differences in costs for harder or more difficult to handle material. The direct striking method is the next stage to consider once the basic figures have been obtained. It will increase indirect costs as more land and protection is needed, but reduce overall production costs

L. RUDIN: Direct striking is increasing in Sweden for species like *Pyracantha* and *Cotoneaster* where three cuttings are inserted in a 1.5 litre pot.

PROPAGATION USING THE FOGGING TECHNIQUE

MARTIN J. HALL

H. Evans & Sons (Europa) Ltd.
Hadlow, Kent

We have mist so why use fog? A question often levelled at our Company over the past two seasons since we installed the MEE Fog System at our Sidcup Nursery in an existing wooden glasshouse block of 9,000 square feet.

At a time of uncertainty and financial constraint any capital investment has to be certain of obtaining a quick return on investment In our case the results obtained by using the fog have surpassed our original expectation.

The use of fog in propagation isn't new and work with Fog Pots in Holland and Switzerland is well documented. Recent engineering technology, much of it derived from N.A.S.A. Space Research, has enabled this system to become a commercial reality

It should be stressed that this equipment is of a far higher precision than anything so far seen and, as such, needs careful attention in its location, installation, and running.

In the United Kingdom the system is being used for green plants and nursery stock propagation, A.Y.R. chrysanthemum cutting propagation and the production of cress. The system is, at the moment, being considered for mushroom production on a large scale.

What is fog? The MEE Fog System is a device for humidifying and cooling the plant environment. It is also a method for controlled application of foliar feeds, insecticides, fungicides, or any liquid or water soluble substance. Fog can be used to control transpiration and evaporation losses during plant propagation and multiplication. It is far superior to the use of misting because overwetting of the growing medium is no longer a problem. Fog can be used during cold weather for freeze protection of outdoor plants and as a means to supplement and increase the efficiency of heating systems (thereby saving significantly on fuel costs).

Humidifying and cooling the plant environment is one of the most important things that can be done to help increase plant production. When a plant is stressed to the extreme by too high a temperature or too low a humidity, it wilts But long before it wilts the plant's natural mechanisms for survival take over and the stomata close. Closed stomata mean the plant leaf can no longer exchange the gases that are so necessary for the manufacture of food. Photosynthesis stops. When photosynthesis stops the plant won't grow. This typically happens for several hours on every sunny afternoon, even in winter! The obvious solution is to relieve the plant stress and this can be done quite effectively with the fog system.

How does the system work? A very special small nozzle — an atomizer — creates the fog In a typical installation about one nozzle for every 50 square feet of growing space will be required. The atomizer, which is about as big as the tip of the little finger, is installed in half-inch plastic pipe and located over the growing zone. The atomizer must operate at high pressure, so a booster pump is used to increase the pressure to about 500 psi. The water must be very clean so several filters are included in the system. The water is filtered before it enters the booster pump, filtered again after it leaves the pump, and then one final time just before entering the orifice of the fog nozzle atomizer All piping and fittings in the system are of a non-corrosive material — either plastic or brass or stainless steel.

The water must also be free from micro-organisms that can create slime deposits and clog filters and nozzles. Mains water is usually treated to remove such micro-organisms But if untreated raw water is used, a chlorine injector must be included in the system. Only a small amount of chlorine, about one part per million, is required to control organism growth This amount of chlorine is much too small to be harmful to plants or to be detected an an odour in the water.

As water jets from the atomizers it is broken into small fog droplets.These fog droplets are so small, about one-tenth the diameter of a human hair, that in a dry atmosphere they immediately evaporate to raise the humidity and cool the air The cooling efficiency of the fog is so great that the air can always be cooled to the maximum theoretically possible by evaporative cooling. The fog system output can be controlled to adjust the temperature and humidity to the desired level. If the output is controlled to saturate the air, then the droplets will no longer evaporate and will remain suspended as in a natural fog.

How does the system work in relation to propagation? For most propagation and plant multiplication work it is desirable to maintain zero transpiration loss without overwetting or leaching of the growing medium. This can be achieved with proper control of the fog system. When the fog is properly controlled transpiration loss can be completely eliminated without irrigating or extensive wetting of the growing medium. This means that soil moisture can be maintained at optimum levels while assuring an adequate oxygen supply to the root zone and no moisture loss through the leaves.

To assure zero transpiration loss it is necessary both to maintain a 100% relative humidity around the plants and to maintain a very light mist of liquid water on the plant leaves. It is necessary that the leaf surfaces be slightly wet because in sunlight the leaf surfaces are always warmer than the surrounding air. By maintaining a very light fog around the plants (not enough to significantly decrease incoming solar radiation), the above conditions can be achieved. Fog droplets are too small to precipitate and cause any significant irrigation but the droplets do migrate through the air and eventually collide with the plant surfaces. After 10 minutes or so in a light fog a light misting of water will occur on the plant leaves.

Fog density is controlled by the number of fog nozzles in a given area, by the ventilation rate, and by the cycle time of the system. Thus a propagation area can be created in several different ways. A house set up for normal growing practices can be converted to a propagation house simply by decreasing the ventilation rate or by increasing the fog output rate. The ventilation rate can be decreased by closing vents or by turning off some fans. The fog output rate can be increased by increasing the on-time of the fog cycle, or by adding more nozzles. By planning ahead an extra line of fog nozzles could be installed with a manual control valve to be turned on only when the area is to be used for propagation.

A portion of a house can be converted to a propagation area by isolating it with poly curtains. By proper arrangement of the curtains the ventilation rate can be decreased and a proper balance of air flow and fog density achieved. This can be done in greenhouses and in shadehouses and usually with dramatic results.

When properly used, fog propagation will usually cause a dramatic increase in plant production. *But a word of caution is necessary.* The fog system is not like the misters you are acquainted with. In misting, water is always sprayed directly onto the plants. In fogging water is *never* sprayed directly on plants, and in fact precautions must be taken to ensure that plants are not directly in or under the spray pattern of the fog nozzles. The best location for placement of fog nozzles is overhead, facing upwards, and over aisles or walkways. This ensures that any drip associated with the nozzles will fall in aisleways and not on plants. Also it should be recognised that true fog droplets are produced only when the nozzles are operating at full 500 psi pressure. In the few seconds when pressure is building up or dropping off during the on-off cycle larger mist-type droplets are produced. Fog droplets will typically drift 15 to 20 feet from the nozzle location before evaporating, but mist drops will fall within about 3 feet from the nozzle. Mist drops irrigate, fog droplets do not. Thus, to ensure that plants are not overwetted fog nozzles should be located at least 3 feet from the edge of the growing zone whenever possible.

At present the system hasn't been fully exploited on the nursery. By the use of timers and solonoid valves the area is capable of being increased three-fold using the existing pump. We are only now looking at the application of chemicals for the control of pests and diseases.

How does the system cater to pest control? It can be used for the controlled application of foliar feeds, insecticides, fungicides, or any other liquid or water soluble substance. If a very dense fog is formed in the growing area, fog droplets will migrate deep into the foliage and eventually wet both the upper and lower surfaces of leaves, stems and flowers To achieve this dense fog, the ventilation rate should be kept as low as possible and the fog system run full on for 5 to 10 minutes. In a greenhouse all vents should be closed and ventilating fans turned off. (Internal fans such as turbulators and heater tubes may actually aid in diffusion of the fog.) In a shadehouse or outdoor area the area to be treated should be curtained off to reduce mixing of outside air.

Once a dense fog has been formed it will usually persist for 5 to 10 minutes after the system has been turned off This should be an adequate length of time to ensure thorough wetting of all plant surfaces. Solutions to be applied can be injected into the fog system water with a special metering injection pump, or can be pumped directly from barrels of premixed solution. A good technique to use is to first saturate the area with a pure water fog. This will prevent evaporation of the nutrients or insecticide solution and minize the amount of active material needed.

In an age of fuel conservation dictated by ever rising costs, the possibilities of using the fog system for freeze protection are numerous. Low energy consumption and ultra low water usage make freeze protection very viable.

Farmers and horticulturists have long recognised that on cold nights crop damage from freezing will be considerably lessened if fog or clouds move in and blanket an area. The reason for this is that the individual droplets in a fog act as very good reflectors of the long wavelength heat radiation which is given off by solid objects during clear-sky night-time conditions. Solid objects such as the ground and plants absorb solar radiation during the day and re-radiate this energy as heat radiation during the night. Fog produced by the fog system works just like a natural cloud to trap this radiated heat and prevent the temperature of the plants from dropping too low. It has been shown that only drop sizes which are close to the wavelength of the emitted radiation are capable of reflecting the radiated energy. The fog system produces droplets in the 10-micron diameter size range, wich is exactly the same as the wavelength of the heat radiation. For freeze protection a dense fog is necessary to reflect the maximum amount of radiated heat.

The fog system also works in other ways to prevent damage from freezing Tiny droplets produced by the fog nozzle saturate the air with water vapour. As this water vapour condenses onto cold leaf surfaces, latent heat is released which warms the leaf. If this water then freezes, more heat is released when prevents the leaf from freezing. (This is the principle behind the use of sprinkler systems for freeze protection).

The fog system can also be used as a supplement to heaters to lower the amount of energy needed to keep a growing area warm. The fog works to reflect back and trap in the heat given off by the heaters, which would normally be radiated away into space. This cuts down on the amount of heating usually required to maintain a desired temperature.

LITERATURE CITED

1 MEE T High-pressure fog A humidity and temperature control *Florists' Review* 164 (4249) 116-117, 169-171

2. MEE Industries Inc Freeze Protection.

3 MEE Industries Inc Installation and Operating Manual for Greenhouse and Nursery Environment Control (Dutrie Plants Marketing, Steenwerck, France)