Project Number: 85-O5
Project Leader: Richard Snyder

1985 ANNUAL REPORT

FROST PROTECTION WITH UNDER TREE SPRINKLERS

OBJECTIVES

1. To study the operation of under-tree sprinklers during a frost night to determine optimum management.

2. To develop a computer model that simulates the environmental conditions on a frost night.

3. To study the interaction between the use of ice-nucleating bacteria control and the use of under-tree sprinklers.

INTERPRETIVE SUMMARY

Operating under-tree sprinklers during a frost night increases the amount of radiation from the soil surface thus providing some heat for protection of almonds from frost. The soil surface temperature is raised by the sprinkler water and a beneficial increase in turbulent heat transfer also occurs.

When the sprinklers are turned on, the air temperature drops, the dewpoint temperature rises and they converge to the wet-bulb temperature. Air temperature will not drop below the wet-bulb temperature so the sprinklers can safely be turned on when the wet-bulb temperature is above the critical damage temperature.

On one night in January, during dormancy, a difference in temperature of 4° F was observed between a sprinkled (0.08 inch/hour) and unsprinkled orchard. The minimum temperature in the control plot was 24° F, and the winds were calm.

There was no frost during flowering or nut development, so no results on the interaction between use of ice nucleating bacteria and under-tree sprinklers were observed.

A theoretical computer model of the environment during a frost night was developed. It will be tested in 1986.

EXPERIMENTAL PROCEDURE AND RESULTS:

An experiment was set up in an almond orchard north of Chico, CA., during January through April, 1985. Two automatic weather stations were placed on a 10 meter tall tower in a sprinkler irrigated orchard and a variety of parameters were measured continuously during the period. A third station was placed in a control plot where sprinkler heads were removed and plugs installed. Sprinklers in the orchard are low-pressure type with a precipitation rate of 0.08 inch per hour. Sample trees in both the irrigated and non-irrigated area were either not sprayed or were sprayed with a copper compound to reduce the concentration of ice nucleating bacteria on the trees.

There were no occasions during flowering to the end of April when temperatures in the orchard were recorded below $0^{o}C$ ($32^{o}F$). However, the temperature did drop to -4.5 C ($23.9^{o}F$) in one night during dormancy and the sprinklers were operated to obtain some data. The results clearly demonstrate that the radiation from the soil surface is increased as a result of sprinkling. A rapid drop in temperature during the initial sprinkler start up was not observed as is often reported in over-plant frost protection experiments. The dewpoint and the air temperatures in the sprinkler treatment area were raised approximately $2.2^{o}C$($4.^{o}F$) relative to the control area. We conclude that at least $4^{o}F$ of protection would have been provided under the conditions observed during operation of the sprinklers.

No results were obtained on the control of ice nucleating bacteria because sprays were not applied until flowering when no freezing temperatures occurred.

Considerable effort has been directed towards development of a theoretical model of weather conditions in an almond orchard during a frost night. The model starts with initial temperature conditions at sundown, information on soil thermal characteristics, and wind speed to generate changes in temperature during successive time intervals until dawn. Soil heat flux is calculated using a finite difference procedure. Net radiation is calculated for clear sky conditions from soil surfae temperature. Air temperature is estimated from turbulent heat transfer which depends on wind and stability conditions. This model will be tested this coming frost season.