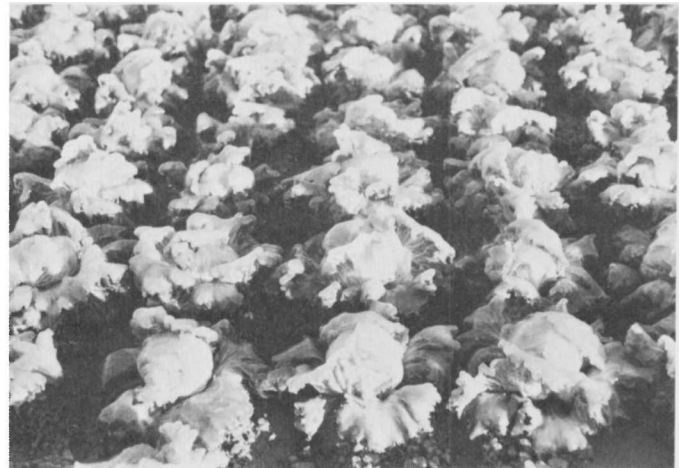




Alfalfa field where thermocouples were placed before icing.



Lettuce heads thickly coated with ice for frost protection.

PRECAUTIONS IN USE OF SPRINKLERS FOR FROST PROTECTION IN ALFALFA AND LETTUCE

FRANK E. ROBINSON

THE USE OF SPRINKLER IRRIGATION to provide frost protection for grapes, artichokes, and strawberries is an accepted practice on many farms in California. Some precautions should be taken, however, including careful consideration of the type of sprinkler used, particularly when low application rates are utilized.

There are very few nights when frost can be studied in Imperial Valley. However, during a span of eight nights in January of this year, ground temperatures dropped well below freezing. Alfalfa

plants "died back" to the soil surface and new growth began when the weather warmed. During this cold period, thermocouples were attached to alfalfa plant stems 6 inches above the ground and sprinkled in three regimes. Sprinklers were turned on at 2:30 pm, and the temperatures dropped rapidly after sundown at 5:00 pm, January 4, 1971. By 7:00 pm, the field was coated with ice and one set of 36 sprinklers was turned off.

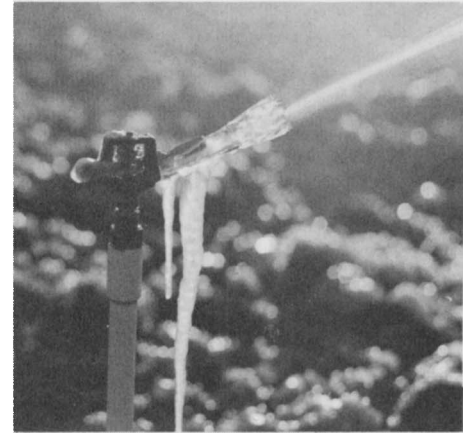
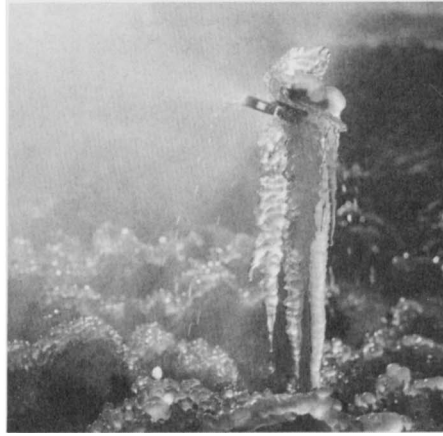
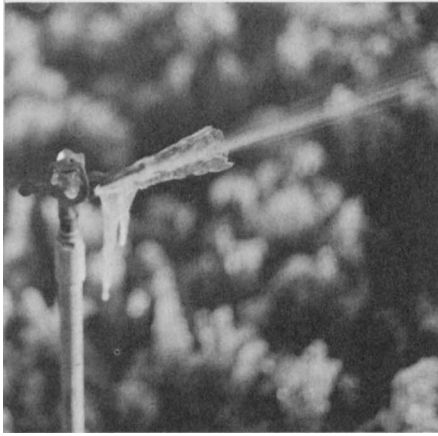
A second set of 36 sprinklers was allowed to run until 7:00 am, at which time it was observed that three of the four sprinklers that surrounded the thermocouples had accumulated ice so that

the sprinkler no longer operated properly. This set was turned off at 7:00 am. In the third set of 36 sprinklers, two of the four test sprinklers were frozen at 7:00 am. The ice was removed and the sprinklers were allowed to run until noon when the ice melted from the plants.

The test area contained several types of sprinklers with many variations in propensities to ice up and stop working. Table 1 shows the percentage of ice failure of the sprinklers. It appeared that the mobile sprinkler arms had varying degrees of ice removal potential. The arms with plastic V-shaped spreaders apparently removed ice from the nozzle

Where sprinklers freeze up and release water unevenly in the field, ice coatings become very thick. Right, ice coating from sprinkling lettuce.





When sprinkler rocker arms freeze away from the nozzle, the ice forms hollow cones around the jet, as shown in photo to left. Sprinkler arms should have enough weight to remove ice from the nozzle (center photo). Plastic sprinkler arms iced up rapidly.

by striking close to the nozzle surface, and because the plastic V was flexed at each stroke the ice flaked off the arm surface. The rigid arms required sufficient weight to build inertia to break away the ice that formed on nozzle, arm, and spring. The lighter solid plastic arm should not be used for frost protection. Ice removed from these arms reformed within 10 minutes. The light aluminum arm was little better than plastic, but the heavier aluminum arm was considerably better. The heavier of the two brass arms also gave better performance.

Sprinkler freeze stoppage

Table 2 shows the consequence of sprinkler freeze stoppage. The plants that had been coated by 7:00 in the evening dropped to 12°F, 5° below the air temperature. This was probably due to the sublimation of water vapor from the ice surface into the very low 21%-humidity northwest wind at this time. Where sprin-

Lighter area to left of center indicating yellow-appearing alfalfa in frost-damaged check plot, as compared with darker (green) area to right that had been sprinkled and allowed to coat with ice for frost protection.

klers continued to run, plant temperatures remained higher than the air; but as the sprinklers froze, these temperatures dropped below air temperature also. The freezing of the sprinklers took place between midnight and 7:00 am.

Warming

It was of interest to note that after sunrise the warming of the ice coated plants was the fastest in those that had gone through the night without sprinkling. This was probably because they had a thinner ice coating. The plants with continuous flow after 7:00 am and those where the flow was stopped at 7:00 am warmed at about the same pace. Other studies have shown an advantage to continuous sprinkling as the ice melts to maintain a more even temperature on the plant.

After the test was completed, there were seven more nights of below 32°F. Most of the alfalfa fields in the valley died back to the soil surface and began regrowth from the crowns. The regrowth in the area that was coated with ice but not sprinkled was slower than the adjacent area that was sprinkled. Thirty days after the icing a distinct boundary was

visible due to the brown stalks still visible in the iced but not sprinkled area. In the adjacent area the green regrowth had hidden the brown stalks.

Temperature

The temperature of the supply ditch water used in these tests was 39°F—considerably lower than the 70° or 80°F water taken from wells in other portions of the state. The rapid freezing in this test was due in part to the low initial water temperature and in part to the very low -16°F-dew point.

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TABLE 1. TYPES OF SPRINKLER ARMS WITH RELATION TO FREEZE STOPPAGE

Type of sprinkler arm	Weight of arm	Nozzle size	Percentage stoppage by icing
	grams	inches	%
1 Plastic	14.2	5/64	100
2 Aluminum	20.3	5/64	75
3 Aluminum	20.3	3/32	63
4 Aluminum	28.0	5/64	20
5 Brass	43.8	3/32	63
6 Plastic V on brass	46.1	5/64	6
7 Plastic V on brass	56.9	5/64	33
8 Brass/insect shield	192.2	3/32	14

TABLE 2. TEMPERATURES (F°) OF AIR AT ONE FOOT AND OF ICE COATED ALFALFA 6 INCHES ABOVE GROUND AS SPRINKLERS WERE TURNED OFF AT THREE DIFFERENT TIMES*

Temperature of	Time							
	3 PM	6 PM	9 PM	12 PM	3 AM	6 AM	9 AM	12 AM
Air				Temperature F°				
Plants ice coated†	54	30	25	21.5	20	17	44	54
Sprinkler off 7 PM	48	28	21	15	13	12	27	44
Sprinkler frozen after 12 PM‡	46	28	28	26	20	18	25	35
Sprinkler off 7 AM	46	28	28	26	20	18	25	35
Sprinkler frozen after 3 AM§	47	28	28	27	27	22	26	35

* Sprinklers on at 2:30 pm and turned off:
 † at 7 pm with plants encased in ice
 ‡ at 7 am three of four sprinklers frozen
 § at 7 am two of four sprinklers frozen—ice removed from sprinklers which ran until ice melted at about 12 am

