Intermittent Mist Control via Solar Cells

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Summary. Comparisons were made between a commercially available, solar-activated mist control device (Weather Watcher®) and time clocks to determine their relative effectiveness, usefulness, and water-use characteristics on a greenhouse mist propagation bench. *Coleus* cuttings produced more roots per cutting and had greater average root lengths under Weather Watcher-controlled mist than those cuttings on a mist bench controlled by time. *Paulownia* cuttings produced the same number of roots under solar- or time-activated mist; however, the average root length was greater under Weather Watcher control. Mist benches controlled by the Weather Watcher used only one-third the water used by benches controlled by a time clock.

Increased relative humidity (RH) around cuttings placed on a propagation bench is necessary to prevent desiccation and death. Various means are used to increase RH, including polyethylene covers (Loach, 1980), wet tents (Whitcomb, 1982), fog (Press, 1983), and intermittent mist (Worrall, 1983). All of these techniques are useful in providing an environment conducive to adventitious root formation. Intermittent mist is probably the method used most frequently for RH control. The duration of the mist and the frequency between mist applications can be controlled with time clocks, "electronic leaves," humidistats, and solar cells. Worrall (1983) evaluated several types of mist systems controlled by conductivity, capacitance, temperature, weight, RH, and light, and found no significant differences in rooting among any of the controlling devices. Time-controlled mist systems are inexpensive, easily installed, and require little maintenance, but they are not sensitive to environmental changes such as light intensity, daylength, or temperature. Electronic leaves control mist systems based on evaporation, causing either a weight change or a break in conductivity on a simulated leaf. These devices are responsive to environmental changes, but they require routine maintenance and, in the case of the conductivity type, will not work with deionized water. Humidistats measure only RH, so other environmental parameters (e.g., temperature, light) may reach damaging levels. Photocells can be used to override time clocks during the night (Teoe, 1977). Solar cells that convert light energy into electrical energy provide several advantages as mist-controlling devices. They can adjust the mist frequency depending on the changing light levels during the day. They turn off at dusk and come back on at dawn in response to light, thus requiring no time clock. They require little, if any, maintenance because there are no moving parts. Light has been found to be an accurate estimator of evapotranspiration, and Moesel (1987) stated that light is the most effective predictor of stress change. In the greenhouse environment, where wind velocities are negligible and rapid changes in temperature rarely occur, light is the most important environmental parameter contributing to evapotranspiration.

Mist controllers may incorporate photocells to override the time clock during the night. The Weather Watcher solar-powered mist controller (Jeffery Electronic Control, St. Leonards, New South Wales, Australia) is one of a few controllers that make sole use of solar energy to control mist systems. The objectives of the present study were to: 1) determine the capability of the solar-powered mist controller to estimate evapotranspiration in a greenhouse, 2) estimate water use characteristics of the solar-powered controller vs. time clocks, and 3) determine the rooting response of *Paulownia* and *Coleus* cuttings placed under time- or solar-controlled mist systems.

Materials and methods

A single mist bench without bottom heat in the propagation greenhouse in the Dept. of Environmental Horticulture at UC Davis was divided into three sections. The mist in each section was under the control of a time clock (mist applied for 2.5 s every 2.5 min, from dawn to dusk), a Weather Watcher set on "maximum" or a Weather Watcher set on "7." The settings on the Weather Watcher dictate how fast the internal capacitor is charged. A setting of 7 means that a fraction of the converted solar energy is sent to the capacitor. The net effect is to lengthen the times between mist applications. Each Weather Watcher was connected directly to the solenoid valve controlling the mist on its section of the mist bench. Chart recorders were connected to the solenoid, as well through a resistance circuit, to record each time the solenoid valve was activated. Each time the solenoid valve was activated by either Weather Watcher, it applied mist for 2.5 s. This fact, and the application rates of the mist head, were used in combination with the frequency data from the chart recorder to calculate total water output over any given period of time. The data from the charts were transferred manually to graphics software for presentation here.

Rooting experiments were conducted with *Coleus blumei* and *Paulownia tomentosa*. Each experiment consisted of three treatments (clock control, Weather Watcher-max, Weather Watcher-7), three flats per treatment, 10 cuttings of each species per flat. Each experiment was repeated. *Coleus* cuttings were 5 cm long with stem diameters of 5 to 7 mm. *Paulownia* cuttings were also 5 cm long, with stem diameters of 3 to 5 mm. All cuttings were placed in a medium-grade perlite : vermiculite (1:1, v/v) rooting medium; no rooting growth regulators were used. *Coleus* and *Paulownia* cuttings were harvested after 7 and 14 days, respectively.

Hourly data were obtained from the UC Davis CIMIS (California Irrigation Management and Information System) station for comparisons between Weather Watcher responses and evapotranspiration or solar radiation.

Results

The Weather Watcher adjusted its mist frequency in response to light intensity and was an accurate estimator of evapotranspiration (Figs. 1 and 2). The two figures show the response

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during a typical summer (August) day and late-fall (November) day in Davis. During the part of the day in August that had the highest solar radiation and evapotranspiration (11:00 AM to 2:00 PM), the frequency of mist applications by the Weather Watcher (set at max) was greatest (Fig. 1).

Coleus and *Paulownia* cuttings rooted well under mist controlled by the Weather Watcher. On a mist bench controlled by a Weather Watcher set at 7, *Coleus* cuttings produced more roots per cutting and had greater average root lengths than those cuttings on a mist bench controlled by time (Table 1). *Paulownia* cuttings produced the same number of roots on all three mist benches; however, the average root length was greater on the bench under Weather Watcher-max control than those under time or Weather Watcher-7 control (Table 2). There were significant savings in water on benches under the control of the Weather Watcher. Overall, mist benches controlled by Weather Watchers used only one-third the water used by benches controlled by a time clock.

The Weather Watcher is an environmentally sensitive mist-controlling device that conserves water and reduces the likelihood of leaching nutrients from cuttings as they proceed through the rooting process. This device can control large solenoid valves so that a large bench area could be misted depending on the water supply and delivery system.

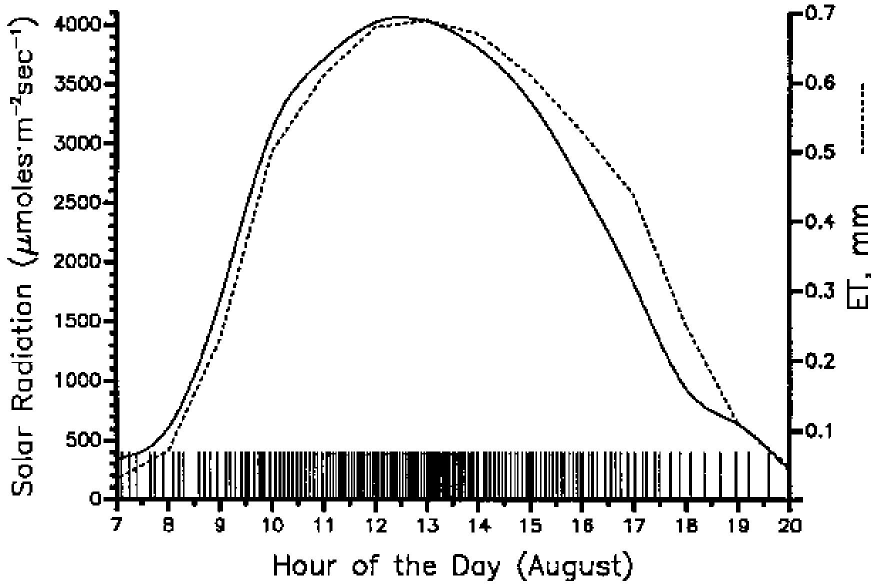

Fig. 1. *Response of a Weather Watcher solar mist controller compared to solar radiation (solid line) and evapotranspiration (dashed line) data collected in August from a nearby weather station. Vertical lines represent individual mist applications.*

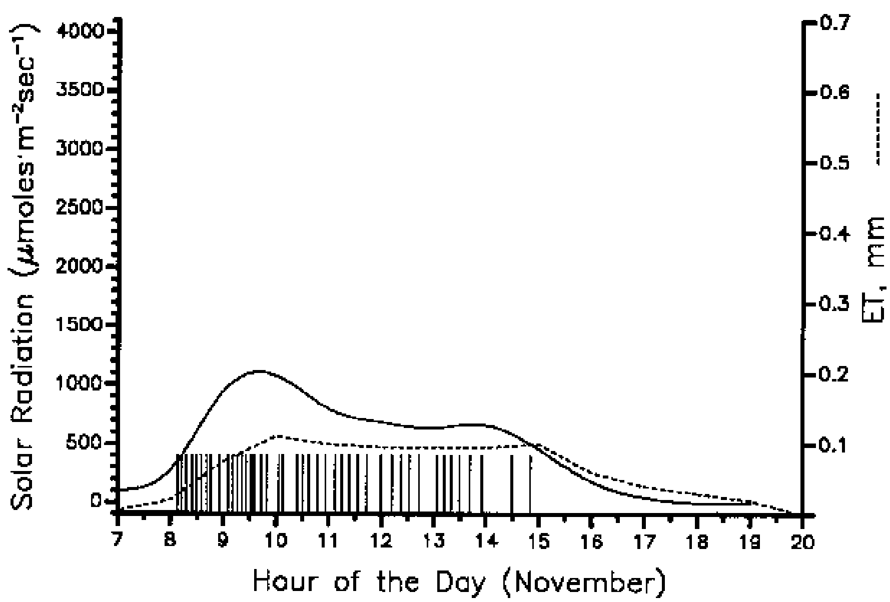

Fig. 2. *Response of a Weather Watcher solar mist controller compared to solar radiation (solid line) and evapotranspiration (dashed line) data collected in November from a nearby weather station. Vertical lines represent individual mist applications.*

Table 1. *Rooting response of* Coleus blumei *cuttings and water-use characteristics on a mist bench controlled by different devices. WW-7 = Weather Watcher set at 7, WW-max = Weather Watcher set at max.*

Control type	No. roots/ cutting	Avg. root length (cm)	Water used/ day (liters)
Clock	13 B[z]	1.5 B	4.2
WW-7	21 A	2.3 A	1.4
WW-max	16 B	2.4 A	1.8

[z]*Means followed by the same letter are not significantly different at* P = *0.05 using Scheffe's multiple range test.*

Table 2. *Rooting response of* Paulownia tomentosa *cuttings and water-use characteristics on a mist bench controlled by different devices. WW-7 = Weather Watcher set at 7, WW-max = Weather Watcher set at max.*

Control type	No. roots/ cuttings	Avg. root length (cm)	Water used/ day (liters)
Clock	6	2.0 B[z]	4.2
WW-7	4	1.7 B	1.3
WW-max	6	4.4 A	1.6
	NS		

[z]*Means followed by the same letter are not significantly different at* P = *0.05 using Scheffe's multiple range test.*

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