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Project No. 89-90 - Freeze Protection - Under Tree Sprinklers
(Continuation of Project No. 88-08)

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Objectives:

1. To study the effects of under-tree sprinkler operation on the environment in an almond orchard during freezing conditions.

2. To determine critical temperatures for freeze damage to almond varieties at various growth stages.

3. To study the effects of ground cover height on surface emitting temperatures.

Interpretive Summary:

Under the advection freeze type conditions experienced during the 1989 tests of under tree sprinklers for frost protection humidity measured 600 yards into an orchard could not be raised to 100% and only about 1 degree Fahrenheit of protection was achieved. Protection was even less closer to the upwind edge of the orchard. During the tests in early February, dewpoint temperatures were low and wind speeds were strong. In previous studies, more protection was afforded with the same sprinkler system (0.08 inch/hour), but the conditions were characteristic of radiation type freezes with calm wind speeds and higher humidity. Even under advection freeze conditions, there was a small benefit derived from sprinkler operation.

Cutting small branches and cooling them in a freezer was found to be a useful method for determining critical damage temperatures. New information was gathered on percentage damage at various temperatures during petal fall and the small nut stages of Peerless variety and at the small nut stage of Nonpareil and Butte varieties.

Using an infrared thermometer, surface emitting temperatures were measured over bare ground and over ground covers of different heights. Our results confirm earlier recommendations that no ground cover is best for frost protection unless the soil surface layer is dried by strong winds. The bare soil was warmest even after the trees had leafed out.

Experimental Procedure:

Automatic weather stations were set up in an almond orchard north of Chico during the spring of 1989 to study the changes in temperature and humidity with distance into an orchard being protected by under tree sprinklers during freezing conditions. Stations were placed on the upwind edge and at approximately 300 and 600 yards into the orchard. During two nights, measurements of temperature and humidity were taken. The objective of this study was to determine how evaporation rates change with distance into a protected orchard.

Small limbs were cut from Peerless, Nonpareil, and Butte variety trees during various growth stages. These excised limbs were placed in a freezer and were cooled at a constant rate to determine percentage damage at different temperatures. Branches were cooled and samples were held for 30 minutes at each temperature of interest before removing them. After removal, the cut ends were placed into water and the branches were later evaluated for percentage frost damage. There were 5 replications of each temperature.

A plot was set up in an almond orchard to evaluate surface emitting temperatures. The treatments were bare ground, uncut grass ground cover, and ground cover cut to 4 inches height. Surface emitting temperatures were measured with an infrared thermometer (emissivity = 0.98).

Results and Discussion:

During experiments in previous years, sprinkler operation always has increased humidity in protected orchards to near 100% relative humidity and has raised temperatures 4-5 degrees Fahrenheit. Under the severe conditions experienced during the 1989 tests, humidity could not be raised to 100% and only about 1 degree Fahrenheit of protection was achieved. The dewpoint temperatures were low and wind speeds were strong during the 1989 tests and the conditions would be classified as an advection freeze. In previous studies, the conditions were characteristic of radiation type frosts. Even under advection freeze conditions, there was a small benefit derived from sprinkler operation.

Cutting small branches and cooling them in a freezer was found to be a useful method for determining critical damage temperatures for Peerless, Butte, and Nonpareil varieties. Peerless was tested at three growth stages. The percentage damage recorded was slightly less than was previously reported during the full bloom stage. New information was gathered on percentage damage during petal fall and the small nut stages. Nonpareil was tested at the small nut stage and it experienced less damage than Peerless at the same stage. Sensitivities of Butte variety had not been previously reported, and we found it to be the most sensitive during the small nut stage. The following table lists our results.

Estimated percentage cold injury to almonds after 30 minutes exposure to various temperatures

Variety	Stage	Temperature (°F)				
		29	28	27	26	25
Peerless	Full Bloom		1	14	50	79
	Petal Fall	3	14	63		
	Nut Stage	9	45	46		
Nonpareil	Nut Stage	3	4	19		
Butte	Nut Stage	10	27	45	90	

Surface emitting temperatures were measured over various ground covers with an infrared thermometer as the trees leafed out. Our results confirm earlier recommendations that no ground cover is best for frost protection unless the soil surface layer is dried by strong winds. Even after the trees had fully leafed out, we still found the bare soil to be warmest.

Plans:

During the 1989-90 winter and spring, we plan to study the potential for using microsprinklers for frost protection. Different application rates will be studied to determine if they are adequate for protection. We also plan to expand our studies on percentage damage to almond varieties at various growth stages.

Publications:

No new publications were completed this year.