Mist Propagation Systems and Humidity Chambers for the Nursery and Greenhouse

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Misting is a technique for minimizing plant moisture loss by controlled periodic wetting of the foliage of cuttings which are being rooted. This technique is helpful for rooting leafy cuttings; however, succulent plants are usually not placed under mist. Constant misting has been successful with a few plants, but results are generally better with intermittent misting. Constant misting wastes water, leaches nutrients from the leaves, and reduces soil temperatures which, consequently, restricts root development. Mist beds can be used in greenhouses year round or during the growing season for nursery stock.

The on-off interval for misting depends upon how quickly water dries from the leaves. Ideally, the mist should be turned on just after the leaves become dry and should remain on long enough to wet all leaf surfaces. Cuttings quickly die if they become dry and are exposed to bright sunlight for even a short period; therefore, it is important that the leaves be kept wet at all times when the sun is shining on them. Over-misting is generally considered less detrimental than over-watering.

Before mist propagation became widely accepted, rooting was attempted by maintaining high relative humidities in the rooting area and restricting sunlight by partial shading when sunlight became intense. The use of partial shading, however, reduces the rate of photosynthesis which indirectly restricts the rate of root development. This, obviously, is undesirable. However, various degrees of shading may be appropriate depending upon the species, location, and time of year.

Misting reduces leaf transpiration in two ways. First, it causes a reduction in leaf temperature due to evaporative cooling as the water on the leaf evaporates. Second, it maintains high humidity conditions at the leaf surface. The cooling is reported to be as much as 1°F to 1.5°F as compared to leaves not misted. These cooling effects are effective, however, it is recommended that mist propagation beds be shaded when necessary.

The development of disease under mist may be a serious problem. Botrytis and bacterial soft rots can be major problems with leafy cuttings, particularly if sanitary conditions are not maintained.

Algae can become a problem in areas which remain wet most of the time. If algae does cause a problem, chemicals injected through the water system can be used for control.

Mist Propagation Bench

Mist propagation is most commonly achieved by adapting a bench for the propagation area (Figure 1) or by using a ground bed. Since the area will be kept wet constantly, the bottom and sides should be of a material that is highly resistant to water. Construct the bench of stainless steel wire and metal frames to provide proper air circulation. The bottom can be covered to a depth of 1-inch with a freely draining material such as gravel or crushed stone. The size of the aggregate should be about 1/4-inch. The gravel should then be covered with 2 to 3 inches of sand.

If flats are used for holding the rooted cuttings, the flats can be placed directly on the bench top or on sand. If the cuttings are to be rooted directly in the bench, the rooting medium (for example, a mixture of 3 parts sand and 1 part peat) should be placed to a depth of about 2 inches on top of the sand. Since the mist tends to lower soil temperature, which restricts root development, best results are obtained when the soil medium is warmed. For most plants, a temperature of 75°F is considered optimum. To achieve such temperatures, electric heating cable can be placed on the bench or slightly above the gravel layer in the sand. Standard soil electric heating cable units are available in lengths of 30, 60, and 120 feet. Thermostat controls are also available that permit raising the soil temperature to whatever level is desired for the specific plant species being rooted. Many growers place flats of cuttings or seeds directly on the bench. This practice allows for greater sanitation since flats can be easily moved and the benches cleaned.

When the greenhouse is heated with steam or hot water, some soil warming can also be provided by placing one or more heating pipes below the bench. If this arrangement is used, the piping below the bench should be separately controlled so that heat can be added even when greenhouse space heating is not required.

Other features of benches such as required supporting framework, bench dimensions, and construction features

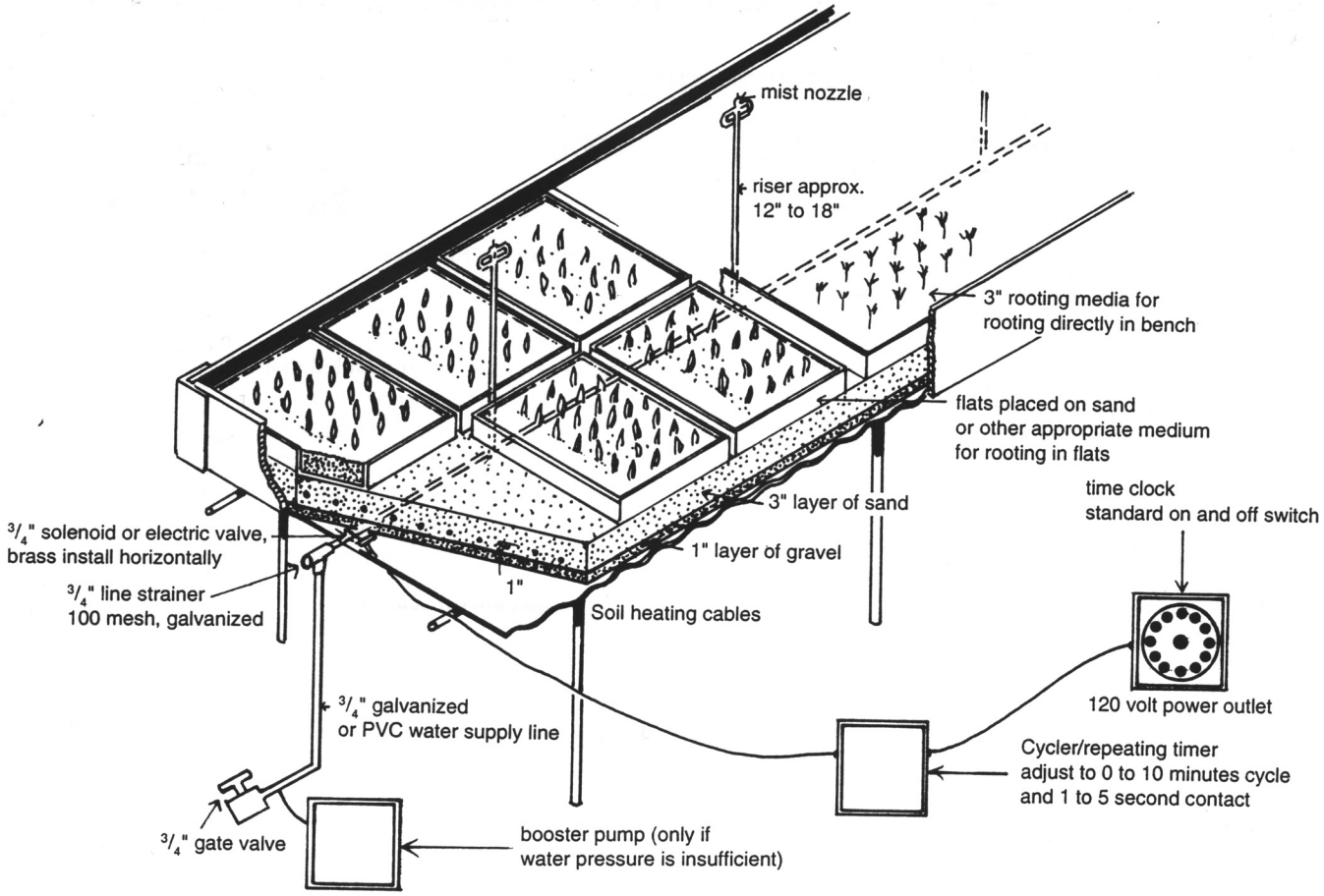


Figure 1. Layout for typical mist bench
Setup appropriate for direct use on the ground as well

are discussed in detail in Extension fact sheet HLA-6703, "Greenhouse Floors and Benches." Mist benches are often placed in inexpensive polyethylene Quonsets in nurseries for added protection to the propagation area. Refer to Extension fact sheet HLA-6700 "Greenhouse Structures and Coverings" for additional information.

Piping Arrangement

The mist nozzles are normally placed on the end of a vertical riser from a distribution pipe placed on or below the propagating bed. Such an arrangement avoids dripping from the nozzles when the water is turned off, and the riser does not interfere with the uniformity of the mist pattern. If the nozzles are placed on a pipe running above the bed, the nozzles should preferably be placed on the bottom of the pipe so that droplet collection on the distribution pipe is minimal. Dripping from the nozzles is still a problem with this arrangement due to water draining from the pipe when the water is turned off.

The distribution pipe size depends upon the water discharged by the nozzles and the number of nozzles installed along the length of the pipe. Most mist nozzles discharge from 4 to 15 gallons of water per hour (gph). A 1-inch line will distribute water to 50 of the higher 15 gph capacity nozzles without significant pressure loss, a 3/4-inch line to 25 nozzles, and a 1/2-inch line to 8 nozzles. Approximately four times as many of the 4 gallon-per-minute nozzles could be placed on each of these lines. To minimize dripping, be certain that the mist lines are straight and level.

The risers should normally be made of 1/2-inch diameter pipe. Depending upon nozzle type, the nozzles require a minimum water pressure of 20 to 40 pounds per square inch (psi) for effective distribution over the bed. Pressures as high as 120 psi can be used with some mist nozzles. If the water main pressure in the greenhouse is below the required pressure, a booster pump should be placed in the water line to obtain the required pressure.

Since all of the nozzles have rather small orifices and openings, a filter or strainer should be placed in the line to remove solids that could plug the nozzles.

The control valve is generally an electrically operated solenoid valve that turns the water on and off in response to a control signal.

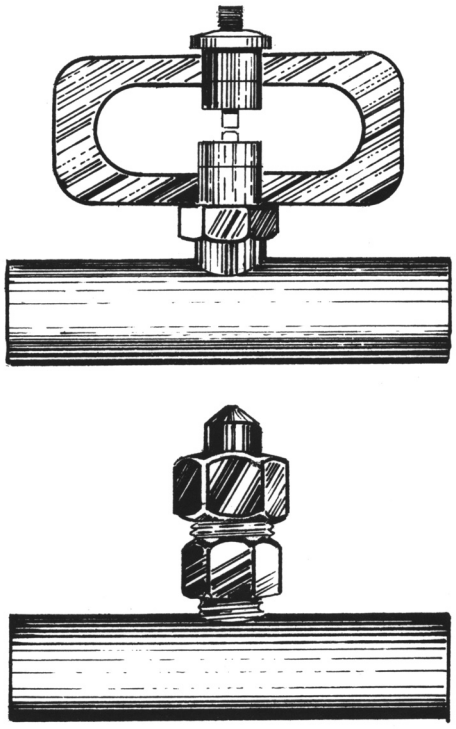
Whirling nozzles use small slots within the internal body of the nozzle to break up the water and to generate small droplets which then pass through an orifice and outward away from the nozzle. Since the slots are small, these nozzles are particularly susceptible to plugging. The whirling nozzles are specifically made for mist-propagation discharge of the water from an angle of 160 degrees. They are recommended for use at pressures from 35 to 100 psi.

The deflection-type nozzles have larger orifices than the whirling nozzles and, therefore, have less of a tendency to be plugged by solid particles in the water. Since they are simpler in construction, they are also generally a little less expensive than the whirling nozzles. The uniformity of water distribution over the bed area with deflection nozzles is quite

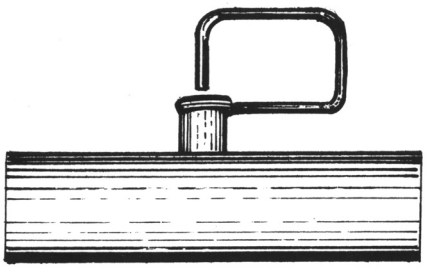
Types of Mist Propagation Nozzles

Two basic types of nozzles are used in mist propagation systems:

1. Oil-burner nozzles, which have a whirling action.



2. Deflection nozzles, which employ a small stream of water impacting against a small, flat plate.



variable and for a given nozzle could either improve or become worse as the pressure increases. You can check the uniformity of distribution by placing water cups over the bed area and observing the water collected after a given period of operation. The gap between the face of the orifice and deflection plate, and the centering of the plate over the orifice can be adjusted for most deflection-type nozzles. Adjustment is recommended whenever uniformity of distribution differs by more than 50 percent. The output of the deflection nozzles is generally higher than the whirling nozzles, varying between 4 and 15 gallons per hour for the nozzles tested.

Nozzle Position

The nozzle should be spaced so that there are no dry areas on the bed and so the overlap is minimal. If excessive overlap occurs, excessive wetting may result. Most nozzle manufacturers recommend the nozzle spacing which they feel provides the best results. The most common recommended spacing is 3 to 4 feet. Be sure to follow the particular manufacturer's advice.

Nozzles are normally placed about 18 inches above the plant-bed surface. Some manufacturers may, however, recommend lower heights.

Controls for Misting Systems

Most mist propagation systems are controlled with two time clocks. The first is a 24-hour clock which turns the system on during the daylight hours and off at night. The second is a cycle timer which controls the duration of the "on" cycle and the interval between mist cycles. The clock should allow both of these intervals to be adjusted to correspond to the growing and environmental requirements. During bright, warm, summer days in Oklahoma, the optimum number of mist cycles can be as many as 20 per hour. Each "on" period should be as short as possible but long enough to fully wet all leaf surfaces.

A number of greenhouse equipment suppliers provide time clocks with the capability to provide such adjustments (see suppliers listed on back page).

The disadvantage of clock-type controls is that they must be set for bright sunlight conditions so that the plants do not become dry during periods of maximum stress. When set in such a manner, they over-water whenever the sun is less intense, when clouds reduce the solar radiation entering the house, or when the drying rate is reduced due to a reduction in air temperature. For this reason, several different types of automatic controls have been developed. One is a pivoting beam (Mist-a-matic) that has a piece of screen on one end of the beam and a movable counterweight on the other. The unit is placed under the misted area where water collects on the screen. The additional weight overcomes the counterbalance causing the beam to move down. A switch connected to the beam then shuts the water off. When the misting stops, the water on the screen dries which reduces the weight on that end of the beam. When adequate water has evaporated, the beam rotates in the opposite direction activating the switch and turning the mist back on. By adjusting the position of the counterbalance weight, the drying interval and mist time can be controlled within reasonable limits.

In a second type of control system (electronic leaf) the water completes an electric circuit between two electrodes,

activating a control circuit. This system does not involve any moving parts and is not as subject to variation due to wind, insects, or dirt accumulation and pivot friction. Salt accumulation is a problem with the electronic leaf as well as the Mist-a-matic. Both require periodic cleaning with the frequency contingent upon the water source.

Regardless of the type of control used, it should permit a gradual reduction in the frequency of misting as plants become rooted. Such control enables the grower to harden the plants to the water stresses involved with normal watering practices before cuttings are removed from the mist propagation area.

Since even short periods of dryness with new cuttings can be fatal, over-wetting is not considered to be as detrimental as under-wetting. For this reason, the solenoid valve used in the water distribution line should be one which is normally open (that is, open when no current is provided to the control). If an electric power failure occurs, the mist will operate continuously, keeping the plants wet throughout the electric power failure. This is, of course, dependent upon having a water supply system which maintains line pressure during periods of electrical power failure.

Humidity Chambers

Humidity chambers provide an alternative to automated mist systems. These systems have proven successful in major United States' greenhouse operations as well as being popular abroad. A humidity chamber will aid in rooting and/or germination of many species. The success rate is comparable or possibly superior to mist systems under certain conditions (Figures 2a and 2b).

Summary

Mist propagation of plant cuttings is a widely accepted practice. For best results, the mist should be operated intermittently. The on-off interval for misting should keep all cuttings constantly wet. The propagation area is generally placed on a bench for convenience. It may, however, be placed directly on the ground in a nursery setting for example.

Ideally, the total propagating area should be uniformly moistened. In practice, this is difficult to achieve due to various nozzle characteristics. However, extreme variations in water distribution should be avoided. Both whirling and deflection-type nozzles can give good results when operated at water pressures between 25 and 60 psi on 4-foot wide benches. For deflection-type nozzles, obtaining the best uniformity of water distribution may require adjustments of the gap between the deflection plate and nozzle orifice, and the position of the plate over the orifice. Periodically check nozzles for plugged orifices.

Some form of automatic control is essential to prevent excessive use of water and detrimental growth effects due to over-watering which occurs with continuous misting. Since as many as 20 on-off cycles may be necessary per hour, manual control is impractical. The most common control is the electric time clock; however, devices which sense and actuate as a result of the drying rate would be preferable. Two such devices are available: a counterbalanced rotating beam with a switch and an electronic artificial leaf where wetting completes an electronic circuit. Lastly, despite the ideal environment a mist bench system provides, rooting powder or quick dip hormone solutions may be necessary for species that are difficult to root.

Hardening-off Cuttings

Tender cuttings will be shocked if not carefully removed from a moist, humid environment to a dryer setting. Below are steps considered to ease this transition:

1. Gradually decrease misting periods.
2. Some nurseries allow cuttings to root into the soil beneath the rooting medium. The mist frame is removed altogether.
3. Root cuttings in small containers arranged in flats under mist. Plants can then be transplanted with little stress. Block-type rooting mediums are routinely used such as oasis cubes and rockwool cubes.
4. Pot up cuttings and move them to a shaded, humid location, gradually increasing sunlight and decreasing watering intervals.

WARNING: Consult a competent electrician for the electrical installation of the mist system. Due to the presence of water, the potential for electrocution from an improperly installed system is high.

Hardware Suppliers

American Plant Products and Services, Inc.
9200 Northwest 10th Street
Oklahoma City, OK 73127
(405) 787-4833

Aqua-Hort Systems, Inc.
P.O. Box 57197
Oklahoma City, OK 73157
(405) 521 -8002

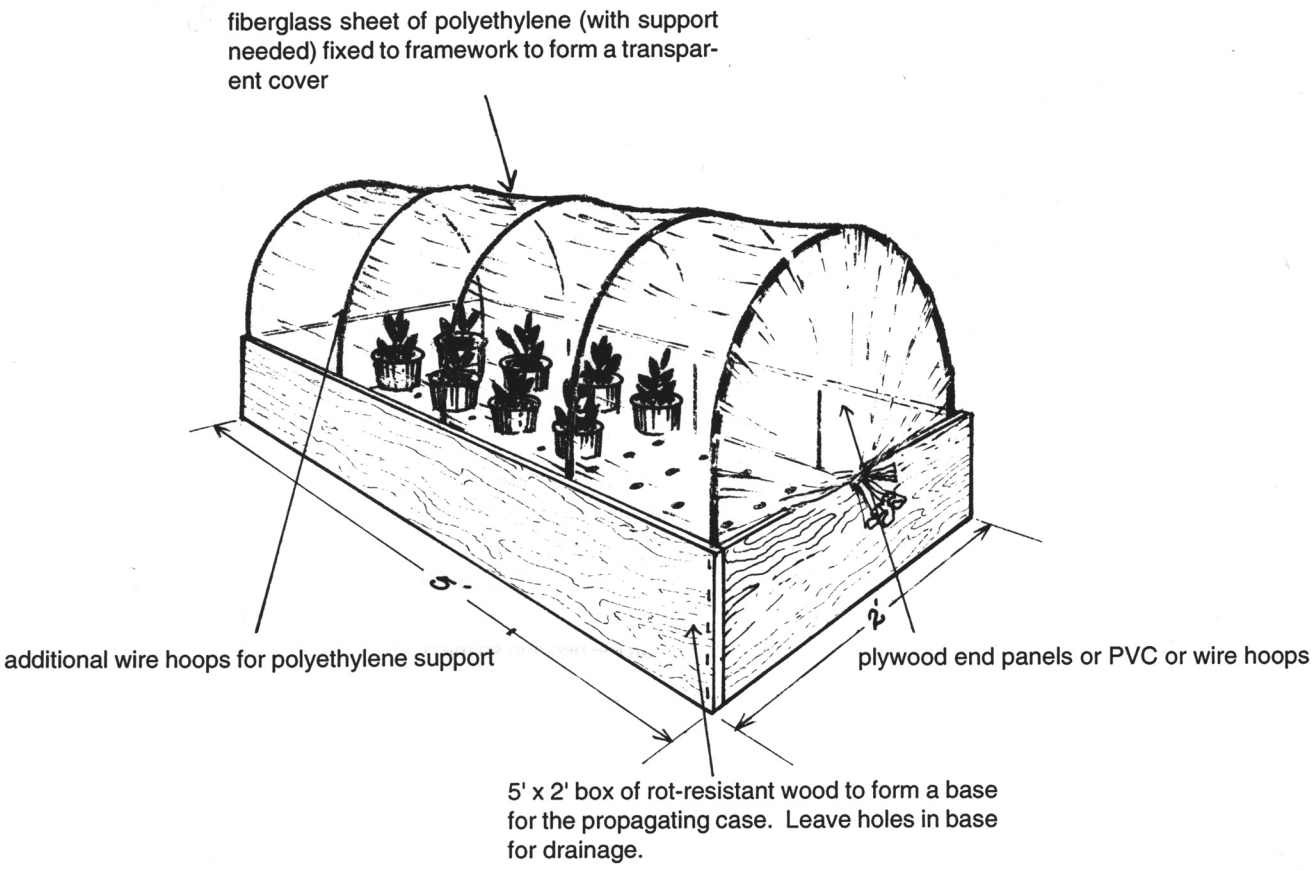


Figure 2a.

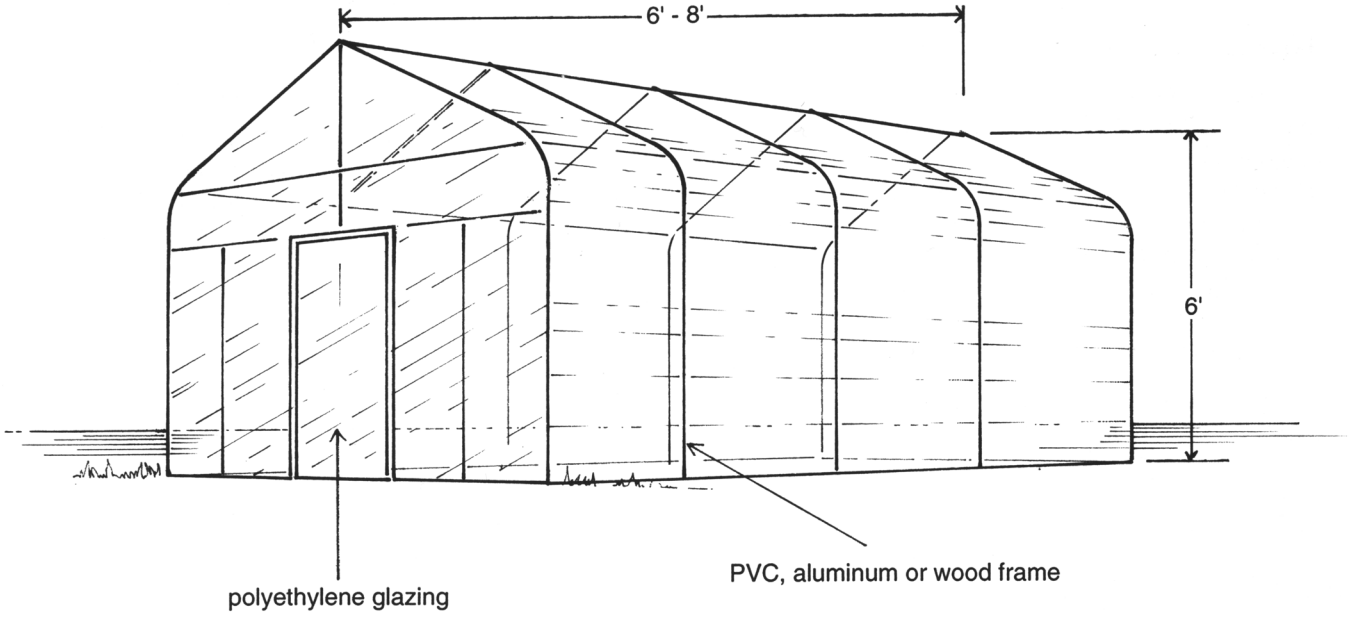


Figure 2b.

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- It is not a regulatory agency, but it does inform people of regulations and of their options in meeting them.
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