PRELIMINARY COMPARISON OF THREE FULL CIRCLE IMPACT SPRINKLERS FOR COLD PROTECTION IN SHADEHOUSES

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Abstract. Five combinations of sprinkler types and orifice sizes supplying water at rates from 4.4 to 6.2 mm-h⁻¹ [0.17 to 0.24 inches-h⁻¹] were compared in shadehouses for effects on sprinkler rotation rates, temperatures at the crop canopy and leatherleaf fern [Rumohra adiantiformis (Forst.) Ching] yield. The post and cable shadehouses, located in Pierson, FL, were 29.3 m (96 ft) long, 29.3 m wide, 2.5 m (8 ½ ft) high and covered with polypropylene shade fabric designed to exclude 73% of incoming radiation. Nine 0.9-m (3-ft) tall sprinkler risers were spaced 9.8 m (32 ft) apart in each shadehouse. Sprinkler rotation rates varied from 7.7 (Rain Bird L20VH with 0.32 cm [¹/₁₆ inch] orifice) to 0.9 rpm (Rain Bird SW2000 with 0.28 cm [¹/₈ inch] orifice), and were positively correlated (r = 0.79) with post-freeze yield. During the coldest part of the freeze, canopy temperatures were higher and fluctuated less in the shadehouses equipped with sprinklers with higher (>6 rpm) rotation rates than those with lower rates (≤1.5 rpm). Postharvest yield was also positively correlated (r = 0.91) with water application rate.

Water, applied using overhead (over-the-crop) irrigation systems, has been used since the 1960s to protect crops in Florida from cold damage (Harrison et al., 1974). This cold protection technique has been a critical factor in enabling several of Florida’s agricultural commodities to be produced during the winter. Research on reducing water application rates needed to cold protect crops in plastic fabric covered shadehouses was started in the early 1980s (Stamps and Chase, 1981; Stamps and Mathur, 1982). As new sprinkler designs become available, there is a need to test them to determine if they will perform adequately during freezes. Additionally, there is the possibility that new sprinkler designs will apply water more uniformly and/or efficiently than older designs and, thereby, allow the amount of water needed to be applied for cold protection to be reduced.

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Published recommendations for minimum water application rates to use for cold protection of leatherleaf fern, the most valuable crop produced in shadehouses in Florida, range from 0.8-0.9 cm-hr⁻¹ [0.30-0.35 inches-hr⁻¹] (Harrison and Conover, 1970; Henley et al., 1980), equivalent to 1,300-1,478 liters-min⁻¹-ha⁻¹ [190-158 gal/min/acre]. Since 1985 the St. Johns River Water Management District (SJRWMD) has listed a maximum over-the-crop sprinkler system water application rate of 0.6 cm-hr⁻¹ [0.22 inches-hr⁻¹], equal to 935 liter-min⁻¹-ha⁻¹ [100 gal/min/acre], as one of the approved water conservation methods for use when growing leatherleaf fern under artificial shade (SJRWMD, 1985). About two-thirds of leatherleaf fern production in Florida occurs in shadehouses (Stamps et al., 1991). The critical temperature below which damage occurs to immature leatherleaf fern fronds is reported to be -1.1°C [30°F] (Henley et al., 1980). The purpose of this experiment was to evaluate the effectiveness of two newer sprinkler designs in comparison to an established standard for use in cold protecting crops in shadehouses.

Materials and Methods

This evaluation was conducted in Pierson, FL in five 29.3 m x 29.3 m [96 ft x 96 ft] post and cable shadehouses spaced 9.8 m [32 ft] apart and filled with established plantings of leatherleaf fern. The structures were 2.5 m [8 3/4 ft] tall and covered on the roof and side walls with woven polypropylene shade fabric designed to provide 73 percent shade when the radiation source is perpendicular to the plane of the fabric. In each shadehouse, nine sprinklers were mounted on risers that extended about 1 m [3 ft] above the soil and were spaced 9.8 m [32 ft] apart. For cold protection, the water pressure at the pump was maintained at 275 kPa [40 psi] resulting in a pressure of about 200 kPa [30 psi] at each shadehouse.

Table 1 lists sprinkler model, nozzle types, sprinkler trajectories, orifice sizes, rotation rates and approximate water application rates tested. Three types of full circle impact sprinklers were tested—L20VH (Rain Bird Sprinkler Mfg., Glendora, CA), S20VH (SteelHead Strong Drive, Rain Bird) and SW2000LF (SideWinder™ 2000, Rain Bird). L20VH sprinklers were tested—L20VH (Rain Bird Sprinkler Mfg., Glendora, CA), S20VH (SteelHead Strong Drive, Rain Bird) sprinklers were tested—L20VH (Rain Bird Sprinkler Mfg., Glendora, CA), S20VH (SteelHead Strong Drive, Rain Bird) and SW2000LF (SideWinder™ 2000, Rain Bird). L20VH sprinklers were tested—L20VH (Rain Bird Sprinkler Mfg., Glendora, CA), S20VH (SteelHead Strong Drive, Rain Bird) and SW2000LF (SideWinder™ 2000, Rain Bird). L20VH sprinklers were tested—L20VH (Rain Bird Sprinkler Mfg., Glendora, CA), S20VH (SteelHead Strong Drive, Rain Bird) and SW2000LF (SideWinder™ 2000, Rain Bird).

<table>
<thead>
<tr>
<th>Sprinkler Model</th>
<th>Nozzle type</th>
<th>Trajectory (°)</th>
<th>Orifice size [ %, inch]</th>
<th>Rotation rates (rpm)</th>
<th>Approximate water application rate [0.19 inch/hr]</th>
<th>Yield (number of bunches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L20VH</td>
<td>LPN-1</td>
<td>13°</td>
<td>0.28 cm [ %, inch]</td>
<td>6.3</td>
<td>0.47 cm-hr⁻¹ [0.19 inch/hr]</td>
<td>2415</td>
</tr>
<tr>
<td>S20VH</td>
<td>QF</td>
<td>7 &amp; 12°</td>
<td>0.28 cm [ %, inch]</td>
<td>1.5</td>
<td>0.45 cm-hr⁻¹ [0.18 inch/hr]</td>
<td>2271</td>
</tr>
<tr>
<td>SW2000</td>
<td>Sidewinder</td>
<td>8 &amp; 13°</td>
<td>0.30 cm [ %, inch]</td>
<td>1.0</td>
<td>0.52 cm-hr⁻¹ [0.20 inch/hr]</td>
<td>2410</td>
</tr>
</tbody>
</table>

Results and Discussion

On the night of 4-5 Feb. 1996, a freeze occurred with a minimum temperature of -6.2°C [21°F] and wind speeds up to 2.2 m-s⁻¹ [4.9 miles/hr] (Fig. 1). The over-the-crop irrigation systems were started when ambient air temperatures reached 0°C [32°F]. All irrigation systems maintained temperatures at the crop canopy above the critical temperature for cold damage. Sprinkler rotation rates varied from 7.7 (L20VH with 0.32 cm orifice) to 0.9 rpm (SW2000 with 0.28 cm orifice) (Table 1). Although rotation rates increased with increased water application rates for a given sprinkler model, the main factor affecting the relative sprinkler rotation rate was sprinkler design. L20VH sprinklers, which are designed for use in frost...
Figure 1. Windspeeds and ambient temperatures outside ferneries and temperatures at the crop canopy in five shadehouses irrigated using various combinations of sprinklers and orifice sizes. 4-5 Feb. 1996.

Figure 2. Comparison of temperatures at the top of the crop canopy during cold protection using irrigation water provided by five combinations of sprinklers and orifice sizes.

22% higher than that from the shadehouse with the SW2000 sprinklers with 0.28 cm orifice. Further testing using replication is needed to confirm this effect.

The two newer sprinklers (S20VH, SW2000) tested proved adequate for use in cold protecting crops in shadehouses under the conditions occurring during this preliminary evaluation. However, these results indicate that efforts to increase the rotation rates of these designs would probably be beneficial in providing better cold protection.

**Literature Cited**


