Ornamental Section

USE OF WATER SPRINKLERS TO PROTECT FERN AGAINST FREEZE DAMAGE

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ABSTRACT

Fern is a tender ornamental plant that is damaged when frost forms on it or when the temperature remains as low as 28° F for two hours or more. To determine the effectiveness of sprinkling with water to prevent freeze damage, thermocouples were attached to fern at various distances from sprinklers on cold nights during the winters of 1964-65 and 1965-66. Records were obtained on calm nights and windy nights. Comparison of temperatures of the sprinkled fern with air temperatures outside the fernery indicate that when properly installed and operated, sprinklers are effective in the prevention of freeze damage to fern.

INTRODUCTION

Approximately 2,000 acres of Asparagus plumosus nanus, commonly known as fern (8) is grown in Florida. Over 1,000 acres is grown in Volusia County with smaller acreages in Lake, Putnam, Marion, Brevard and Seminole Counties. During the past few years a fern known as leatherleaf has also been cultivated. The plumosus fern has a fine feathery texture, while leatherleaf is more flat and broad. Both types grow near the ground, ranging from 6 to 18 inches in height. The wholesale value of all fern is well over $3,000,000 (8) per year. Since the ferns require partial shading from sunlight, they are grown under a slat roof or in oak tree hammocks.

Fern is damaged when the air temperature remains at 28° F for two hours or more (2). A common method of protecting fern from freeze damage has been with oil heaters or wood fires. Occasional attempts have been made to protect fern by spraying it with water. One such experiment was reported for the winter of 1937-38 (7). Businger (1) has reported on the theory of this method of cold protection. Gerber and Harrison (5) have also reported on the general theory and conclusions of their experiments with citrus in Florida. Briefly, this method of cold protection utilizes the latent heat of fusion of water. Heat is released to the plants when the water freezes. The quantity of heat released is 80 calories per gram of water, or 1,200 BTU's per gallon.

EXPERIMENTAL

A fernery at Pierson, Florida was used to determine the effectiveness of sprinklers. Tests were conducted during the 1964-65 and 1965-66 winter seasons. The results of the former were summarized in April 1965 (3). The fernery was approximately 2 acres in size, had a slat roof 8 feet high and was surrounded by a wooden wall. Oak trees projected upward through the roof in several places. Rainbird No. 20-A low angle sprinklers were placed 30 feet apart. Distances varied slightly because of posts and tree trunks. This spacing permitted almost complete overlapping of the water. Most sprinklers had a nozzle opening of 5/32 inch but some had openings of 1/8 inch. All sprinklers were 2 feet above the ground. The average rate of rotation of the sprinklers was once per minute although some rotated slower and others slightly faster. The system was operated at a pressure of 45 PSI, supplying approximately 0.4 inch of water per hour. Differences in elevation of the ground and the condition of the walls and roof cause temperature variations within the fernery. Usually minimum temperatures inside slat ferneries are from 1° to 2° F warmer than those outside at the same elevation and may be from 1° to 3° F warmer under good oak hammocks (2).

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Occasionally during the early evening light winds prevail outside, but winds are calm inside the fernery. Temperatures during these times are slightly colder in the fernery than they are outside.

Thermocouples were used to measure temperatures inside the fernery. The temperatures were recorded by a Leeds and Northrup potentiometric, multipoint recorder with automatic reference junction compensation. Two minimum registering thermometers were also placed in the sprinkled area. A control station equipped with a minimum thermometer and thermograph was placed 150 feet southwest of the fernery. Seven thermocouples were attached to fern near the top of the plants. One was attached to a fern under an oak tree. Distances from sprinklers varied. During these experiments (after the sprinklers had been running for some time) temperatures varied slightly at any given time in areas that were receiving water from at least two sprinklers. The temperature variations were usually 1° or 2° F but occasionally as much as 3° F and they were probably caused by changes in the amount of water received at the temperature sensor due to changes in wind direction and velocity.

In the results that follow, the temperature recorded from thermocopule No. 9 is representative of the temperature in those parts of the fernery receiving water from at least two sprinklers having nozzle openings of 5/32 inch. During the January 1966 freezes, station No. 13, under an oak tree, received less water than the others due to deflection by the tree trunk and the smaller nozzle openings in the adjacent sprinklers. Temperatures from station No. 13, during the January freezes are indicative of areas receiving inadequate water for cold protection of fern.

FIELD RESULTS

Figure 1 shows temperatures recorded at No. 9 and No. 13 in the sprinkled area and at

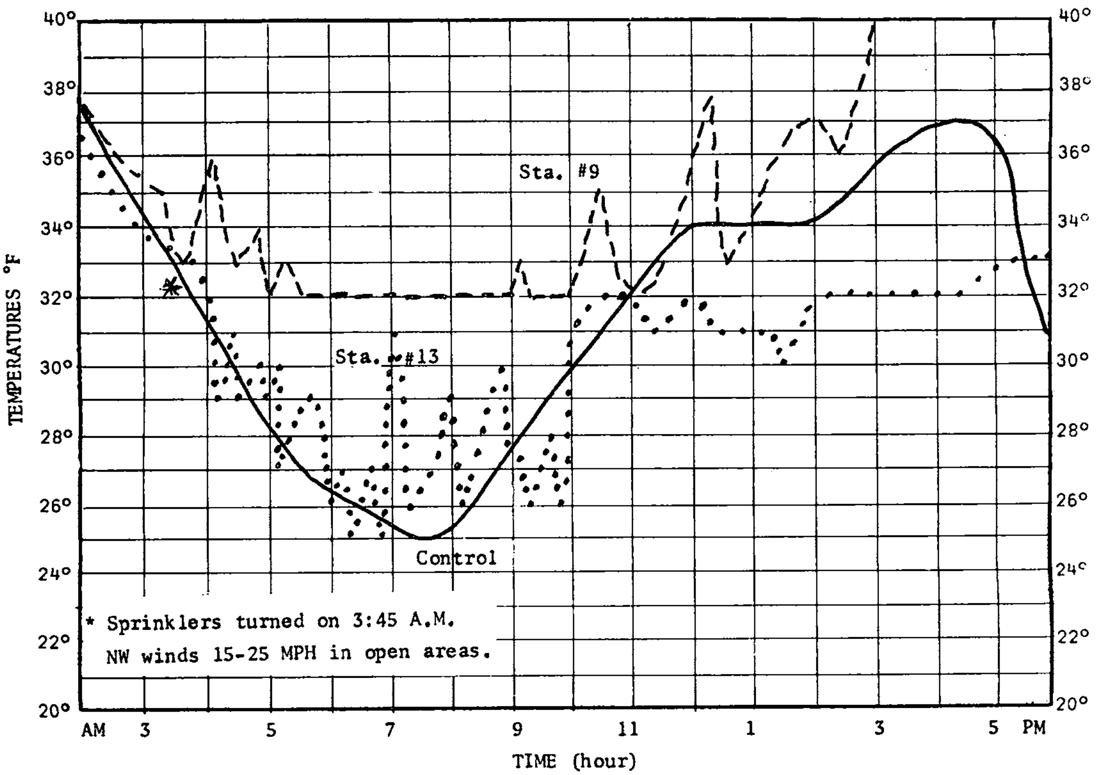

Figure 1. - Effect of overhead sprinkling on leaf temperature of fern, stations 9 & 13, compared with outside air temperature at control station, January 30, 1966.

the control station on January 30, 1966. A cold front reached Pierson about 9:30 P.M. of January 29 and was accompanied by gusty northwest winds. The temperature fell steadily at the control station after the frontal passage, reaching a low of 25° F at about 7:30 A.M., January 30. Thereafter, the temperature rose to a high of 37° F at 4 P.M. The temperature at No. 9 and No. 13 was 33° when the sprinklers were turned on at 3:45 A.M. on January 30. The temperature at No. 9 rose to 36° in less than an hour and never fell below 32° during the remainder of the day. Thermocouple No. 13 showed great fluctuations in temperature after the water was turned on. The general trend at No. 13 was downward until just before 7 A.M. when a low of 25° was reached. For a brief period of time between 6 and 7 A.M. the temperature at No. 13 was actually lower than that recorded at the outside check station. Wind velocities were estimated at 15 to 25 mph in exposed areas on January 30 and ranged from 5 to 10 mph as measured with an anemometer 3 feet above the slat roof covering the fernery. Damage to fern on January 30 was severe in the area near No. 13 but was mostly light elsewhere in the protected area. Wide variations in temperatures inside the fernery after sunrise probably were due to differences in the amount of shading provided by the roof and to unequal amounts of ice on the fern. A small quantity of ice was observed in shaded areas of the fernery as late as 4:30 P.M. of January 30.

Figure 2 shows the temperature regime inside the fernery and at the control station for the night of January 30-31. On this night winds were light northwesterly 1 to 3 mph with periods of calm and no frost formed. Other tests have shown that there is a relationship between wind velocity and the amount of protection afforded plants by the use of water sprinklers (1), (5). Overall protection is much better with

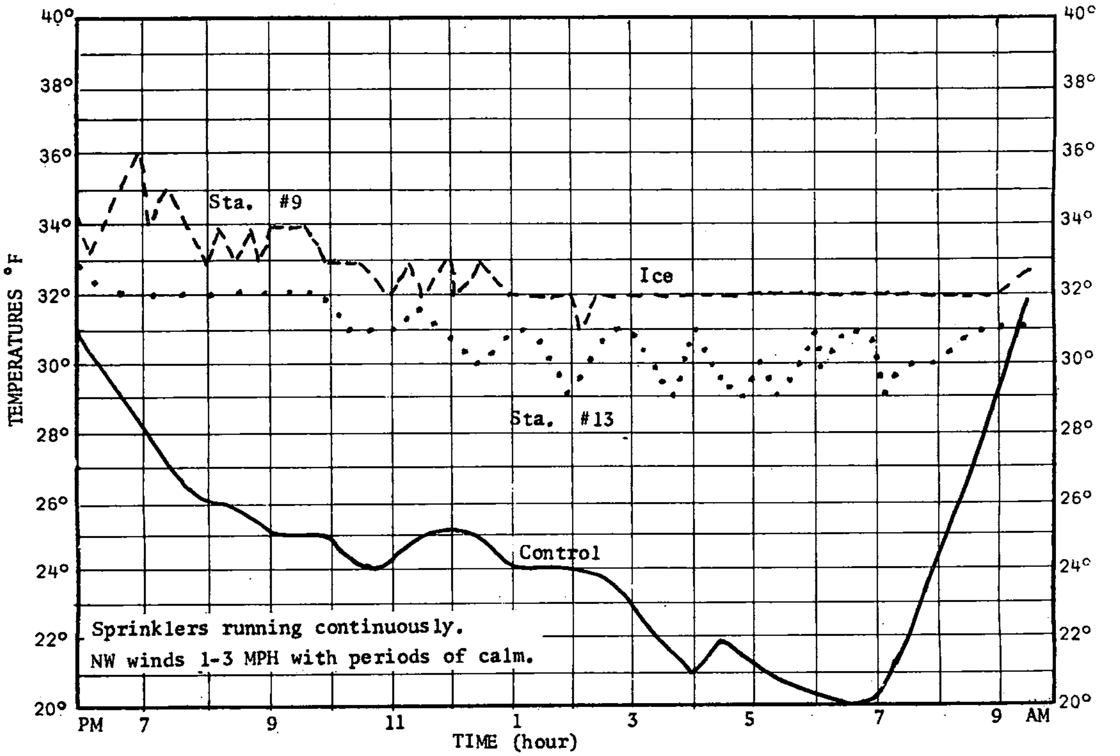

Figure 2. - Effect of overhead sprinkling on leaf temperature of fern, stations 9 & 13, compared with outside air temperature at control station, January 30-31, 1966.

nearly calm conditions. Because of the nearly calm conditions in the fernery on January 30-31, temperature differences were not as great between No. 9 and No. 13, as they were on the previous night when higher winds prevailed. The minimum temperature at the control station was 20°; at No. 13, 29° and at No. 9, 31°. The temperature at No. 9 ranged from 32° to 33° most of the time and dropped to 31° for only a few minutes.

Figure 3 is the graph of temperatures on the night of February 5-6, 1966. Thermocouple No. 13 had been moved from behind the tree trunk and received water from at least two sprinklers with nozzle openings of ⅛ inch. Calm prevailed during most of the night and heavy frost formed in the unprotected areas. The sprinklers were turned on at 10:50 P.M. of the 5th when the temperature was 29° at No. 9 and No. 13 and 27° at the outside control station. Within a few minutes after the sprinklers were turned on, the temperature rose to 38° at both stations. Thereafter, the temperature varied between 35° and 39° at No. 9 and between 32° and 37° at No. 13. The minimum temperature at the outside check station was 23°; 12° lower than the minimum at No. 9 and 9° colder than at thermocouple No. 13. The sprinklers were turned off at 8:50 A.M., February 6, when the temperature at the control station was 39°. Very little ice formed in the sprinkled area and was confined primarily to the area near station No. 13 where the temperature fell to 32° for a short time.

Discussions and Conclutions

Cold damage to fern in the sprinkled area during these experiments was estimated at 10 to 15 percent. Most occurred on the cold windy morning of January 30. Damage was mostly confined to tender new growth and to tall ten-

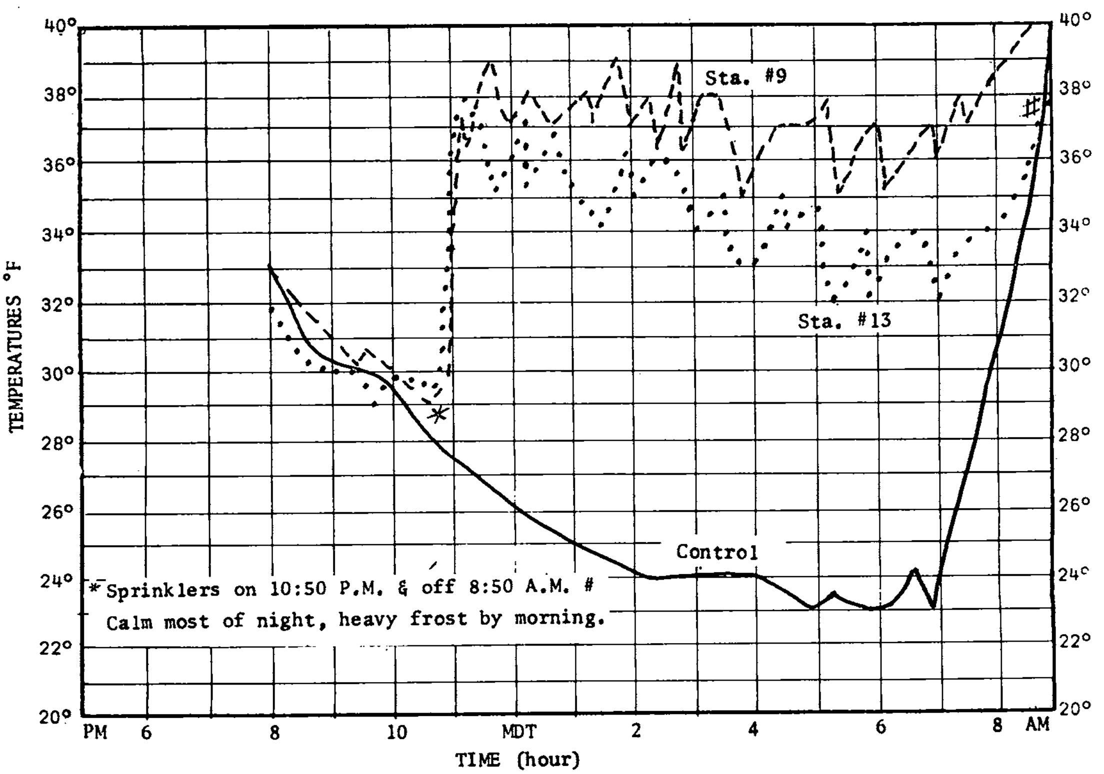

Figure 3. - Effect of overhead sprinkling on leaf temperature of fern, stations 9 & 13, compared with outside air temperature at control station, February 5-6, 1966.

der spikes in areas where sprinkler nozzles had openings of ⅛ inch. Figure 3 shows that protection on the calm night of February 5-6 was sufficient at station No. 13, receiving water from at least two sprinklers having ⅛ inch nozzles. Protection was 3° better at No. 9 where nozzle openings were 5/32 inch. This extra margin of safety will be required at times, particularly on cold windy nights such as depicted in Figure 1.

It was concluded that sprinklers should be turned on when air temperature reaches 32° and is expected to drop to critical levels during the night. It is necessary that liquid water be on the fern at all times since it is the latent heat of fusion that supplies heat to the plants. This was accomplished in these experiments where the nozzle openings of the sprinklers were 5/32 inch, the rotation rate was one rotation per minute, and the plants received water from at least two sprinklers. If liquid water is not on the fern at all times, the fern temperature can fall below its critical value. This is what happened at thermocouple No. 13 on January 30 (Fig. 1). Further, it is important that once begun, sprinkling should not be stopped unless there is positive evidence that no threat of danger to the fern exists. Other studies have shown that when sprinkling is stopped after plants are coated with ice, damage may be more severe than if they had not been sprinkled (4), (6).

In the past, many growers have let their sprinklers run until all ice had melted or at least until the ambient temperature had reached the forties or fifties outside the fernery.

A better criterion for stopping the sprinkling would be the wet bulb temperature. When this temperature becomes greater than 32° F, the sprinklers can be safely turned off. Lacking the instrument to obtain wet bulb temperatures, sprinklers can be safely turned off when the air temperature is several degrees above freezing and ice is observed to be melting in shaded areas.

Within the limits of the weather conditions experienced during the winters of 1964-65 and 1965-66, data from the Pierson experiment indicate that fern can be effectively protected against frost and freeze damage by the proper use of correctly chosen and correctly installed sprinklers. Observations of results in other ferneries using this method of protection confirm this conclusion.

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GARBAGE COMPOST AS A POTENTIAL SOIL COMPONENT IN PRODUCTION OF CHRYSANTHEMUM MORIFOLIUM 'YELLOW DELAWARE' AND 'OREGON'

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ABSTRACT

Two 6 x 3 factorial experiments were initiated to test effects of media and fertilizer levels on growth and composition of 2 chysanthemum varieties. Media consisted of all garbage compost, garbage compost-sand, peat-sand, shredded pine bark-sand and garbage compost-vermiculite in 1:1 by volume mixtures and garbage compost-sand ⅓:⅔ by volume combination. N and K were supplied at rates of 200, 400 and 800 pounds per acre each during the experiments.

Growth measurements included average diameter of the 4 largest flowers per pot, growth index $\frac{\text{(height + width)}}{2}$, in cm. total number of flowers per pot showing color, analyses of mid-section leaf tissue for N, P, K, Ca and Mg,

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