Real-time Weather Monitoring for Frost Protection Sprinkler Operations in Almond Orchards

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Objectives:

1. Develop and test an automated computer-based model to monitor real-time weather conditions in orchards as a basis for managing sprinkler operations for frost protection.
2. Develop guidelines for using the model to manage sprinkler operations on radiation frost nights.

Background:

A perennial question that besets almond growers seasonally is whether to use sprinklers to protect against frost, and when to turn them on and when to turn them off.

Making poor decisions about sprinkler usage can lead to significant crop losses. Insufficient usage has obvious consequences. Under severe conditions, it is better not to use sprinklers.

Excessive usage can lead to excessive energy consumption and possibly waterlogged soils and eventually to shortages of irrigation water.

This project is designed to assist growers in making prudent decisions about sprinkler usage. It calls for developing a customized computer model for tracking and estimating wet-bulb temperature trends during radiation frost nights. The data will be transferred real-time and the model will adjust as updated meteorological information becomes available.

The model will provide guidance on whether to use sprinklers and if used, starting and stopping them.

Data inputs for the model will be provided by a remote, sensor-equipped weather station set up at an orchard location. The data will travel to the computer by wireless or wire.

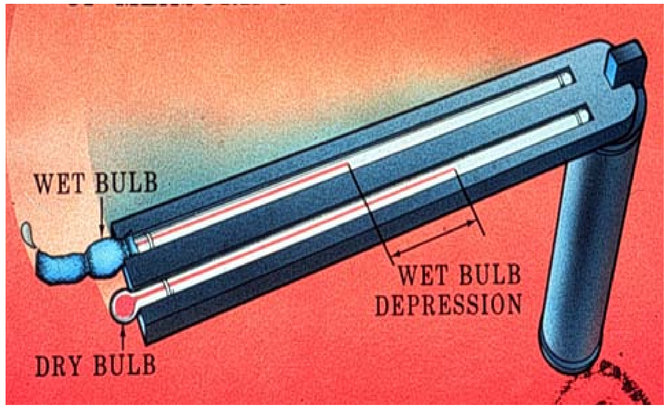

Fig. 1. Psychrometer for measuring wet-bulb and dry-bulb temperature. When wetted, the wet-bulb temperature decreases and the humidity around the bulb increases until the air around the bulb becomes saturated. The temperature when this occurs is the wet-bulb temperature. Wet plants will go to the wet-bulb temperature if wetted and no additional water is applied to freeze and raise the temperature. Thus, starting sprinklers too late or stopping too early can result in frost damage.

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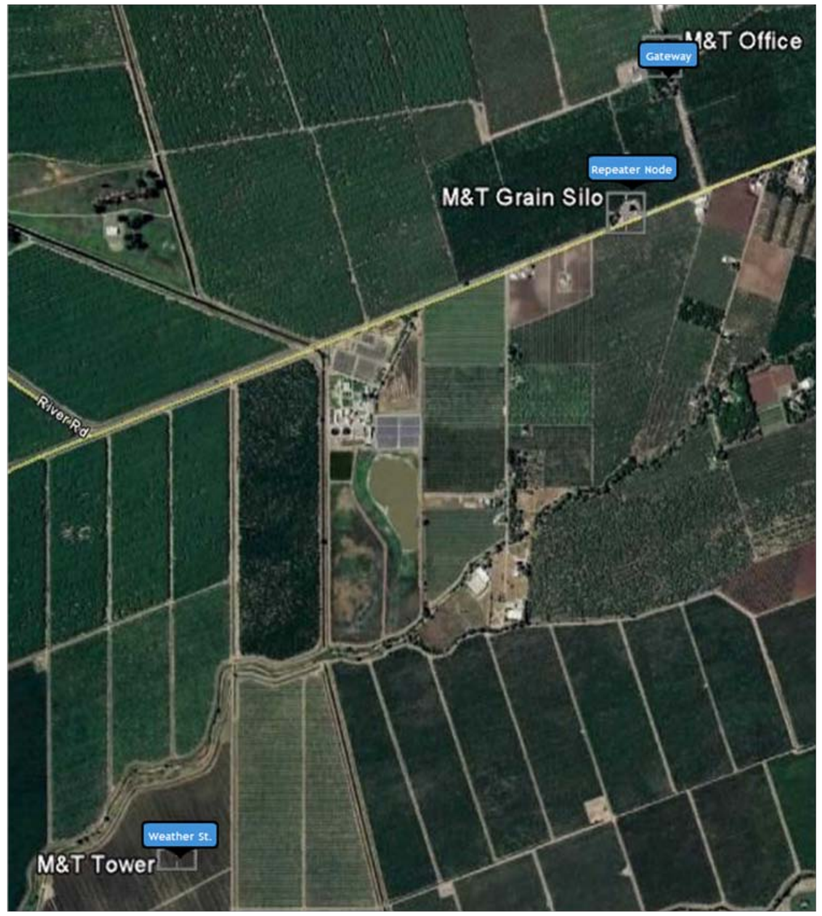

Fig. 2. Location of weather tower and Ranch Office about 5 miles west of Chico, CA

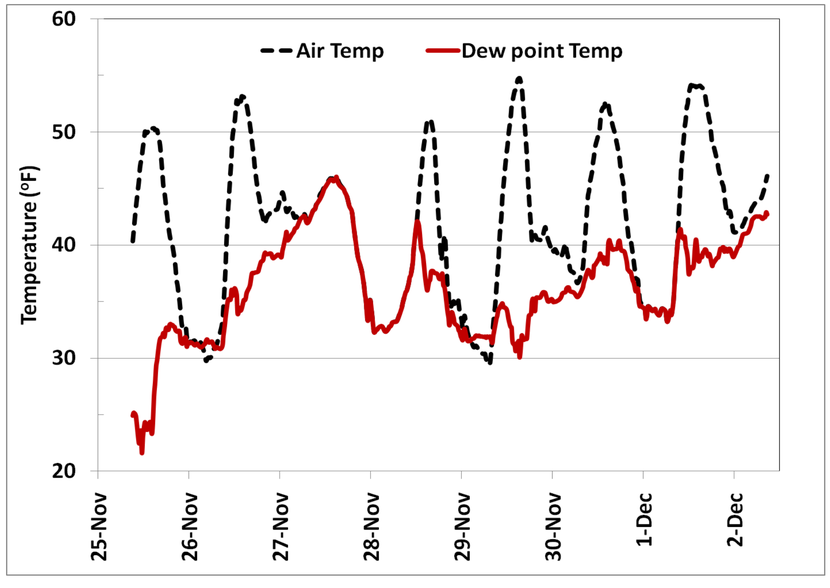

Fig. 3 Air and dew point output sample from the M&T wireless weather station. These data will be used to update the air and dew point temperatures during the night to improve the estimation of the nighttime wet-bulb temperature trend. Sprinklers should be started and stopped when the wet-bulb is above the critical temperature for damage.

Starting sprinklers too late and stopping too early can result in frost damage. To avoid damage, sprinklers should be started and stopped when the upwind wet-bulb temperature is above the critical damage temperature. Our goal is to combine continuously recorded temperature and humidity data with a wet-bulb forecast model to update and improve predictions of the wet-bulb temperature. This will provide the information needed to time the timing of sprinkler operation for frost protection.

Fig. 4. Ice accumulation from under-plant sprinklers in an almond orchard.

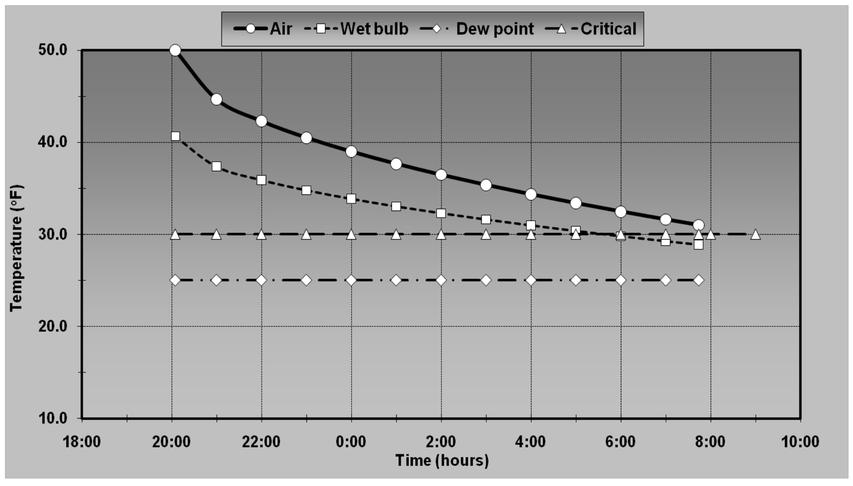

Fig. 5. Prediction of wet-bulb from air and dew point temperatures versus time for a predicted minimum of 31ºF without updating during the night.

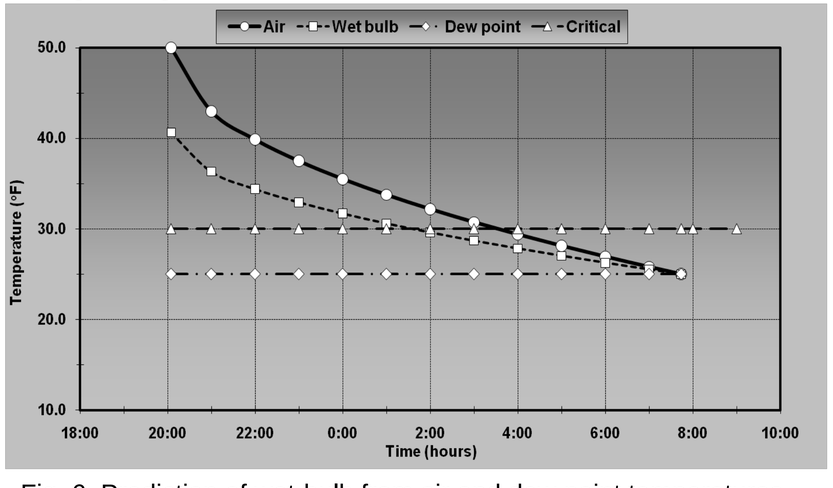

Fig. 6. Prediction of wet-bulb from air and dew point temperatures versus time for a predicted minimum of 25oF without updating during the night.