

## DRY AIR A FACTOR IN SPRINKLING AVOCADOS FOR FROST PROTECTION

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Sprinklers have been used for many years to protect some crops from freezing. For tree crops such as avocados one of the important limitations is the accumulation of ice on the trees causing limb breakage. Also, the excessive amount of water necessary for protection during a long cold period may increase root trouble.

Another limitation was observed the past winter (1962-63) where sprinkling produced an adverse effect on avocado trees. These trees were receiving a regular irrigation with low head sprinklers which wet the trees to a height of about 3 to 4 feet. The sprinklers were shut off in the afternoon after a weather report was made predicting freezing temperatures for the coming night. Air temperatures during this period were in the range of 35° F to 40° F. However, while the sprinklers were running there was considerable ice formed on the trees. A contributing factor here was that during this cold period the air was extremely dry as indicated by a low dew point. This increased evaporation had reduced the temperature of the water causing it to freeze. While the freezing of water liberates about 80 calories of heat for each gram of ice formed the evaporation of each gram of water requires about 600 calories. This points out the important cooling effect of evaporation. After the sprinklers were shut off there was no water freezing and therefore no benefit from the liberation of heat due to ice formation. In addition, the evaporation of moisture continued from the surface of the ice. This lowered the ice temperature to the range where severe damage occurred. The leaves which were covered with ice were frozen, the fruit was frozen and twigs to a diameter of  $\frac{3}{4}$  inch were killed. The trees were protected during the time that the sprinklers were running even though ice was formed. The damage due to the evaporation of moisture from the surface of the ice occurred after the sprinklers were shut off. Adjacent trees were not damaged as is indicated in the photograph.

Similar observations were made of damage to citrus trees in other areas. Sprinklers which had been used to protect against frost during the night were turned off in the morning after air temperatures rose above freezing. This is a good practice when using orchard heaters but not satisfactory with sprinklers in dry air conditions. With dry air, it would be desirable to run the sprinklers until the ice was melted from the trees or at least to make certain that the ice was melting rather than remaining frozen. Ice that is melting would have a temperature near 32° F.

The dew point is a measure of moisture in the air. Usually the dew point during winter cold periods ranges from 20° F to 30° F with one or two nights as low as 15° F. As an example of the unusually dry conditions this winter, during the freezing periods the dew

point was low in all districts and was 8° F to 10° F below zero in some.

In a test to measure the effects of this dry air, a series of temperature readings were made in an orange grove near Elsinore on the morning of January 20 when sprinklers were running.



Skirts of trees in foreground were sprinkled during the day and ice formed with temperatures of 35° F to 40° F and dew point estimated at about 0° F. Sprinklers shut off in late afternoon. The ice remained on the trees all night and into the next day. Trees in background not sprinkled.

Thermistors (for determining temperatures) were placed at six locations and readings made at about four minute intervals for the period from 5:30 a.m. to 6:30 a.m. Two thermistors were suspended, 8 inches above the ground, from the outer low branches of the north east corner of two trees just up-drift from the sprinkled area. Another pair was placed at a similar location on two adjacent trees which were wet by low head sprinklers. A third pair was placed  $\frac{3}{4}$  inch below the surface of the ground in the sprinkled area just below the second pair of thermistors. The temperature of the ground  $\frac{3}{4}$  inch below the surface was consistent at 32° F to 32.5° F. The temperatures at the other two points are indicated by Table 1. At the end of the test period, icicles about  $\frac{3}{4}$  inch long had formed on the two thermistors located in the spray from the sprinklers. The dew point was difficult to determine accurately but at 7 p.m. the previous evening the dew point in Corona was  $-8^{\circ}$  F. This test shows the formation of ice with sprinklers where air temperatures averaged 35° F for one hour.

TABLE I

Elsinore District \*

January 20, 1963 from 5:30 p.m. to 6:30 a.m.

Wind draft 2-4 miles per hour from northwest.

Sprinklers Rainbird 14V-3/32 nozzle operated at 25 p.s.i.

Time a.m.	North Trees			South Trees		
	8" Hi Sprinkled	8" Hi Dry	Difference	8" Hi Sprinkled	8" Hi Dry	Difference
5:30	31.0	33.5	-2.5	29.5	35.5	-6.0
5:40	32.0	36.0	-4.0	31.5	37.0	-5.5
5:52	31.0	31.5	-0.5	29.0	31.0	-2.0
6:04	32.0	36.0	-4.0	33.0	36.5	-3.5
6:15	31.0	36.5	-4.5	32.0	36.5	-4.5
6:30	31.0	35.0	-4.0	29.25	35.0	-5.75
average all readings	31.5	34.7	-3.2	30.6	35.4	-4.8

\* There were 16 readings made in this 1 hour period. These are samples of the data.

## SUMMARY

Sprinkling avocados during low temperatures and extremely dry air conditions either for frost protection or irrigation can be a hazard to avocado trees. If trees are sprinkled and ice forms, then to protect the trees the sprinklers should be continued in operation until the ice is melting. To be certain, the sprinklers can be continued in operation until the ice is completely melted. A film of water should be maintained continuously on the surface of the ice on the trees. Ice with this film of water on the surface will have a temperature of near 32° F.