PRACTICAL ASPECTS OF HIGH PRESSURE FOG SYSTEMS

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Abstract: It is the opinion of the author that one should decide how the fog system is to be used, whether for cooling or for the production of high humidity required for plant propagation. Furthermore, the greenhouse manager must realize that the system will require extensive maintenance, as well as having periods of downtime.

Mist propagation increases rooting percentages in cuttings of woody ornamentals. The reason for this is that by maintaining a humid atmosphere around a leaf, it will prevent the leaf from desiccating, thereby allowing the stomates to remain open, providing gaseous exchange, and subsequently, photosynthesis and growth. Intermittent mist is a tool for producing a water-saturated atmosphere, but it does have some disadvantages. The droplets produced by the mist system do not remain suspended in the atmosphere for a long period of time, thus increasing the transpirational loss from the plant. Furthermore, it has been noted by Good and Tukey (1) that large droplets are responsible for the foliar leaching of nutrients from the leaf, and subsequent lower rooting percentages.

With the development of fog systems, it has become possible to produce water droplets that are about 10 microns (10 μ) in diameter; these droplets are capable of remaining suspended in the atmosphere for long periods of time. Subsequently, the transpiration loss of the plant will be reduced to practically zero, and the foliage of the cutting will not be water saturated, thus reducing foliar leaching.

With some kinds of fog systems, one is working with high pressures (900 to 1,000 psi) and nozzles with small orifices. These two factors produce a system that is maintenance-intensive, and prone to have mechanical and electrical failures.

Perhaps, the most important component of a fog system is the water filtration. The nozzles that we have used have orifices that are very small (0.006 inch or 150 μ) in diameter, and are expensive (about $10.00 each). To prevent the orifices from becoming plugged, particulate matter suspended in the water must be removed. Different water filtrations systems have been designed; such designs include sand-media type filters, low-pressure cartridge filters, high pressure cartridge filters, and combinations of all the above. If materials such as disinfectants, fungicides, or fertilizers are injected into the fog system, they should be injected to the upstream side of the filters to filter out any inert carrier ingredients or precipitates that form when salts in the water and injected chemicals react. Water quality is a factor which must be considered with some fog systems. The filtration system will filter out suspended solids but not the dissolved salts. In areas with high bicarbonates, carbonates, and chlorides, the nozzles will have to be cleaned periodically to eliminate the salt precipitates that form on the fog nozzles.

One chemical that we have been injecting into our system is Agribrom (1-bromo-3 chloro-5, 5 dimethyl—2,4-1 imidazolidinedone) which is a biocide that is active against algae, fungi, bacteria, viruses, and other microorganisms. Neither Agribrom, nor any of its residuals or breakdown products, are phytotoxic to plant materials. The recommended concentration of Agribrom used in a continuous injection program should be 0.25 ppm and, at this level, we have observed a decrease in algae production in the mist houses. By injecting Agribrom into the fog system, the routine maintenance of cleaning the benches and floors has been lessened.

To produce the high pressures (900 to 1,000 psi) required by the fog nozzles, an elaborate pump system is required. The pumps used are low gallonage (5 gpm) but produce high pressures, (1,000 psi). Such pumps require a high torque to produce high pressures. One consideration that must be taken into account is the source of electrical power available at the installation site, whether it be single-phase or three-phase. The high power requirement of the pumps make the use of the single phase motor impractical. If the only power source available is single phase, be ready to replace capacitors and centrifugal switches within the motor. With the constant on-off demand of the fog system, capacitors begin to leak and contacts on the centrifugal switch become burnt. To prevent any damage to the pump if the water supply is shut-off, there should be a low pressure cut-off switch to prevent the pump running dry when the water supply is shut down. Inherent with any motor-pump combination, vibration is a problem; rigid tubing under such conditions often breaks at fittings. To alleviate such problems, flexible tubing should be used on the low pressure side of the pump and hydraulic hose on the high pressure side.

To control the pump system, some form of controller is required; timers and humidistats are being used at this time. The normal timing circuit consists of an interval timer in series with a 24-hour time clock. This system allows the grower to select an "on" period during the day and/or night that satisfies the mist requirement of the plant material. Mechanical humidistats operate by the expansion and contraction of a fiber that is water sensitive; this motion of expansion and contraction is attached to a microswitch which opens and closes the circuit. It is my opinion that the reaction time of mechanical humidistats is too slow to react to the changes of the relative humidity within the greenhouse. Perhaps with the new generation of electronic environmental sensors, an electronic humidistat can be produced that has a rapid response time to changes in humidity.

At Moennig's Nursery, we have installed a high pressure fog system in our quonset-style mist houses (30 ft. by 70 ft.). To provide for more flexibility, two separate systems have been installed in each house; one system for cooling and one system for fog propagation. The fog propagation lines are installed overhead with each fog nozzle covering 50 sq. ft. of bench space, in a manner similar to the overhead mist system. The cooling system is designed as such: on one end wall (the intake side), two fog lines are run parallel to the ground behind the polywall (polyethylene connection tubing) which inflates and deflates upon temperature change. The opposite wall has a 48 in. exhaust fan that draws the fog through the house, cooling the air. Presently, we are using one controller to run all the fog houses. However, we are in the process of controlling each house and each system independently. Electric solenoid valves, capable of working under high pressures are available and are to be installed. Each house will then be controlled by a solid-state controller which has the capability for "staging" cool-hour times, warm-hour times, and transitional times. By implementing this system, we will have the flexibility of using each house for different purposes.

In conclusion, the fog system will become a more popular propagation tool in time. As with any new principle, there are engineering problems that must be overcome. The advantages of the fog system do outweigh the disadvantages.

LITERATURE CITED

1 Good, G L. and H B. Tukey, Jr. 1964 Leachmg of nutnents from cuttmgs under mist *Proc Inter. Plant Prop Soc.* 14.138-142

VOICE: Question for Bob Mazalewski. Does your rooting medium dry out more under fog than under mist and is your light intensity reduced under fog as compared to rust?

BOB MAZALEWSKI: Yes, the media does dry out faster under fog. And we do have a light intensity drop with a water-saturated atmosphere, as with fog.

BEV GREENWELL: At what humidity level are you setting your humidistat for in the fog on hot, sunny days?

BOB MAZALEWSKI: We are setting for 100%.

DON HERZOG: I would like to say that often we can get useful equipment from other industries. I have written to NASA about time clocks, etc. and they have responded with some useful information from their experiences, concerning environmental controlling devices.

MIKE EVANS: A few years ago a paper was presented by Phil Barker (Franklin, A.L. and P.A. Barker, 1985. An intermittent mist system with pressure boosted by continuous pumping. *Proc. Inter. Plant Prop. Soc.* 35:222-227) on high pressure mist or fog in which the pumps were allowed to run continuously. Two valves operated simultaneously to allow high pressure to enter the system. This would prevent damage to the motors from constantly starting and stopping. I am wondering if anyone has followed through on this, or is it still in the experimental stage?

BOB MAZALEWSKI: Any time you have motors starting and stopping continuously you are going to have burn-out problems. Continuously running motors might prove to be a very efficient system.

FRITZ BIETH: I am wondering if you have checked at all with the ultrasonic system of generating fog rather than the high pressure fog. In the ultrasonic system there is no pump and no high pressure lines, no motors, and it has large orifices, so there is no clogging.

BOB MAZALEWSKI: No. I haven't but I would like to talk to you about it.

FRITZ BIETH: This was described briefly by Natalie Peate from Australia in our meeting in Sacramento in 1986 (Peate, N.F. 1986. Plant Propagation in Australia. *Proc. Inter. Plant Prop. Soc.* 36:52-55).

(ED NOTE. See also Hartmann, H.T., D.E. Kester, and F.T. Davies, 1989. Plant Propagation: Principles and Practices, 5th ed., p. 294. Prentice-Hall, Englewood Cliffs, N.J. 07632).