EVALUATION OF COMMERCIAL MIST CONTROL UNITS

R.J. WORRALL

New South Wales Department of Agriculture
Horticultural Research Station
Gosford, New South Wales 2250

Abstract. The performance of five commercially available mist propagation controllers were evaluated. Those tested were a cyclic timer with day/night switching, paper sensor (A.C. resistance), light sensor, resin block (capacitance) and relative humidity (temperature differential).

When properly adjusted and maintained all the units provided a constant moisture film over the test plants. There was no significant difference in rooting among plants on beds controlled by the various units. The most obvious difference among the units was the level of maintenance and the re-adjusting of required settings. Once installed and calibrated the light sensor and the relative humidity controllers required no further attention for the duration of the trial (6 weeks).

INTRODUCTION

The basic aim of cutting propagation is to maintain the material in a turgid state until roots form. Intermittent misting is a successful way of achieving this for a wide range of plants, especially during warm weather. It allows the cuttings to receive high levels of light yet to be maintained in a turgid state. It also avoids problems associated with continuous misting, i.e. excessive water usage and leaching.

This system maintains a thin film of moisture on the leaf by activating a high or low pressure misting system at regular intervals. Because of the frequent application of mist, e.g. every 10 minutes, some type of automatic controller is obligatory. The types of mist control units available, with some of their most important characteristics, are listed in Table 1.

Table 1. Mist Control Systems.

	Method of Operation	Maintenance	General Comments
	DIRECT SENSING		
1. *Conductivity*			
(a) Absorbent material (usually paper)	As paper dries out its resistance increases and activates mist at preset level	Change paper every 1-2 weeks depending on water quality	Not suitable for water that is dirty or high in salts
(b) Impervious (usually plastic) surface with electrodes	Measures directly the electrical resistance of moisture film on its surface. As film evaporates and the resistance increases to a set value mist is activated	Wipe every 1-2 weeks	Not suitable for water that is dirty or high in salts

Table 1. Mist Control Systems. (Continued)

	Method of Operation	Maintenance	General Comments
2. *Capacitance*	Measures thickness of moisture film on an impervious surface indirectly. When thickness falls below present level mist is activated	Wipe every 1-2 weeks	Less affected by salts or dirt than previous methods but still a problem
3. *Temperature*	Measures temperature difference between surface wetted by mist and wet bulb temperature. When temperature differential increases to preset level, i.e. top surface dries, mist is activated	Refill water container for wet bulb temperature as required (about once a month)	Not significantly affected by dirt or salts
4. *Weight*	Measures weight of water on a mesh by balance. As water evaporates and weight falls below a preset level, mist is activated	Clean every 1-2 weeks	Very susceptible to dirty water and algal growth. Less susceptible to salts. Must be protected from wind and draught
	INDIRECT SENSING		
1. *Light*	As light intensity increases, frequency of misting increases	none	Sensor not affected by dirt or salts in water. Relies on evaporation rate being in proportion to light intensity. This is generally true for environmentally controlled glasshouses but does not take into account wind or relative humidity which vary considerably under outdoor or shade house conditions. Zero maintenance is a big advantage
2. *Thermostat*	As temperature increases to a preset level either mist is activated directly or via cyclic timer	None — but frequent attention to settings needed	Evaporation is generally less related to temperature than light. Usually poor accuracy. Setting may be needed to be adjusted frequently

Table 1. Mist Control Systems. (Continued)

	Method of Operation	Maintenance	General Comments
3. *Humidistat*	Directly measures relative humidity of air. When it falls (i.e. the plants dry out) mist is activated at preset level	None — but calibration may drift	Usually poor accuracy at the high relative humidities that are required. Not a precise method but relatively low cost
	TIMERS		
	Cyclic timer operates mist for short periods — may also have day-night/on-off facility (desirable)	None — but frequent attention to settings needed	Popular with some large operations due to reliability and direct control over mist. Cycle needs to be changed with varying environmental conditions. Tends to use more water than some other systems

Direct sensors attempt to measure the actual amount of water on a surface. The mist is activated when the surface dries to a predetermined condition ("set point"). This type of controller is generally the most successful in widely varying environmental conditions, but poor quality water can mean considerable maintenance will be required.

Indirect sensors measure some environmental parameter on which evapotranspiration (rate of water loss) depends, e.g. light, temperature, or relative humidity. The success of these sensors depends on how accurately they predict actual evapotranspiration. In a greenhouse, for example, potential evapotranspiration depends mostly on incoming radiation (i.e. light levels). However this relationship does not hold as closely in a shade house where wind and relative humidity may be more important.

It is very important that the positioning of sensors for both types be representative of greenhouse conditions. Often large gradients in light, temperature, and relative humidity exist, especially on hot days when proper functioning of the mist control system is the most important.

The success of timers depends on the skill of the propagator who controls the timing interval. For example, if the plant material becomes too dry the misting frequency must be increased by the propagator. The biggest disadvantage of this type of controller is the level of attention required, especially during changing weather conditions. Both indirect sensors and timers have the advantage that they are not affected by water quality.

The study reported here examined the performance of commercial mist control units selected from each of the three groups of controllers.

MATERIALS AND METHODS

A comparison of the mist control units was conducted starting 1st September 1982 (spring), initially for a 6 week period, in a plastic double-skinned greenhouse at the Horticultural Research Station, Gosford, N.S.W. The greenhouse had 60% shade with a minimum temperature of 18°C and a maximum of 27°C over the first 6 weeks of the trial. Cooling was via a ducted evaporative cooler. Light intensity on the mist beds used to evaluate the controllers varied by no more than 10% among beds, and the air temperature throughout the greenhouse varied by less than 1°C. The water used had a pH of 7.2, a conductivity of 0.2 milliseimens, and was free of suspended organic matter.

The mist control units tested were:

1. **Cyclic Timer.** This had 3 timing units:

(a) 24 hour clock

(b) time off (0-60 min)

(c) time on (0-30 sec)

The misting rate was controlled by varying the time cycle manually. The 24-hour clock was set to turn the unit on and off at sunrise and sunset, respectively.

2. **Paper Sensor** (Jeffrey Electronic Control)

This unit functions by maintaining a paper strip at a preset electrical conductance which depends on moisture content, salt content, and temperature. To prevent an excessive accumulation of salts by evaporation the paper was changed weekly. Past experience has shown this to be essential for the reliable operation of this type of unit. When the conductivity of the paper falls below a pre-set value the unit turns on the mist until the pre-set point is reached again (with some hysteresis). Misting rate was controlled by varying the pre-set valve.

3. **Light Sensor** ("Weather Watcher-D" — Jeffrey Electronic control)

The amount of light in the greenhouse is measured by this unit and when a pre-set quantity has been received it activates the mist for a predetermined time. Mist rate is controlled by internal shading of the sensor.

4. **Resin Block** (Modern Networks — 6001)

This unit estimates misting requirements by measuring the capacitance caused by the water film on a resin block. When the capacitance (i.e. water film thickness) falls below a set point the unit activates the mist for a predetermined period. Control of the misting rate is achieved by varying the capacitance pre-set point. The time the mist is on is also set by the user (this determines the hysteresis of the unit). The sensor block was wiped with a cloth once a week to prevent a build-up of salts and dirt.

5. **Mist/Relative Humidity Controller** (Thermo-Mister — La Bella Vista Nurseries)

This unit maintains a preset temperature differential between a surface exposed to the mist ("dry" bulb temperature) and one kept continuously moist with a wick ("wet" bulb temperature). As the surface of the "dry" bulb dries out its temperature increases because it is no longer cooled by evaporation of water. When the "dry" bulb temperature exceeds the wet bulb temperature by a preset amount the mist unit is activated until the differential is reduced to or below the preset value. Misting rate is controlled by varying the temperature differential.

Criteria used for evaluation were:

1. **Ability to maintain a moisture film**

This was assessed by visual observations of test plants with a range of leaf types (*Pilea*, *Callistemon* and *Dieffenbachia*) and continuous electronic recording with thermocouples attached to paper strips placed in each of the misting beds. A saturated paper strip was maintained as a wet bulb reference. Drying of the paper strips could be detected by deviation from the wet bulb reference towards the ambient temperature.

2. **Water usage.**

This was measured by placing 100 mm diameter containers on the mist beds (2 on each).

3. **Rooting of test plants.**

Cuttings of *Pilea cadierei*, *Callistemon viminalis* 'Hannah Ray' and *Dieffenbachia* 'Compacta' were placed on each of the mist beds to determine the effect of the control units on the rooting of a range of plants. Three replicates of 20 cuttings of each plant was used. Assessment was by total number of cuttings rooted and a grading score of root formation.

For 1 week prior to the commencement of the trial control units were adjusted to provide a continuous film of water with minimum water usage over a variety of environmental conditions. Controls were also adjusted as required during the course of the experiment.

After the initial 6 weeks trial the light sensor and mist/relative humidity controller were assessed for an additional 5 months during routine propagation by cutting in the greenhouse.

RESULTS AND DISCUSSION

Performance of the mist control units was generally in accordance with theoretical considerations. When all the units were properly adjusted and maintained during the initial trial of 6 weeks they all provided a constant moisture film over the test plants. There was also no significant ($P > 0.05$) difference in either number of cuttings rooted or root formation among beds controlled by the various units.

The most obvious difference among the units was the level of maintenance and readjusting of settings required. After the initial calibration the light sensor and Thermo-Mister required no further attention. Unlike the manufacturer's recommendations the Thermo-Mister did not require cleaning or filling although this may well be necessary if poor quality water is used.

The settings of the paper sensor and resin block units required small adjustments between their weekly maintenance despite the fact that good quality water (i.e. low in salts) was used in this trial. The resin block required wiping weekly. Both tended to drift slightly in their settings between cleaning or replacement due to a build up of salts. The settings on the cyclic timer required frequent attention (1 or 2 times daily) due to changing weather conditions and because it had to be adjusted to the maximum expected rate of evapo-transpiration in any time period. It used 25% more water than any other unit. There was little difference in water usage among the remaining units.

During the 5 months after the completion of the initial 6 weeks trial the Thermo-Mister and the light sensor maintained a film of water on the cutting leaves during routine propagation except on a number of days with maximum air temperatures of over about 38°C. On these days cuttings in the mist beds tended to have leaf surfaces drier than normal — although they apparently suffered no ill effects. A worthwhile improvement to these two units may be to slightly increase the misting rate at higher air temperatures.