unprotected areas the radiation of heat from the surface was greater. This radiated heat was intercepted by the trees and, hence, they were more protected.

It seems that starting and stopping temperatures should be based on the wet-bulb temperature rather than air temperature. Wet-bulb temperature is the temperature of a thermometer with a wetted cotton wick over the bulb, which is aspirated by swinging the thermometer or blowing air over it with a fan. When the sprinklers are first started in an orchard, the air temperature drops and the dewpoint temperature rises. The wet-bulb temperature, however, remains constant and the air temperature will not drop below the wet-bulb temperature.

Experimental Procedure:

Sprinkler heads were modified in one block of an almond orchard to obtain the following treatments:

1. Low-pressure sprinklers 0.08 in/hr.

2. Conventional sprinklers 0.12 in/hr.

3. Microjet sprinklers

4. Triangular orifice sprinklers 0.12 in/hr.

5. Control - no sprinklers.

Pressure in the sprinkler system was too great and the microjet sprinkler plot did not work properly Some of the Nonpareil trees were sprayed for ice-nucleating bacteria control in the control and the conventional sprinkler plots to determine if the combination of sprinklers and bacteria control was beneficial or detrimental.

Each of the plots was instrumented with an automated weather station to measure the following parameters:

1. Soil temperature at 5 cm depth.

2. Soil surface temperature.

3. Temperature at 0.75 m height.

4. Temperature at 1.5 m height.

5. Temperature at 3 m height.

6. Relative humidity at 1.5 m height.

7. Net radiation at 4 m height.

8. Wind speed at 2 m height (control).

Ten-minute averages of the data were taken during the night.

Results

Figures 1-4 show the results obtained on the one night that temperatures dipped to 28 F. Figure 1 shows the temperature, wet-bulb temperature and dewpoint temperature for the low-pressure treatment (0.08 in/hr) on the night of January 6, 1982. Sprinklers were started at 12:40 a.m. on January 7, 1982, and the drop in air and rise in dewpoint temperature is apparent. The wet-bulb temperature remained fairly constant during sprinkler operation. Wind speed increased and decreased intermittently during the night and prevented temperatures from dropping further.

Figure 2 shows the effect of sprinkler operation on soil surface temperature. The surface temperature increased from approximately -1.1 C to -0.2 C after the sprinklers were started.

Figure 3 illustrates the influence of sprinkler operation on net radiation. When the sprinklers were started in treatment 1 plots the net radiation went from

$-59\ W\ m^{-2}$ to $-62\ W\ m^{-2}$. This means that more energy is being radiated from the orchard and, hence, the temperature in the orchard is greater. Much of the increased temperature is at the soil surface as was indicated in Figure 2.

Figure 4 shows that the air temperature did not drop as low in sprinkler irrigated plots. Treatment 1 was started earlier than treatment 2 and the difference in minimum recorded temperature was approximately 0.8 C.

Discussion:

The experiment must be operated under colder conditions to differentiate between application rate effects and to determine how much protection can be afforded by the different rates. The wet-bulb temperature does appear to be the critical temperature to monitor for stopping and starting sprinklers. Droplet sizes still need to be evaluated as well as the benefits of heaters in combination with sprinklers.

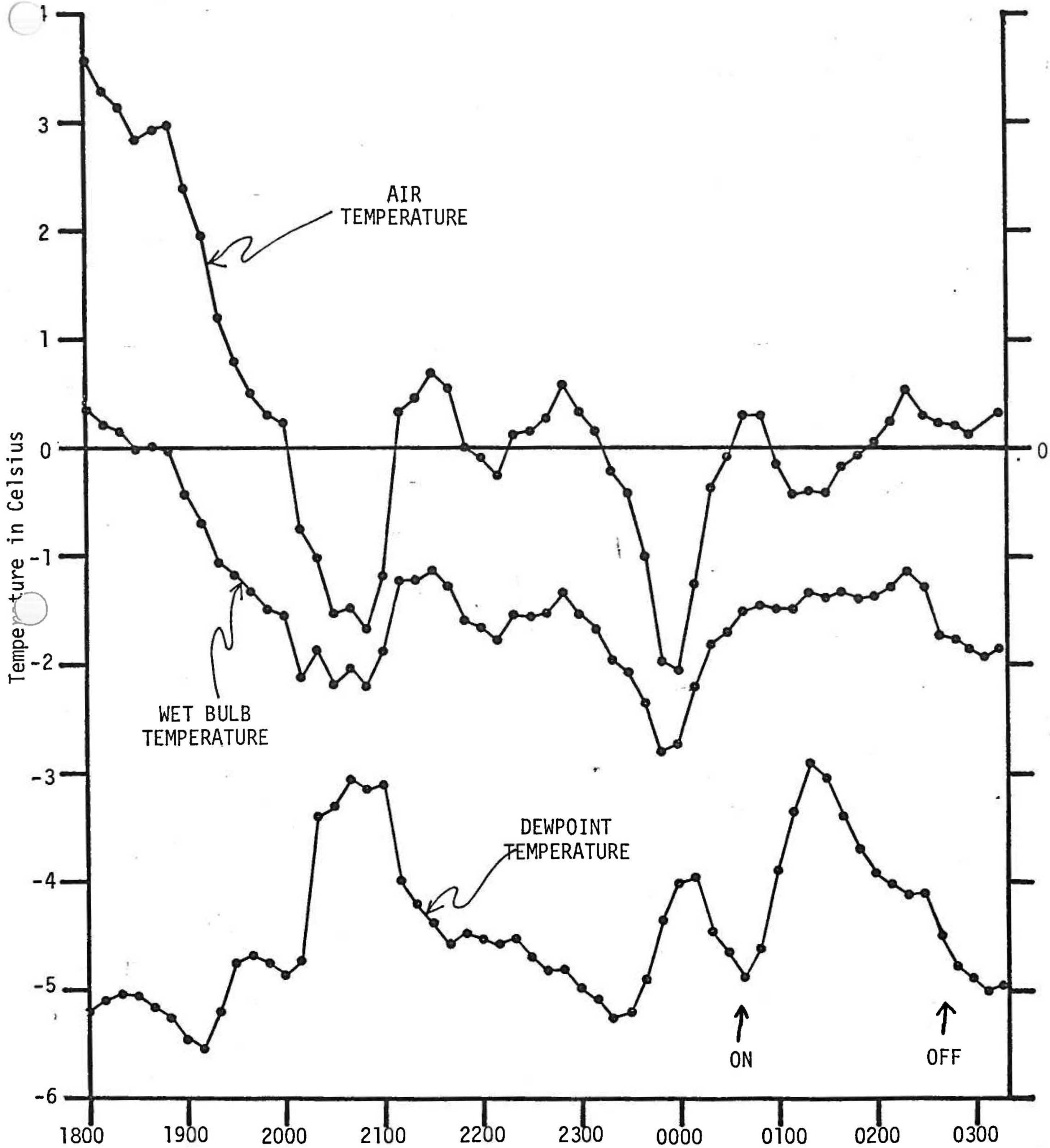
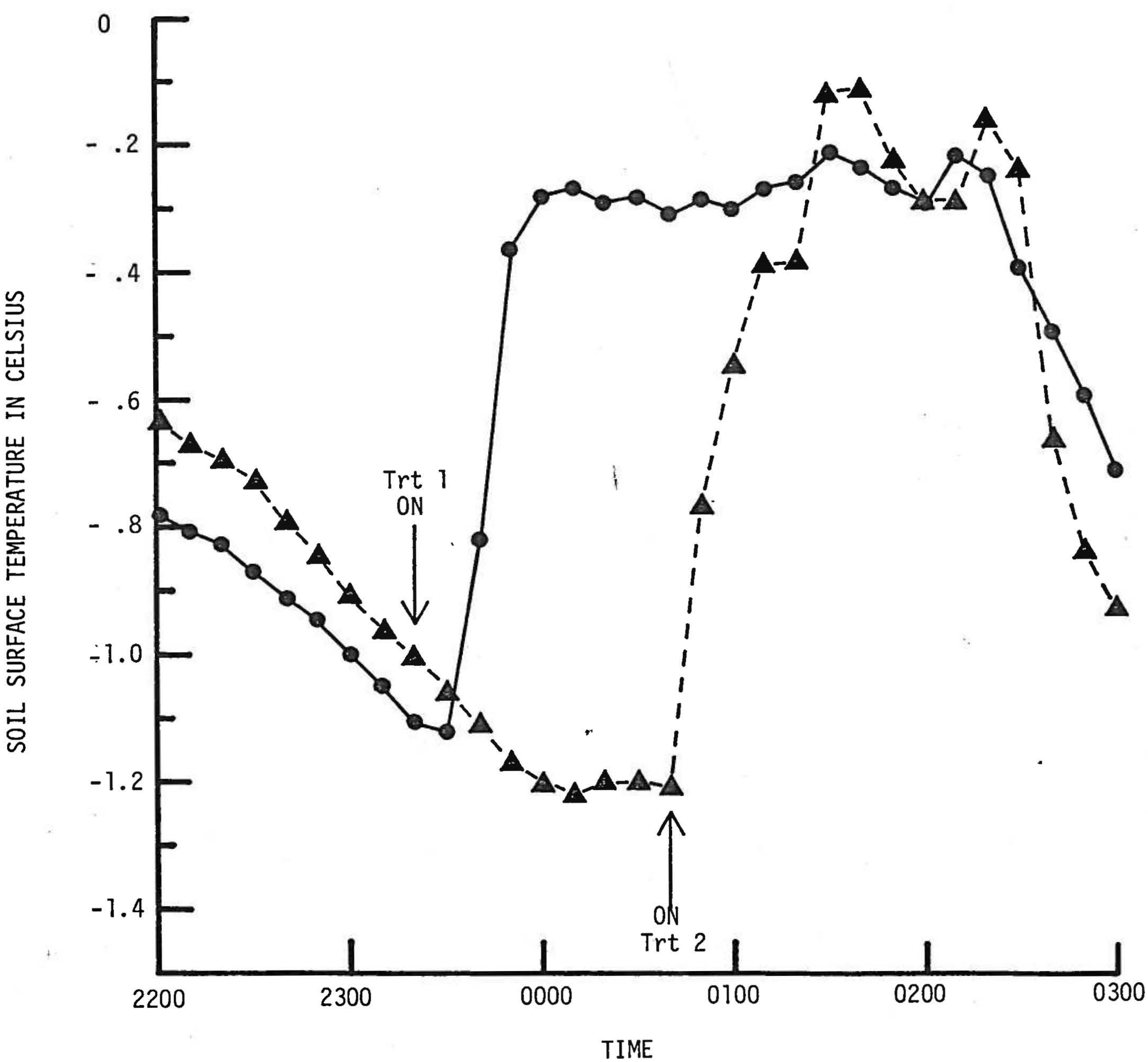

AIR TEMPERATURE
WET BULB TEMPERATURE
DEWPOINT TEMPERATURE
ON
OFF
Temperature in Celsius
3
2
1
0
-1
-2
-3
-4
-5
-6
0
1800
1900
2000
2100
2200
2300
0000
0100
0200
0300

Figure 1



0
- .2
- .4
- .6
- .8
-1.0
-1.2
-1.4
SOIL SURFACE TEMPERATURE IN CELSIUS
Trt 1
ON
ON
Trt 2
2200
2300
0000
0100
0200
0300
TIME

Figure 2

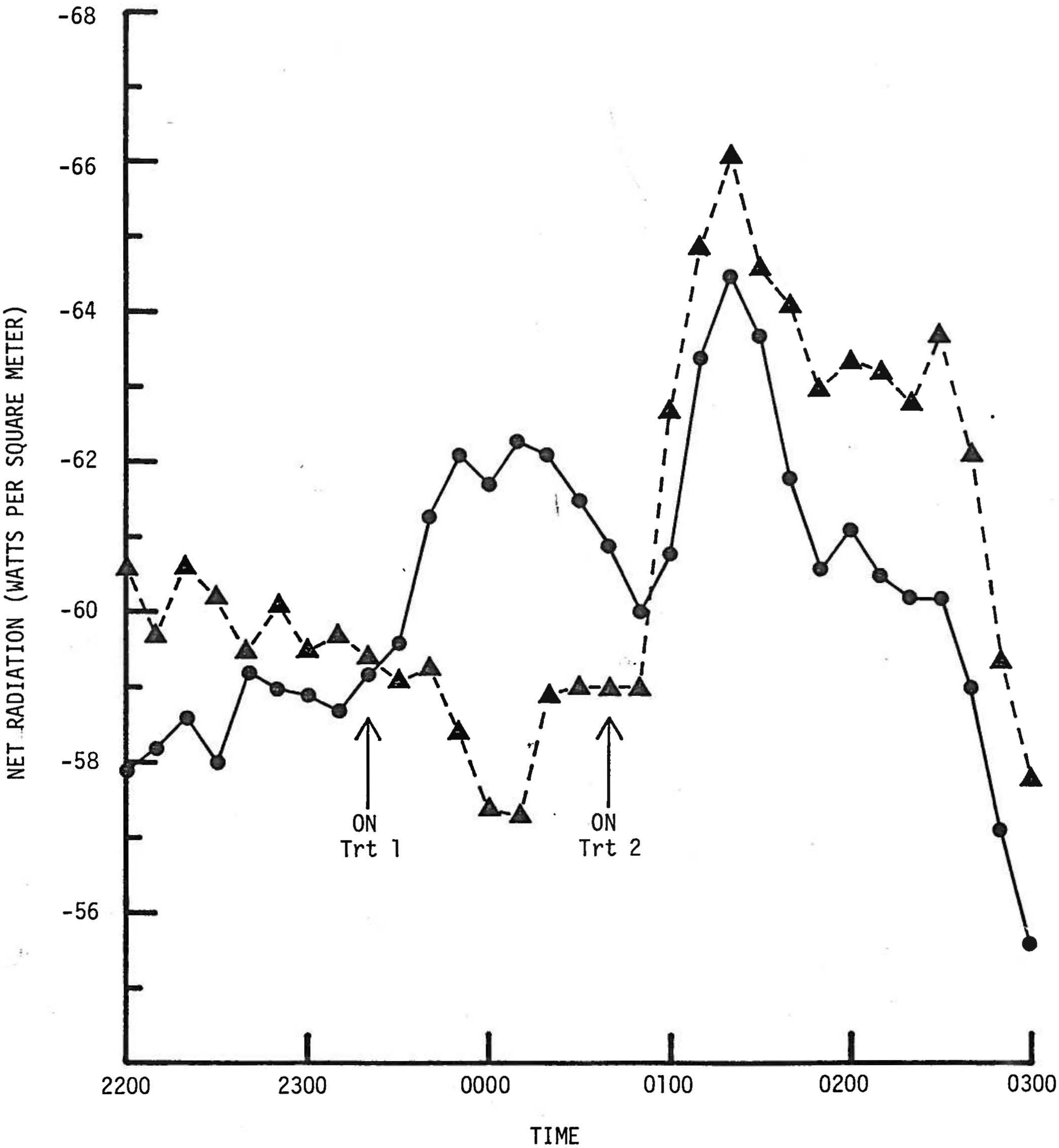

-68
-66
-64
-62
-60
-58
-56
NET RADIATION (WATTS PER SQUARE METER)
ON
Trt 1
ON
Trt 2
2200
2300
0000
0100
0200
0300
TIME

Figure 3

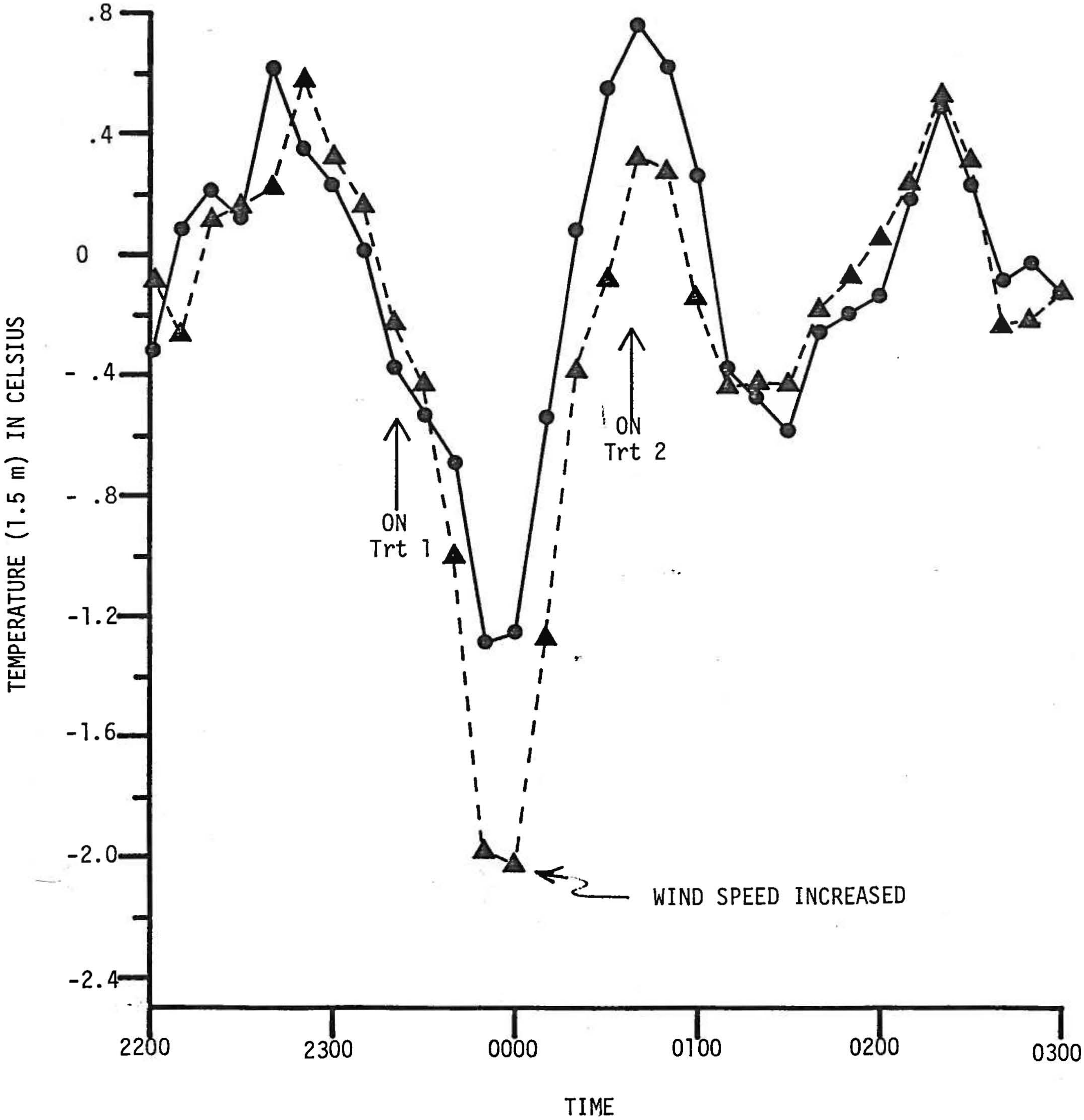

.8
.4
0
- .4
- .8
-1.2
-1.6
-2.0
-2.4
TEMPERATURE (1.5 m) IN CELSIUS
ON
Trt 1
ON
Trt 2
WIND SPEED INCREASED
2200
2300
0000
0100
0200
0300
TIME

Figure 4

the dormant season can irreversibly inactivate these dead cells. Potentially dormant applications of copper sulfate could be used in lieu of fixed coppers and could also have some activity against brown rot and shothole. To date, copper sulfate at the rates applied has not been phytotoxic.

The application of copper or phosphoric acid for frost control cannot be recommended at this time because their efficacy under actual field conditions has not been demonstrated for almonds. To date, there has been no frost in almond field plots and all results are based on laboratory assays.

Project No. 82-M2 - Tree and Crop Research
Part 1 - Freeze Protection - Irrigation
Part 2 - Nitrogen on Drip Irrigated Almonds

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Part 1 - Freeze Protection - Irrigation

Objectives: To evaluate and improve on the practice of under-tree irrigation for freeze protection in almonds by determining the proper timing, amounts, and methods of precipitation to meet environmental conditions on a given freeze night. To determine if the combination of heaters with under-tree sprinklers is more effective than a single method and under what conditions should the combination be used. To determine if the combination of under-tree sprinkling with control of ice-nucleating bacteria concentrations offers additional protection against severe freeze conditions.

Interpretive Summary: Influence of ground sprinklers on the climate inside an almond orchard was studied north of Chico during January, February and March, 1982. The air temperature within the orchard never fell below 28° F during this period, so it was not possible to differentiate differences in protection resulting from application rates of 0.08 inch/hour applied with low pressure sprinklers and 0.12 inch/hour applied with conventional sprinklers.

Even though temperatures were not low enough to cause plant injury, benefits from sprinklers were measured. Ground temperatures were raised from near 28° F to near 32° F in the plots that were sprinkler irrigated. Because the ground surface was warmer than in unprotected areas the radiation of heat from the surface was greater. This radiated heat was intercepted by the trees and, hence, they were more protected.

It seems that starting and stopping temperatures should be based on the wet-bulb temperature rather than air temperature. Wet-bulb temperature is the temperature of a thermometer with a wetted cotton wick over the bulb, which is aspirated by swinging the thermometer or blowing air over it with a fan. When the sprinklers are first started in an orchard, the air temperature drops and the dewpoint temperature rises. The wet-bulb temperature, however, remains constant and the air temperature will not drop below the wet-bulb temperature.

Part 2 - Nitrogen on Drip Irrigated Almonds

Objectives: Evaluate the effect of rate and timing of nitrogen application at two water application rates on growth, nutrient concentrations of several plant parts, fertility and nut yield of almonds.

Interpretive Summary: The trial has been established at the Nickels Estate. Water is being applied at 1.0 ET and 0.6 ET. Urea is being applied at five levels: Zero, one, two, three and four ounces per tree per season. One and two ounce treatments are being divided equally among April, June and August applications. The three and four ounce treatments are being divided among April, May, July and August applications. Nonpareil, Carmel and Butte trees planted in 1981 are being used in this study.

Monthly samples indicate that until August there were little or no differences in leaf N levels between the different irrigation or fertilizer rates. In August higher concentrations of total N were found in leaves at the higher water application rate. Also, within each water application rate, total nitrogen levels increased as the fertilizer rates increased. Twig samples and tree circumference measurements are being taken during the dormant period. Total, ammonia-N and nitrate-N will be completed on 1982 samples and run on the monthly leaf samples to be collected 1983.

Project No. 82-N7 - Tree and Crop Research
Weed Control

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Objectives: (1) To find a safe economic preemergence herbicide for annual weed control; (2) to develop an effective perennial weed control program using