Frost Protection:
When to Turn Sprinklers On and Off

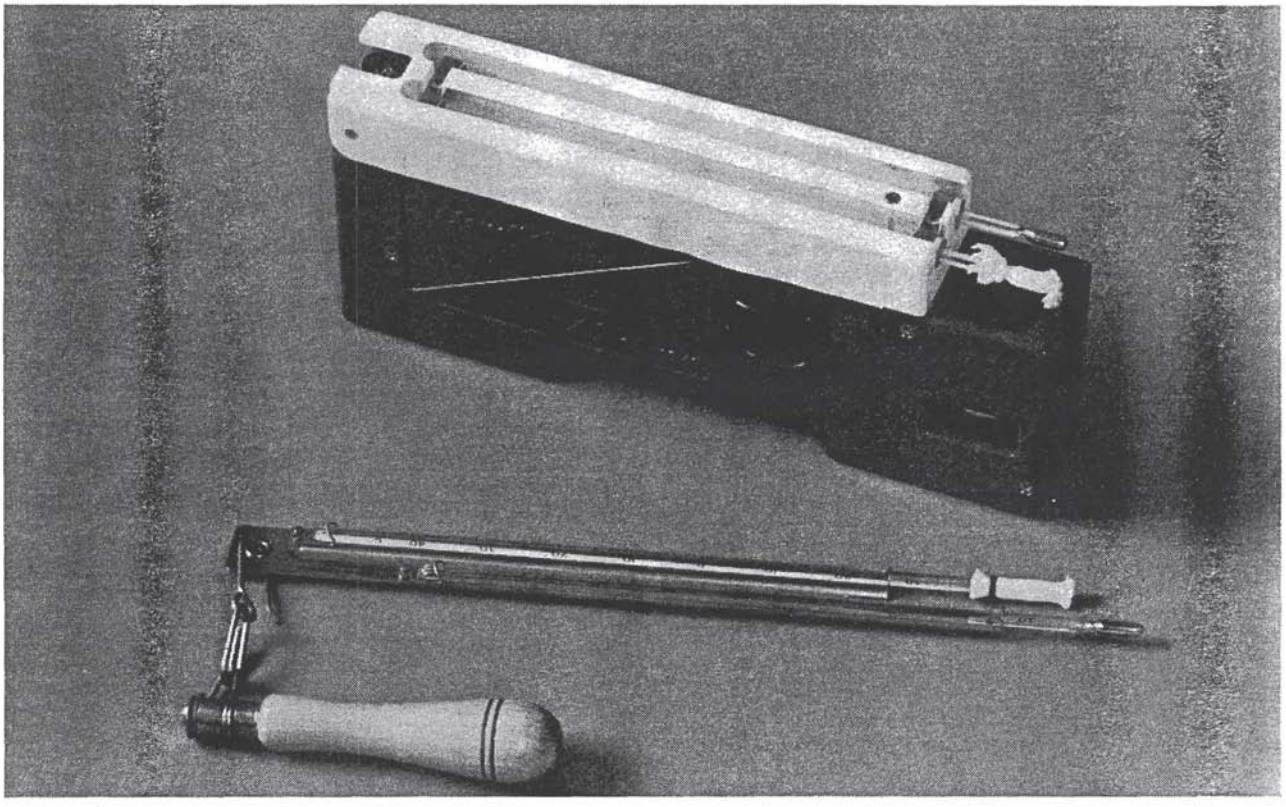
Sprinklers have been used extensively for frost protection in California, and proper management is required to obtain beneficial results. Two of the most critical decisions are when to turn the system on and when to turn it off. The decisions should be based on both temperature and humidity in the orchard.

Recommendations given here can be used for either over-plant or under-plant sprinklers. Sprinklers can be turned on or off at higher, but not lower, temperatures than those recommended. All sprinklers in a protection area should be on when the temperature drops to a specified air temperature that depends on humidity and the "critical temperature" for crop damage.

A wet plant's temperature will not fall below the wet-bulb temperature, if sprinklers stop or if an application rate is inadequate. Consequently, starting and stopping sprinklers should always occur when the wet-bulb temperature is above the critical temperature for damage to the crop. Even if the sun is shining on the plants and the air temperature is above the melting point (0°C or 32°F), sprinklers should not be turned off unless the wet-bulb temperature is above the critical temperature. Permitting the wet-bulb temperature to exceed the melting point before turning off the sprinklers can be done safely if soil waterlogging is not a problem.

The wet-bulb temperature can be measured directly with an instrument called a psychrometer (see photo) or it can be determined from the dew point and air temperature (table 1).

The wet-bulb temperature is determined with a psychrometer by wetting the cotton wick and swinging the psychrometer (or aspirating with the fan)



Aspirated (*upper*) and sling (*lower*) psychrometers are used to determine humidity by measuring dry-bulb and wet-bulb temperatures. The cotton wick on a wet-bulb thermometer is wetted with distilled or deionized water, and it is aspirated by a fan or by swinging the psychrometer until the temperature stabilizes at the wet-bulb temperature. This resulting wet-bulb temperature can be used to time the operation of sprinklers for frost protection.

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until the temperature of the wet-bulb thermometer stabilizes. If the temperature is below 0°C (32°F), the water on the cotton wick should be frozen and aspirated until the temperature stabilizes. Touching the wick with cold metal or ice will cause freezing.

Air temperatures for a range of wet-bulb and dew-point temperatures are given in Table 1. A wet-bulb temperature just above the critical temperature can be chosen and, if the dew-point temperature is known, the air temperature to turn the sprinklers on or off can be selected from table 1. If relative humidity and temperature figures are available instead of dew-point temperature, use table 2 to determine the dew-point temperature; then use table 1 to obtain the desired air temperature.

Critical temperatures are specific to the crop being protected and sensitivity to frost damage during the growth stage when the frost night occurs. Generally, sensitivity increases from first bloom to the small nut or fruit stages when a crop is most likely to be damaged. Sensitivity is also higher when warm weather has preceded a frost night.

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TABLE 1. Minimum turn-on and turn-off air temperatures for sprinkler frost protection for a range of critical damage and dew-point temperatures*

Dew-point temperatures (°F)	Wet-bulb temperature (°F)										
	22	23	24	25	26	27	28	29	30	31	32
32											32
31										31	33
30									30	32	34
29								29	31	33	34
28							28	30	32	33	35
27						27	29	31	32	34	35
26					26	28	30	31	33	34	36
25				25	27	29	30	32	33	35	37
24			24	26	27	29	31	32	34	35	37
23		23	25	26	28	29	31	33	34	36	38
22	22	24	25	27	28	30	32	33	35	36	38
21	23	24	26	27	29	30	32	34	35	37	39
20	23	25	26	28	29	31	33	34	36	37	39
19	24	25	27	28	30	31	33	34	36	38	39
18	24	26	27	29	30	32	33	35	37	38	40
17	25	26	28	29	31	32	34	35	37	39	40
16	25	26	28	29	31	33	34	36	37	39	41
15	25	27	28	30	31	33	34	36	38	39	41

*Select a wet-bulb temperature that is above the critical damage temperature for your crop and locate the appropriate column. Then choose the row with the correct dew-point temperature and read the corresponding air temperature from the table to turn your sprinklers on or off. This table assumes a barometric pressure of 1000 millibars.

TABLE 2. Dew-point temperatures for a range of air temperatures and relative humidities

Relative humidity (%)	Temperature (°F)					
	20	25	30	35	40	45
100	20	25	30	35	40	45
90	18	23	27	32	37	42
80	15	20	25	30	34	39
70	12	17	21	26	31	36
60	8	13	18	23	27	32
50	4	9	14	18	23	28
40	0	4	9	13	18	22
30	− 7	− 2	2	7	11	15
20	−15	−10	− 6	− 2	2	6
10	−18	−24	−20	−16	−12	− 8

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