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COOLING AVOCADO TREES BY SPRINKLING

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Avocado trees are subject to fruit drop from hot weather. Field tests have been made in an avocado orchard using overhead sprinklers for evaporational cooling to determine if air temperatures could be modified sufficiently to control this disorder. Temperature reductions up to 5° and 7° were obtained.

Hot weather has caused fruit drop of avocados during the summer. It also causes excessive fruit drop at fruit setting time in the spring if the weather suddenly turns hot. As a possible means of protecting trees from this adverse weather, tests were made to determine the air temperature reduction which might be expected from evaporation from sprinklers. Three representative tests are presented here out of the 11 made during the 1962 summer season. The tests were made in an 85 acre avocado orchard on the low portion of an east facing hillside. The orchard was non-cultivated, sprayed for weed control, and sprinkled for irrigation. The avocado trees, spaced at 18 by 18 feet, had a uniform height of about 18 feet as they had been mechanically topped at 16 feet. The treating and monitoring set-up for the orchard tests is shown in fig. 1.

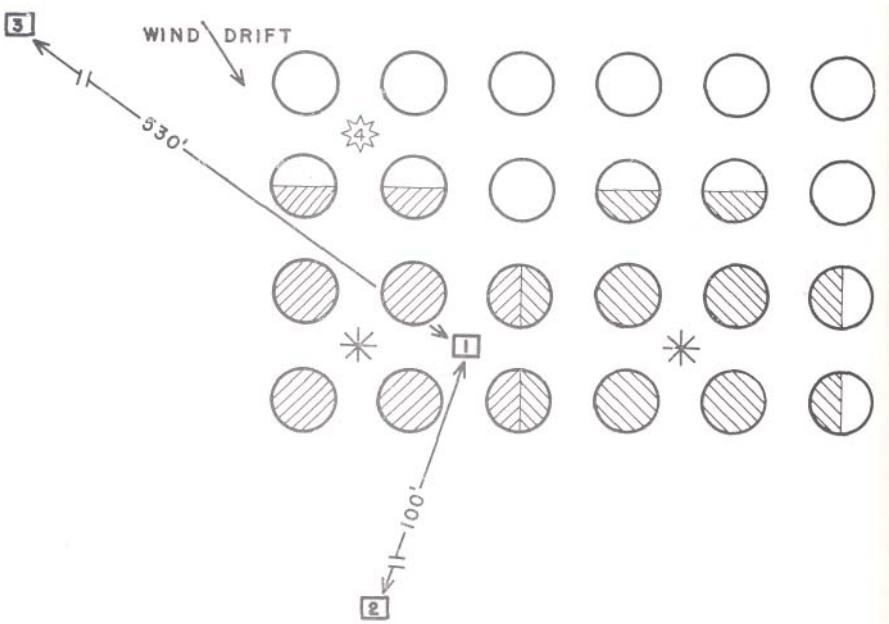

Figure 1. Location of sprinklers (*), microclimate stations (1, 2, 3), anemometer (4) and portions of trees wet during sprinkler tests (shaded).

Temperature and humidity measurements were made at the test station (1) and two controls located at station (2) 100 feet south of the test station and station (3) 530 feet north westerly from the test station. The hygrothermographs at Station 1 and 2, fig. 1, were operated in standard Weather Bureau shelters so that none of the instruments would be wet by the sprinklers.

Anemometer recordings of wind velocity and wind direction were made 80 feet north of station, fig. 1.

Three overhead sprinklers were set in a line east and west through the number 1 test station area as shown in fig. 1. They were 15 feet high with 3/32 inch nozzle and wet a ground area 50 feet in diameter, except where the pattern was modified by trees. Pressure was maintained at the base of the sprinklers at 70 to 80 pounds per square inch so that each sprinkler delivered about 2.1 gallons of water per minute.

Test 1—September 5, 1962—1:20 p.m.

The air temperature had risen to 94°F (table 1) at the test station when the sprinklers were turned on. The air drift estimated to be 3-5 miles per hour, was from the north west with occasional gusts from the west.

TABLE 1

Test 1—September 5—Change* in air temperature of avocado orchard from starting temperature due to sprinkling.

		Temperature at 4 ft. (degrees F)		
Operation	Time	Station 1	Station 2	Station3
Sprinklers Started	1:20 p.m.	0	0	0
	1:45	—5	0	0
Shut off sprinklers	2:20	—5	0	+½
	4:00	—½	—4	0
Test 3—September 6				
Sprinklers started	1:45 p.m.	0	0	0
	2:15	—4	+3	+1
Started hand sprinkling	2:45	—4	+3	+½
	3:00	—4	+4	+½
Stopped hand sprinkling	3:15	—5	+4	+½
Started hand sprinkling	3:30	—4½	+4	+½
Stopped all sprinklers	3:50	—5	+4	+½
	5:00	0	+5	+2
Test 2—August 16—				
Sprinklers started	11:50 a.m.	0	0	0
	12:30 p.m.	—3½	+½	+1
Started new sprinkler	1:30 p.m.	—4	+ 1	+2½
Stopped all sprinklers	2:40	—6	—½	+2½
	4:00	0	— 3	+½

*(—) Indicates air temperature decrease.
(+) Indicates increase.

After starting the sprinklers, the air temperature dropped rapidly from 94° F to 89° F. The temperature was maintained rather uniformly at this level as long as the sprinklers were running. At 2:20 the sprinklers were shut off. The temperature quickly began to rise and reached a peak of 93½° F by 4 p.m. (fig. 2). Relative humidity at the start of the test was 20% and increased to 24% during the experiment. By 4:00 the relative humidity had gone down to 22% (fig. 2).

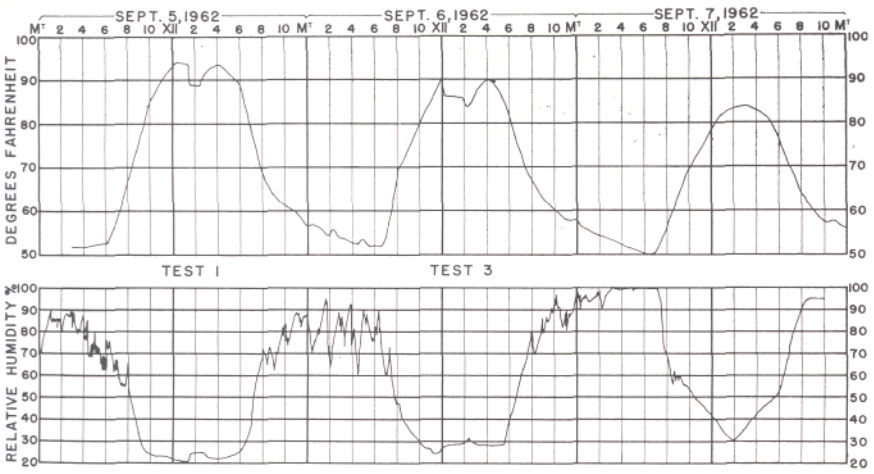

Figure 2. Hygrothermograph record showing air temperature (upper curve) and relative humidity (lower curve) changes in degrees Fahrenheit and per cent respectively for tests 1 and 3.

Test 2—August 16, 1962—12:00 Noon.

The sprinklers were turned on at 12:00 o'clock. There was an air drift from the northwest estimated at 5 mi/hr. Air temperature dropped rapidly from the starting temperature of 98° F to 94° F before leveling off (table 1). This drop obtained at station 1 was 4° while previous drops of 5° to 7° had been noted during several previous tests. In this case, the wind drift displaced the north margin of the sprinkler pattern about 8 feet downwind. This reduced the wetted leaf area of the trees on that side of the sprinkler. To offset this effect several trees upwind of the trees in the wetted area were sprinkled by hand. While the hand sprinkled trees were wet, the temperature went down another degree at station 1 making a total drop of 5° which shows the effect of increasing the evaporating area. When the hand sprinkling was stopped for 15 minutes, the temperature rose ½° F, and went down when the hand sprinkling was again started. At 3:50 p.m. all the sprinklers were shut off and the temperature quickly rose to 98° F (table 1). During the 2 hours and 5 minutes which they were operated, the sprinklers maintained a 4 to 5° reduction in temperature.

Test 3—September 6, 1962—11:50 a.m.

For this test the end sprinkler on the west end of the three sprinkler system (fig. 1) was moved. The new location was northwest of station 1 which placed it north of the sprinkler nearest this station. The temperature at station 1 at 11:50 a.m. was 90° F. The two sprinklers on two sides of station 1 were started. By 12:30 p.m. the temperature was 86.5° F, a drop of 3½°. It remained at this level until 1:30 p.m. when the third sprinkler was started (table 1). The temperature then dropped to 84° F by 2:40 p.m., or a reduction of 2½° in addition to the first drop. All sprinklers were then shut off and the temperature rose to 90° F, showing an increase in air temperature of 6° by 4:00 p.m. During this period, the wind drift was from the northwest and varied only slightly from the average of 4 miles per hour. The relative humidity, which was 24% at 11:50 a.m. rose to 29% at 12:30 p.m. and 33% by 2:30 p.m., then dropped to 28% by 4:00 p.m.

(fig. 2).

SUMMARY

Eleven tests were made to determine the effect of tree-sprinkling on the reduction of air temperature in an avocado orchard. There was a natural wind-drift of 3-5 miles per hour which persisted in the test area through most of the experimental period. Reductions in air temperature of 5° to 7° were obtained when the air movement was 4 miles per hour and the sprinklers were both sides of the trees in the two adjacent rows and one side of the second row in the test area. The wet leaves acted as evaporator cooling pads. Reduction in the area wet reduced the cooling effect while increases resulted in a greater cooling in the range of these tests. The maximum potential cooling from water evaporation was not obtained as the relative humidity was usually 20% to 25% before sprinkling began and increased only 6% to 12% during sprinkling. Additional cooling from evaporation could be expected if a larger area were wet or if more finely divided sprays were used.