CONCLUSIONS

Monochloramine at 680 mgl^{-1} appears to be a suitable replacement for 70% isopropyl alcohol. It provides equal or better disinfection, and is considerably less expensive (Table 8). A 680 mgl^{-1} monochloramine solution costs about $0.01/gal.(3.785 liters) compared with $1.81/gal.(3.785 liters) for 70% alcohol. Because the cost of monochloramine is so low, a nurseryman can frequently discard and replenish solutions without economic concern. These solutions can easily be made from locally available materials such as liquid pool chlorine (sodium hypochlorite) or Clorox and ammonium sulphate. Pool chlorine solutions deteriorate rapidly, and a supposedly 10% labelled chlorine solution may be close to 7%, as we found with 3-month old material. Consequently, it is wise to test the available chlorine with a test kit, or assume deterioration with time and adjust the make-up of the solutions accordingly. Monochloramine solutions should be made using a ratio of 2:1 Cl:N or less to assure sufficient ammonia to form monochloramine. Concentration of chlorine using liquid sodium hypochlorite should be based on percent available chlorine rather than percent sodium hypochlorite.

LITERATURE CITED

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COMPUTERIZED IRRIGATION AND ENVIRONMENTAL CONTROL SYSTEMS FOR GREENHOUSE PROPAGATION AND NURSERY PRODUCTION

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As our understanding has grown of the relationship between plant growth and environmental conditions, it has become a standard practice in nursery production and greenhouse propagation to exercise control over these *environmental conditions.*

The advent of computerized control systems has made possible the means whereby environmental conditions are monitored, and automatically modified per the operator's preprogrammed instructions. The complexity of this function is best and most effectively performed by the computer — leav-

ing time for the operator (nursery/greenhouse manager) to perform his/her appropriate management functions. Not only can the computer perform the monitor and control functions, it can also generate a data base for the manager to manage from.

Why a computer? The key concept in nursery and greenhouse control is that every function is inter-related, in cause and/or effect, to other functions. For example, bench misting of cuttings should be at a frequency such that the cutting remains "turgid" or fresh, but we want to avoid excessive foliage wetting to prevent fungus diseases. Simply setting a time clock for 10 seconds "on", 5 minutes between cycles, is failing to take into account sudden cloud cover, sudden change in relative humidity, etc. Also, during daylight, the solar radiation varies, at its peak around noon, and influences the rate of evapotranspiration.

The goal of the person in charge of the propagation operation is for the highest quality and greatest quantity of production at the lowest possible cost of production. This requires constant and accurate monitoring of the environmental conditions and operation of the various control systems — a level of skill that is typically found only with the nursery/greenhouse manager. Add to this the requirement for around-the-clock monitoring and operation, and it soon becomes evident where the computer can assist the manager.

A computer, to date, does not have any form of intelligence. It simply is a storage bank of the operator's pre-programmed responses (open a vent, turn on valve #20, turn on lights, etc.) to external signals or programmed intervals (temperature, time of day, light intensity, etc.) The computer performs the function of scanning sensors as well as reading the operator's program, processing the information (it searches for the correct pre-programmed response), and executing a given command — all at a speed that is beyond human capability.

As an example, referring back to the bench misting of cuttings, assume the nursery/greenhouse manager has a computerized control system. The controlled or automated functions include:

— Mist system valves and pump
— Greenhouse roof vents
— Overhead heat
— Cooling pads (fan and circulating pump)
— Bottom heat on bench
— pH control — acid and base dosing for mist water source
— E.C. control/de-ionizer monitoring for mist water

source

To complete the system, the computer will monitor:
— Solar radiation
— Greenhouse ambient temperature
— Outside wind speed and direction
— Rooting medium temperature
— Supply water pH and E.C.
— Greenhouse relative humidity

The manager's task is now to load the computer with the relevant information regarding:

— Programmed combinations/sequences of valves/devices
— Duration of valve/device operations
— Frequency of valve/device operations
— Temperature set points for vent positions/cooling pad system activation, or heating systems activation.
— pH set points and which material to dose into water supply
— E.C. set point to trigger alarm and stop misting if deionizer loads up.
— Conditions under which the computer is to start, wait (later to resume when the condition reverses), or to stop a given operation or function.

In the example of bench misting, the program might include:

(GROUP 1) Activate mist valves sequentially, 10 seconds duration, every 10 minutes, start 07:00, stop 10:00; condition of operation (condition #1) —

START: line pressure greater than 90 p.s.i.

WAIT: line p. less than 90 p.s.i., OR relative humidity greater than 80%.

RESUME: line pressure greater or equal to 90 p.s.i. AND relative humidity less than or equal to 80%.

STOP: E.C. greater than 0.5 mmhos/ALARM.

(GROUP 2) Activate mist valves sequentially, 15 seconds duration, every 6 minutes, start 10:00, stop 14:00; condition #1.

(GROUP 3) Activate mist valves sequentially, 8 seconds duration, every 15 minutes, start 14:00, stop 18:00; condition #1.

Similarly, groups can be written for automatic operation of the water treatment equipment, greenhouse vents, heating and cooling systems, and so on. The application has been demonstrated here in a simplified and abbreviated manner. Remember that the computer integrates all the variables into one

control system, performing the monitor and control function with great speed and without taking time out for lunch, coffee breaks, holidays, etc. The nursery/greenhouse manager is now free to go about his/her duties.

Benefits.

— The computer performs *continuously* the monitor and control functions with speed and accuracy.

— Alarm signalling by the computer can advise the manager when his/her attention is required.

— The computer generates records of its operation for the manager.

— A print-out records events as they occur.

— Greater control of costs of production through precise and timely control; savings are commonly seen in energy (electricity, gas, fuel oil), manpower, water, fertilizers, pesticides, water treatment chemicals, etc.

— Higher quality plant materials and decreased loss of plants due to close control of the greenhouse or nursery environmental conditions.

Typical applications. Computerized control systems for nurseries and greenhouse are commercially available for:

— Mist propagation
— Hydroculture (hydroponics)
— Aeroponics
— Tissue culture/micropropagation
— Drip irrigation for pots and containerized stock
— Drip and conventional irrigation for field-grown stock
— Greenhouse environmental control

APPLICATION OF A MICROCOMPUTER IN A WHOLESALE NURSERY

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At our nursery we need to manage the complex scheduling that comes in hand with our production volume. In order to schedule the propagation of over three million plants, manage labor data of 30 employees, and handle over 100 orders a week, we gradually turned to the computer for assistance. Our first microcomputer was purchased in October, 1982. Shortly thereafter we needed another microcomputer to handle all the work that had been transferred onto the computer.