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Propagation Equipment 101 ©

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INTRODUCTION

This paper is a review of equipment used to provide the best environment for propagation. For some it may seem a rather basic review, but sometimes going back to basics is not a bad thing.

It has always been said by propagators "If you have the basic understanding of plant propagation and the required environment, you can root cuttings in any type of structure." History and I.P.P.S. tours have proven that sophisticated propagation structures are not always necessary to be a successful propagator. As many of us have learned over the years by attending I.P.P.S. meetings, no two nurseries have the same system or the same way to propagate and grow the same plant.

While most nurseries now use a mist or fog system for propagation, cuttings have been rooted for hundreds of years using very simple methods. These simple structures and systems were used before the advent of more automated systems like the mist system. The I.P.P.S. was founded at a time when mist propagation was in its infancy as a commercial system in the U.S.A., and the founding members played a significant role in its development. Mist propagation has frequently been viewed as a mechanical version of cold frame methods that involved manually applied overhead watering of cuttings.

The first reported use of mist for propagation was in 1936, but it was not until the 1940s that nurserymen were obtaining suitable results. The mist system as we know it today was developed in the 1950s with Harvey Templeton, Jim Wells, and other well known I.P.P.S. members perfecting the system. The interest in the use of mist for propagation was sufficiently great that at the 1954 annual I.P.P.S. meeting an entire session was devoted to mist propagation.

Propagation structures can range from the simplest structure of a cold frame, outdoor mist beds, a bed covered with poly, or a small covered poly house to a sophisticated structure controlled by computers. Whatever type of system you use, the same general principles apply to all propagation facilities.

The important factor with any structure used to root cuttings is to maintain the cuttings in a turgid enough state to prevent them from wilting or drying out. The propagation environment is made up of a number of factors including light, temperature, humidity, and air movement. This is usually achieved by maintaining a humid environment with the assistance of mist, fog, or covering the cuttings with a thin layer of poly, and by manipulating the temperature and light through shading and ventilation. Improper control of this environment can result in death of cuttings or poor rooting percentage.

PROPAGATION STRUCTURES

The structures used for propagation include:

- **A cold frame.** A low-cost structure.
- **An outside ground bed.** Usually used for summer cuttings.

- **A low hoop sun tunnel.** A low cost structure usually used for summer cuttings.
- **A low poly structure within a greenhouse.** This method allows the propagator to increase humidity and reduce mist frequency. This type of structure is frequently used for acclimation of tissue culture material.
- **Polyfilm laid directly over cuttings.** This method usually has limited applications because there is no mist system in place.
- **Greenhouse.** The most commonly used structure for propagation is a greenhouse. Quonset style houses are commonly used for propagation, and we are seeing more sophisticated greenhouses used due to the improved growing environment. Retractable-roof and retractable-side houses are among those that provide the improved environment.

The incorporation of labor-saving devices is becoming more important in the design and use of a propagation facility. The size and sophistication of the structures will depend on the size and complexicity of your propagation needs.

GREENHOUSE PROPAGATION STRUCTURES

Greenhouse Coverings. Glass has a very high initial cost but offers the best light transmission. You very rarely see glass used now. Polyethylene film is the most common covering because it has relatively low cost, but it needs replacing every few years. The use of a double polycover can give up to a 40% saving in heating costs.

Polycarbonate type material is often used for roof and end walls and other areas requiring a rigid covering. Polycarbonate is often used as a replacement covering for old glasshouses.

Greenhouse Floors and Benches. Benches come in various shapes and sizes: fixed bench systems, rolling bench systems, greenhouse floors used as benches, and sand benches.

Floors as Benches. Concrete is a good material for a propagation house floor because it is easy to keep clean and sanitized. Porous concrete was popular about 20 years ago, but has been found to be unsuitable for propagation house floors since propagation media will often clog the porous matrix and prevent drainage.

Gravel or dirt floors are inexpensive when compared to concrete. However, they cannot be cleaned or disinfected as easily as concrete. A compromise is often to use gravel and a weed-barrier-type material over dirt floors with concrete aisles. The use of floors as benches allows for the maximum use of available space. The disadvantage is the added back strain for employees.

Raised Benches. Many growers utilize fixed benches of various designs. The benches are laid out in a longitudinal design to minimize the number of aisles and increase percentage of bench space. Fixed benches are more commonly used, but we are seeing an increasing use of rolling benches. These benches can increase efficiency up to 90% of the available floor space. A crank at the end of the bench moves bench platforms. The high cost of installing rolling benches has been challenged by some growers, while others seem to have taken a leaf out of the commercial greenhouse growers' manual and proved their cost-effectiveness.

Raised benches can be made very simply out of wood, steel piping, concrete blocks, and wire mesh. Various types of prebuilt bench systems are also available. Consideration must be given if a bottom heat system is to be incorporated into the bench.

ENVIRONMENTAL CONTROLS

To create the ideal environment, propagators regulate water, humidity, temperature, light, and ventilation by various types of controls. They include simple time clocks, mist controllers, thermostats, mist sensors, humidistats, and computers. Before mist propagation became widely accepted, rooting was attempted by maintaining high relative humidity in the rooting zone and restricting sunlight by shading. Mist and fog systems break water droplets into very fine particles so that droplets surround the leaves of the cutting.

Mist Systems. Because the primary function of mist is to create a humid environment around the cutting and a continuous layer of water over the leaf, the first requirement of a mist system is to distribute the water as evenly as possible over the cuttings.

A mist nozzle must break water droplets into very fine particles so that droplets surround the leafy cutting. This must be done using the minimum amount of water to keep the cutting turgid without saturating the medium.

In designing a mist system there are many different things that must be taken into consideration: water pressure, nozzle spacing, nozzle height above the plants, type and capacity of nozzle, and air movement.

A good mist system should take into consideration every condition that is causing water to evaporate from the cutting — mist application, sunlight, temperature, and air movement.

Most mist nozzles use low amounts of water (2.5 to 5 gph), but require adequate water pressure to operate and provide the fine mist. Regardless of the type of nozzle used, they should be spaced to adequately cover the propagation bed or bench. Mist nozzles produce a round pattern, and fitting them to a rectangular bed or bench can be problematical, so adequate overlapping is needed.

Two types of mist lines are most common: overhead and in-bench systems and mist booms.

- **Bench systems.**
  - **Overhead systems.** These seem to be more common since they are easier to install and do not reduce the available space on the bench.
  - **In-bench systems.** Water pipes are either buried in the bed or the pipes are run below or on top of the bench with nozzles placed on an upright pipe attached to the water supply line.
- **Mist booms.** This is really a traveling irrigator. Uniformity is the biggest advantage of a boom mister. A traveling mist boom has a flat fan nozzle, so with proper spacing every inch of the cutting bed receives the same volume of water, thus providing for more uniform rooting.

Mist Controlling Methods. The two main types of control include:

- **A system without environmental controls.** Environmental conditions have no influence on misting frequency. This system will need close personal observation and frequent adjustments are needed as conditions change. A 24-h time clock turns the mist controller on and off at predetermined times. The mist controller can be as simple as a 10-min mister or a variable mister that allows for a set amount of mist at a predetermined interval.
- **A variable system dependent upon the environment.** With variable systems there may not be time clocks, but there are separate systems related to light, evaporation, humidity, or weight that control the cycle.
  - An electronic leaf maintains a uniform level of moisture at the leaf surface. Two electrodes imbedded in a plastic surface are wired to a control box connected to a solenoid. The electronic leaf is activated as water evaporates from the plastic surface and cuts off as water again covers the surface.
  - The weight system is a type of controller that when adequate water collects on a small stainless steel screen, the screen lowers and activates a switch, which closes the solenoid and turns off the mist. As water evaporates from the screen, it rises and turns on the mist. The screen balance is placed among the cuttings. The frequency of misting is controlled by a combination of the temperature, humidity, and light intensity.

There is no one best system. The system that works for one propagator may not work for another. In comparing different control systems, attention must be paid to their effectiveness and their adjustment and maintenance requirements. With a timer the onus is on the operator to adjust the settings in accordance with the weather.

While a mist is used to maintain a film of water on the leaves, it is important to use the minimum amount of water needed to keep the cuttings turgid without oversaturating the media.

Droplet size is also an important consideration; small droplets allow the mist to remain suspended as a cloud before landing on the leaf surface of the cutting.

A good mist control system should take into account every condition that is causing water to evaporate from the cutting — sunlight, temperature, and air movement.

Preventing Operational Problems in Mist Systems. Anti-drip devices should be installed between the mist nozzle and the supply line. The device prevents dripping from nozzles between misting cycles. Excessive dripping will saturate the rooting medium.

A pressure gauge is a useful addition to a system — operating pressure is between 20 and 80 psi. If constant water pressure is a problem, the addition of a pressure tank will assist with maintaining constant pressure. An in-line filter is recommended to reduce potential nozzle clogging.

Fogging Systems. Fog plays a very important role in the art of propagation, despite its advantages very few nurseries seem to have utilized its advantage fully. When used for cutting propagation fog provides an environment that reduces the

stress on plants while not over wetting the rooting zone. The plants are able to tolerate more sunlight and higher temperatures and therefore root faster.

The droplet size produced by fog is many times smaller than produced by mist. Fog droplets will remain suspended and float in the air and do not settle on the rooting media.

A fog system produces a visible fog that surrounds the cutting and maintains relative humidity close to 100%. This reduces evaporation and therefore transpiration loss from the cutting is virtually eliminated.

Fog uses less water than mist so the rooting media does not become over saturated.

Two main types of fog systems:

- **High-pressure fog.** High-pressure system as the name implies uses high-pressure water or a combination of air and water to create a very fine droplet size through a very small nozzle opening.
- **Spinning type atomizers.** Nozzles are fixed to an arm that spins at high speed. As water is released from the nozzles the droplet sizes are such that they stay suspended. A fan behind the system forces the fog into the propagation area. This type of system tends to produce a larger droplet size that may not stay suspended as long as a high-pressure system. This system is more flexible and cheaper.

Bottom Heat or Root-Zone Heating. Propagators have been aware of the importance of bottom heat for more than 100 years. Providing a warm environment at the base of the cutting will usually speed up the rooting process. Optimum temperature ranges for propagation benches is 68–70 ºF. Since mist tends to lower media temperature, which can slow rooting, heat is usually added below the cuttings to keep the media at a predetermined temperature. Thermostats are used to control the temperature.

Bottom heat systems commonly used include a recirculation hot water system, electric heating cables or forced heated air.

Electric heating cables are generally used for small propagation areas. The hot water systems rely on hot water being pumped through a series of pipes buried in the floor or laid on the bench under the cuttings. This can be a very simple system utilizing a domestic water heater for small areas. The hot water system is the most common system used today and with the use of a highly efficient boiler can be very cost effective.

Forced air systems rely on a poly tube attached to a heater and blower, which forces the heated air under the bench.

A sensor connected to a thermostat controls the bed temperature at the base of the cuttings.

Shading, Ventilation, and Air Movement. Temperature control and light manipulation are both critical factors in cutting propagation, especially in the summer. Shading and ventilation are used to help maintain the correct environmental balance between humidity, temperature, and light intensity.

Air movement within the propagation house is important. This helps reduce disease and is often achieved with either a jet tube running the entire length of the house or with the use of horizontal air flow fans.

MATERIAL HANDLING DEVICES

Demands on labor costs represent the one of biggest single items of expenditure in a propagation department. Layout of a facility is critical although, unfortunately, this aspect is nearly always an "after the event" situation. Older units usually suffer from paths that are too narrow or have limited accessibility.

OBJECTIVES IN PLANNING A PROPAGATION UNIT

- Provide near optimum growing environment facilities for a wide range of plants.
- Maximize use of space.
- Use labor economically.
- Plan for efficient use of water, energy, and labor.
- Be innovative.
- Plan for success.
- Be profitable.