UNIVERSITY of FLORIDA
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Installation of Mist Propagation Equipment[1]

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When propagating plants by cuttings, it is important to prevent wilting until roots are produced. Maintaining plants in a turgid state requires a humid atmosphere accomplished by a misting system. There are two types of mist application, continuous and intermittent.

Continuous misting systems are not recommended for commercial operations. They lower the temperature of the rooting medium, resulting in slow rooting, and cause excessive leaching of nutrients from the foliage. In addition, too much water can reduce oxygen in the rooting medium and create a favorable environment for decay-causing organisms.

Intermittent mist (i.e. mist "on" for a specified period and "off" for a specified period) reduces leaching of nutrients and helps prevent excessive water in the medium. Intermittent mist also negates some of the cooling effects found under continuous mist systems. This system can be developed in various ways and most control mechanisms are readily available.

Intermittent mist may be used in greenhouse benches or in outside beds. Raised beds are preferred to ground beds. Ground beds should be equipped with drainage tiles to insure adequate drainage (Fig. 1).

Bed length whether raised or above ground can vary with needs of the propagator. But bed width should not exceed 60 inches since this is the most efficient width to work from both sides. Height of raised beds can vary from 30 to 36 inches, depending upon type of construction.

There are two types of intermittent mist lines-overhead and in-bench. In-bench mist lines, usually used in ground beds as support for overhead mist, may not be feasible. With overhead systems, the water supply line and nozzles are placed over the center of the bench. These are easier to install and maintain than in-bench systems since all parts are readily accessible.

With in-bench mist systems, the supply can be placed along the bottom of the bench under the medium or directly on the surface of the medium. Nozzles are placed on upright lines attached to the supply line.

Mist systems used outside must be protected to eliminate wind drift and insure complete mist coverage. Otherwise, cuttings will become dry. Ten minutes without water on a hot, sunny day can desiccate cuttings. In areas where freezing temperatures occur during winter months, check valves should be installed on the end of each line for drainage after each misting cycle.

SOLENOID VALVES

All systems for intermittent mist require solenoid valves to control flow of water through the system. Solenoid valves are available in two designs: the normally-open type and the normally-closed type. The normally-open valve is constructed in such a way that if electric power becomes disconnected, the valve is open and allows water to pass through. Flow of electric current closes the valve and shuts off the water. If an accidental power failure occurs on the solenoid line or any failure in the time clocks takes place, the mist remains on

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continuously with no permanent damage to the cuttings (Fig. 2).

A normally-closed valve requires electric current to open and allow the flow of water (Fig. 3). Power failure to the valve causes the mist to stop. This could cause severe damage or loss of cuttings due to desiccation.

The normally-closed solenoid valve is more readily available and a cheaper initial investment than the normally-open valve. It will operate as efficiently as the normally-open valve, but has the disadvantage of remaining closed when electricity is off. To eliminate this problem a bypass can be built into the system so that when power fails the mist can be manually operated (Fig. 3). However, if water pumps also operate from electric current, the bypass would also be inoperative in a power failure.

For safety purposes, the solenoid valve should be the type which operates from 24-volt current. To reduce the normal 100-200 volts of current a 24 to 27 volt transformer should be installed for wiring the valve. Because the solenoid is usually close to water, this is an inexpensive safety item.

MIST NOZZLES

The most satisfactory mist nozzles must break water droplets into very fine particles of fog so that droplets fill the area around cuttings, wetting both sides of the leaves. The primary function of mist is to produce 100 percent humidity and a continuous film of water over the entire leaf surface.

Two types of mist nozzles are available for plant propagation: (1) the oil burner types and (2) deflection or baffle types. Oil burner nozzles produce a very finely distributed spray bypassing water through small grooves at angles to each other. This type of nozzle uses very small volumes of water (2.5 to 5 gallons per hour), but they require high water pressures (50 to 100 pounds per square inch) to operate satisfactorily. In addition, high pressure nozzles cover only 3 to 4 feet of area per nozzle, and several nozzles are needed to achieve adequate coverage. Spacing from 30 to 48 inches apart will usually give sufficient coverage. Oil burner nozzles are often more expensive initially than deflection types and have a tendency to become clogged more readily.

Most commercial propagators in Florida use deflection type nozzles. They produce a rather coarse spra from water striking a flat surface. The larger aperture used in this type greatly reduces clogging but uses larger volumes of water (4 to 20 gallons per hour).

On the other hand, deflection nozzles will operate with water pressures as low as 20 to 30 pounds per square inch and will cover a greater area than high pressure types, usually 5 to 6 square feet. Therefore, a smaller number of these nozzles are required. Usually a spacing of 48 to 60 inches is satisfactory for a deflection-type nozzle.

Regardless of the type of nozzles used, they should be spaced effectively to cover the propagating bed. Mist nozzles should produce a spray with an umbrella type pattern of 360 degrees. Different brands of nozzles deliver different mist patterns. Therefore, individual nurseries must select the type that fits their operation. Generally, a nozzle that delivers no more than 5 to 6 gallons of water per hour in an even dispersal of mist is desirable. It should be designed to operate as efficiently at 25 to 30 pounds pressure as it will at 100 pounds pressure.

Ideally, nozzles should be nonclogging and nondripping, easy to clean, low in cost and easy to install and maintain. Nozzles should fit standard plumbing fittings. Most nozzles can be obtained with a plastic, stainless steel, or brass orifice. Those with a stainless steel orifice usually cost twice as much as those with brass, but they have a life expectancy five times greater than the brass orifice. All styles are available for installation directly to the line with adjustable fittings or with steel and poly (PVC) pipe or copper tubing.

INSTALLATION OF EQUIPMENT

There are some basic rules for installing a mist propagation system that should be followed for a successful operation. First, make sure the mist propagation line is installed completely level or horizontal. This ensures that between misting cycles lines will remain full of water so that when each cycle comes on, each nozzle will discharge water at the same time. A slight slope to one end may be necessary for drainage on outdoor systems in areas where freezing temperatures occur.

It is equally important that pipe from the solenoid valve to the misting line runs upgrade and the solenoid is installed below the level of the misting line. This is to insure that when the solenoid valve shuts off, no water drains, forming air pockets from the solenoid valve to the nozzles. Nozzles must be installed in an upright position with the spray heads facing upward (Fig. 4).

The height of the misting nozzles should not be less than 12 to 15 inches from the top of the propagating bed and not more than 3 feet above it. If the bed is wider than 31/2 feet, a double line should be installed over the bed.

Regardless of the type of nozzle used, it is impossible to spread the mist more than 31/2 feet. Nozzles that spread mist greater distances do so by increasing droplet size. Some growers prefer larger droplet size in outdoor operations to minimize drift of the mist from wind. However, if outdoor propagation areas are protected properly, the small droplet and finer mist are still more desirable in terms of runoff and conservation of water.

For small installations, it is desirable to have a petcock installed on each line so that the system can be shut off at selected sections. Usually in larger operations, an entire bed is filled with cuttings at one time so that individual nozzle control is not necessary.

The purpose of the strainer is to filter water before it goes through the solenoid, thereby preventing damage to the valves. Strainers also help reduce clogging of mist nozzles. The most commonly used strainer is the "Y" type with an 80-100 mesh screen basket which can be cleaned. Other types of strainers such as the "T" type or straight flow are equally effective.

MIST-CONTROLLING DEVICES

Control of intermittent mist propagation systems can be constructed three ways.

A preset system without environmental overrides.

A preset system with environmental override.

A variable system dependent upon the environment.

All types have been used successfully by propagators, but the variable system is the most sensitive and sophisticated.

Preset Systems Without Environmental Overrides

Environmental conditions have no influence on misting frequency when time checks or humidistats are used for control. Without environmental control, close personal observation is needed and daily adjustment may be required.

The preset mist system requires two time clock controls (Fig. 5). The day-night or 24-hour timer turns the system on and off at predetermined times. In addition, a cycle timer is wired to the solenoid valve to regulate mist cycles when the timer is on. The cycle timer is controlled by the 24 hour timer. Cycle timers are available in several forms including 1 minute maximum cycle with 1 second on-off intervals, 6 minute maximum cycles with 6 second on-off cycles and 12 minute maximum cycles with 12 second on-off cycles.

Humidistats have been used to replace the time clock systems. However, as drying of leaves is not directly related to humidity they are not the best means of control.

Preset Systems With Environmental Overrides

Some propagators use a thermostat-control system to override the cycle of time clocks. When temperatures reach a certain level, the thermostat overrides the time clock controls and applies continuous mist until the temperature is reduced. A sensing element for the thermostat is placed just above the cuttings.

This system can also utilize a photocell to override the preset time clock. A short period of mist is applied after a predetermined amount of light has been received by the photocell. When using light to override the time-clock system, the amount of misting does not vary. Only the intervals between applications will vary. Therefore, the higher the light intensity, the more frequent the mist will turn on. This system is effective only in plastic or greenhouses where high humidity can be maintained.

Variable Environmental Cycles

With variable systems there are no time clocks, but there are separate systems related to light, evaporation, or weight that control the cycle.

An electronic leaf system maintains a uniform level of humidity at the leaf surface. Two electrodes are imbedded in a plastic or nonconductive surface and are wired to a control box connected to a solenoid valve. The electronic leaf is activated as water evaporates from the plastic surface and cuts off as water covers the surface.

This system can vary with placement of the leaf in the propagating bench, and it is difficult to use outdoors because the wind influences the amount of water applied. In areas where water has a high salt content, salts tend to accumulate on the plastic and prevent the leaf from turning the water on and off properly.

The weight system is another type of environmental cycle control (Figure 6 and Figure 7). When enough water collects on a small stainless steel screen, it is lowered, activating a mercury switch which closes the solenoid and turns off the mist. As the water evaporates from the screen it rises and closes off the mercury switch, which opens the solenoid valve and turns on the mist. Where water has a high salt content or fertilizer injectors are used, the screen must be cleaned periodically to prevent a buildup of salt or the system could be held indefinitely in the on position.

Environmentally dependent light operated systems are available which operate without time clocks, or other controls. They operate strictly on light accumulation in a photocell. After the photocell has absorbed a predetermined amount of light in a given period of time, the solenoid is activated. However, for this system to be effective for outdoor use, adequate protection must be provided.

Probably the most frequently asked questions after a discussion of mist propagation are: (1) What is the best system, (2) how much water should be applied and (3) what cycles are best? The system that is best for one propagator may not be best for another. Cycles, such as 5 seconds of mist per each 10 minutes or 2 seconds per minute, will have to be adjusted to the cultural and environmental conditions at individual nurseries. Absolute requirements dictate that the rooting medium remain moist but not wet and that a film of water be constantly present over the cutting surface. The system used must be regulated to obtain these conditions. Cuttings must be misted until well rooted. However, misting frequency should be reduced as cuttings begin to root in order to avoid soft and weak growth.

COSTS FOR INTERMITTENT MIST PROPAGATION FACILITIES

While much has been written about the principles, techniques, and equipment required in intermittent mist propagation, little information is available concerning basic prices associated with maintaining this equipment.

Cost of mist controlling devices, nozzles and other equipment will vary considerably, depending on type, source and quality of equipment selected and the particular requirement of each propagator. There will be cases where booster pumps may be required to increase line pressure, or special filters may be necessary if the water supply has a large amount of particulate matter. Special equipment of this type obviously would increase the basic cost of installing the mist propagation system.

Cost figures for an intermittent mist system, regulated by a 24-hour time clock with an interval timer are presented in Table 1. These figures are for an existing raised bed where the water source is readily available. Costs of the bench construction or actual installation of the intermittent mist system will not be considered here.

Nozzle types and the mist control system used in determining the cost of equipment were selected because of their popularity and common usage in the trade. The actual prices of all material listed in Table 1 were derived from 1976 dealer price lists in the catalogs of nursery aud greenhouse suppliers.

The Flora-Mist nozzles were selected for discussion because of their common usage in the trade. Cost of other comparable nozzles are listed in Table 2. The Flora-Mist nozzles are designed with a standard 1/8 inch pipe thread and can be inserted into a 1/2-inch PVC pipe when a saddle is used. The pipe saddle is cemented to a 1/2-inch PVC pipe where a nozzle is desired. Using a 5/16-inch drill, a hole is drifled in the 1/2-inch PVC pipe following the attachment of the pipe saddle to the feeder line, and the Flora-Mist nozzle is then inserted into the pipe saddle.

Operation of other regulatory systems such as the electronic leaf, Solatron and Mist-A-Matic have been discussed. Cost figures for these three systems are listed at 1976 dealer prices in Table 1. While these systems will increase the cost of the intermittent mist bed, it must be noted that they are much more sensitive systems and ultimately give better control of mist and water level in the propagation bed.

When the electionic leaf system is used, the 24-hour time clock and interval timer are excluded. However, the total cost of the propagation system increases to $188.05, based on the 200 square foot model. With the Mist-A-Matic system, the 24-hour time clock and interval timer are again excluded, but the total cost increases to $199.05 in the same model. Likewise, the Solatron system operates without either of the time clocks, but its use increases total cost of the system to $233.05.

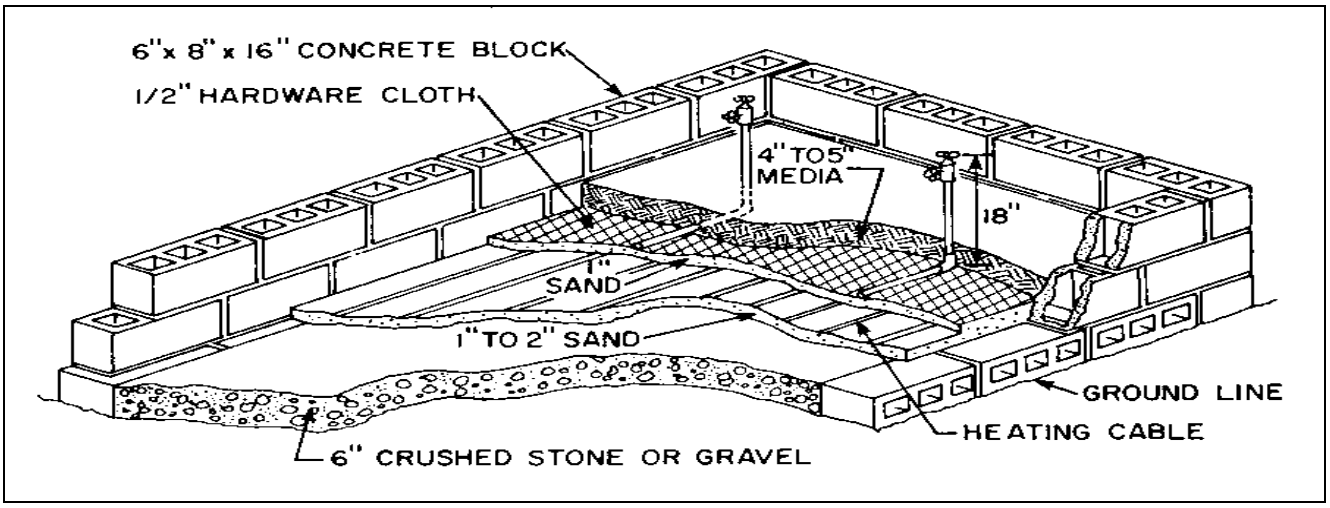

Figure 1. A cutaway view of construction of a plant bed for outside conditions. Width of bed should not exceed 60 inches. Nozzles are spaced 30 inches apart and 15 inches from sides and ends of bed. The first layer of concrete blocks facilitates drainage.

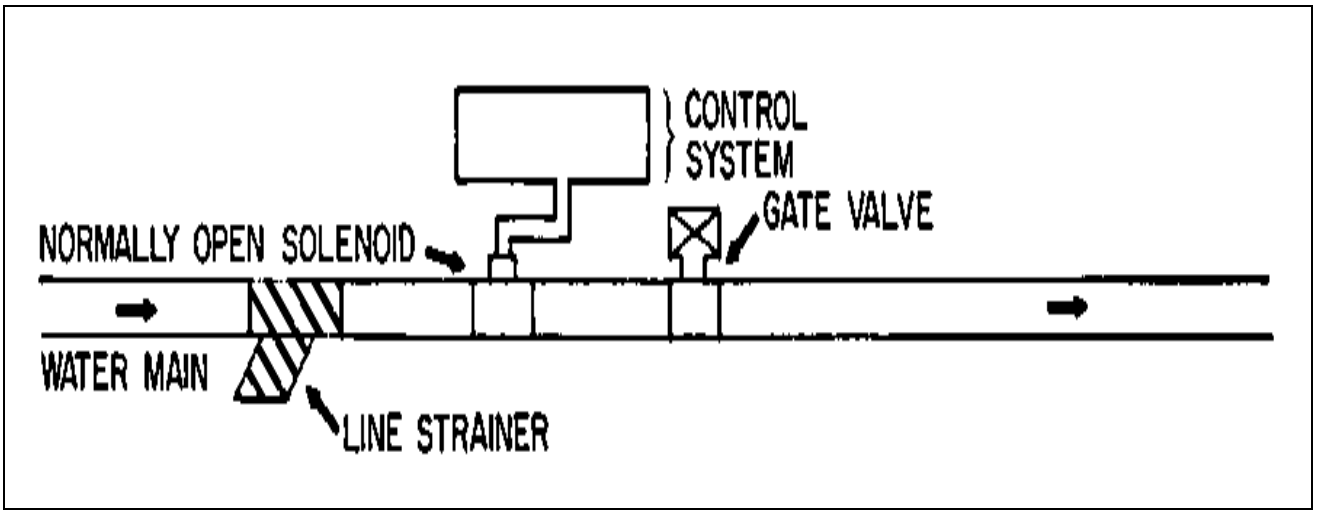

Figure 2. Schematic diagram showing a mist system with a normally-open solenoid valve.

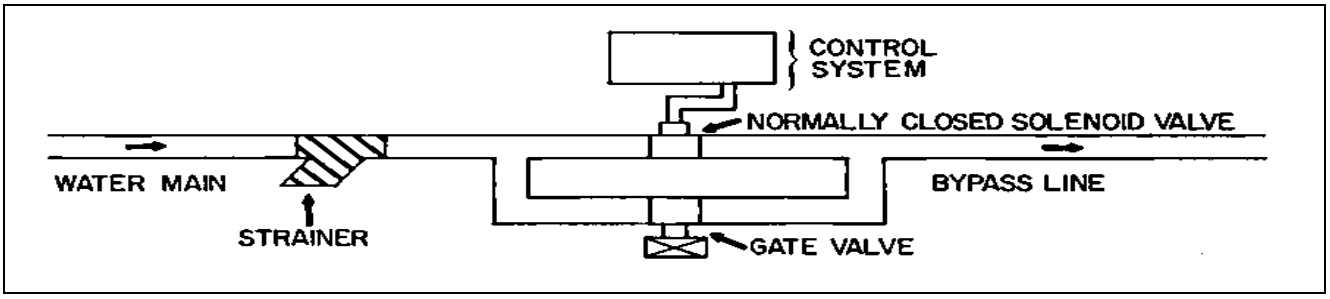

Figure 3. Schematic diagram showing a mist system with a normally-closed solenoid valve.

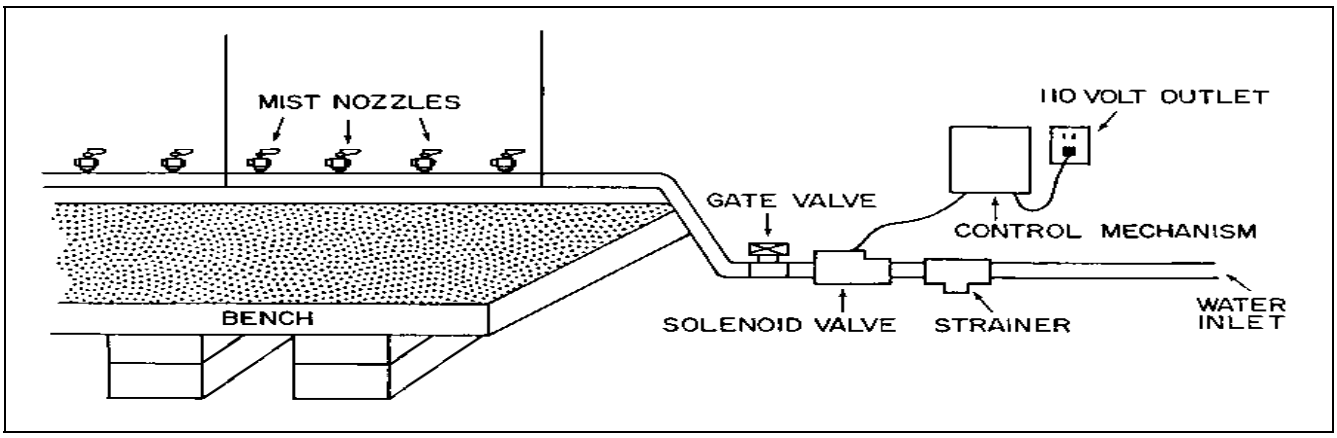

Figure 4. Diagram of the overall mist system.

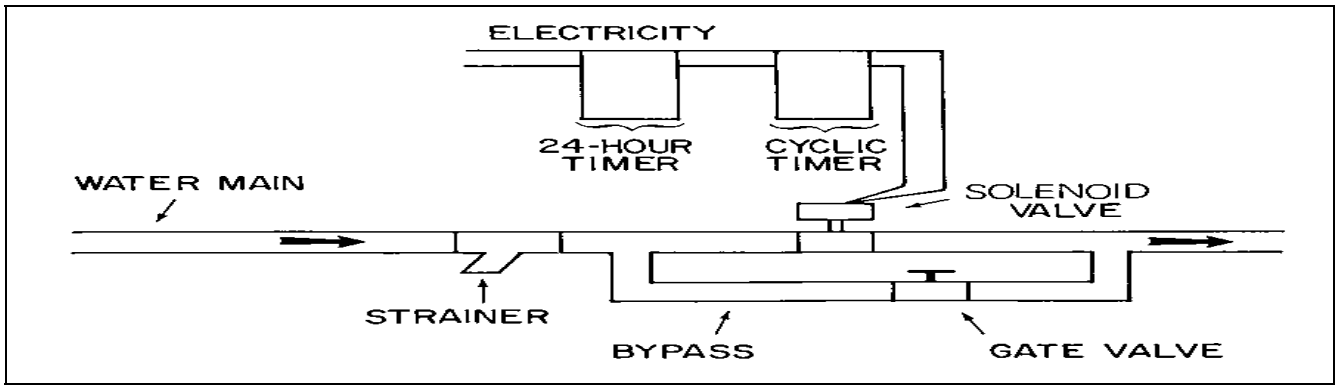

Figure 5. Schematic drawing of a preset cycle mist propagation control setup.

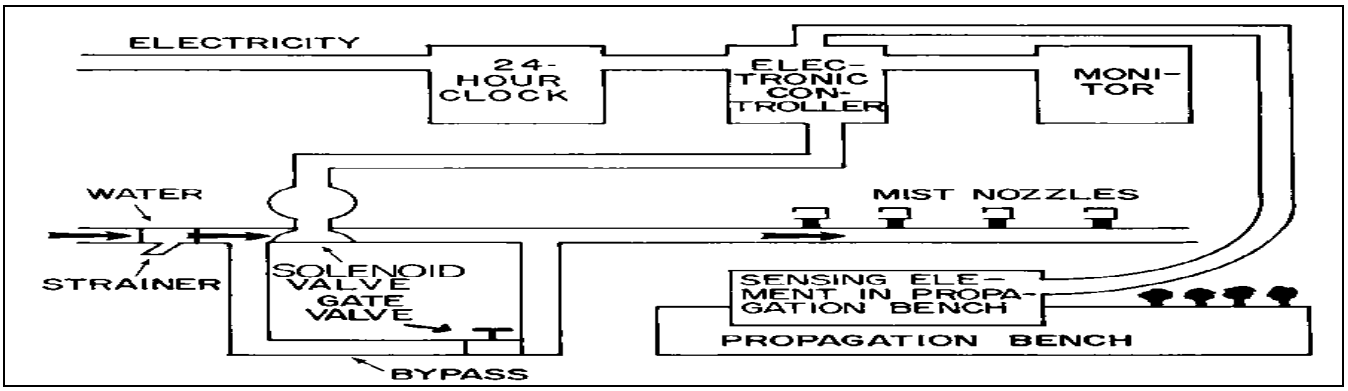

Figure 6. Schematic drawing of mist propagation system where mist is controlled by a sensing element from which water evaporates.

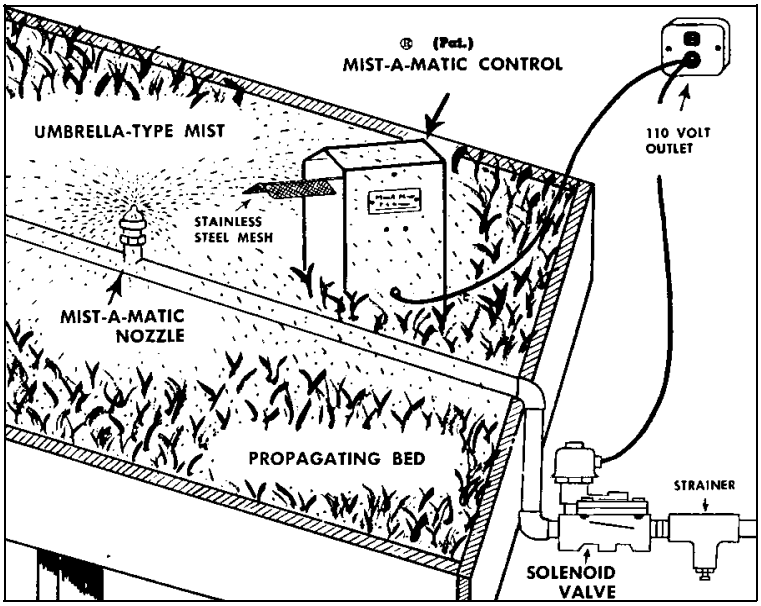

Figure 7. Schematic diagram of Mist-A-Matic system for propagation (Photo courtesy of E.C. Geiger Co., Harleysville, Pa.)

Table 1. Supplies and equipment necessary to install an intermittent mist system in an existing raised propagation bench 4 ft. x 50 ft.

Supplies/Equipment Quantity	Description	Cost*
50 ft.	1/2 inch PVC pipe at $2.99 per 100 feet	$1.50
17	Flora-Mist Fogger Nozzels at $.70	11.90
2	1/2 inch PVC T's at $.38	.76
2	1/2 inch PVC 90° ELLS at $.34	.68
1	1/2 inch PVC Cap at $.25	.25
17	1/2 inch PVC Pipe Saddles at $.26	4.42
1	1/2 Solenoid Valve at $36.00	36.00
1	24 Volt Transformer at $8.00	8.00
1	1/2 inch Globe Valve at $4.00	4.00
4	1/2 inch PVC TXS Male Adapters at $.28	1.12
1	1/2 Line Strainer at $13.82	13.82
	EQUIPMENT SUBTOTAL	**83.05**
1	24-Hour Time Clock	20.30
1	Interval Timer-6 minute cycle with 6 second adjustable increments	34.85
	TOTAL WITH TIME CLOCK SYSTEM	**$138.20**
1	Mist-A-Matic Control System	116.00
	TOTAL WITH MIST-A-MATIC	**$ 199.05**
1	MacPenny Electronic Leaf	105.00
	TOTAL WITH MACPENNY ELECTRONIC LEAF	**$188.05**
1	Solatron Model 561-9	150.00
	TOTAL IN SOLATRON SYSTEM	**$233.05**

* Prices from 1976 Distributor Price Lists.

Table 2. Characteristics and cost of some commonly used nozzles for intermittent mist systems.

Description	Type	Area of Coverage (dia. Ft.)	Operating pressure (lbs./sq. in.)	Rate of discharge (gal./hr.)	Cost	Comments
Flora-Mist Fogger	Deflection	6-7	40	4-14	$.60	1/32 inch orifice 1/8 inch std. Pipe threads
Mister Green Fogger	Deflection	5-7	20	12		
			40	17	1.10	.040 inch orifice
			60	20		5/16-24 machine threads
Fog-Mist Nozzle #550	Deflection	4	20	6	3.60	3/8 inch std. pipe threads
Fog-Mist Nozzle #551	Deflection	4	20	6	2.00	1/8 inch std. pipe threads
Jet-Mist Nozzle	Deflection	4	40	1	.75	5/16-24 machine threads
Eddy-Mist Nozzles	Deflection	12	45	90	.90	Requires an adapter
Supreme Electric A6	Oil Burner	3-4	100	15	3.00	1/2 inch pipe fitting
Supreme Electric T16	Oil Burner	15	50	1.5	5.00	