for that naturally coming from the buds, some of the latter can be removed to prevent their becoming competitive "sinks" during bud break and elongation. Cuttings taken before sufficient natural chilling has occurred must be cold-stored to remove inhibitors to bud break and root initiation.

Studies are being continued to substantiate in detail the conclusions outlined in this paper.

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PRESIDENT KRAUSE: Thank you, Al. Save those questions for the end of our session this morning. Now we will consider techniques in misting; first a talk on under-bench misting by Bruce Usrey. Bruce:

ECONOMICS OF A CONTROLLED HIGH HUMIDITY ENVIRONMENT FOR PROPAGATION

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In 1964 Monrovia Nursery designed and built a controlled environment greenhouse. This plastic house was designed to provide the best possible environment with the least operating and maintenance cost. Along with this was the hope of increasing rooting percentages and decreasing the amount of labor used in airing, watering, and shading the hot frames.

In designing this house a number of problems had to be solved. These were:

1. Control of humidity
2. Efficient heating
3. Control of air temperature
4. High light with minimum heat
5. Low maintenance cost

First, atmospheric humidity is electronically controlled by use of an Hygrodynamics, Inc. humistat. This humistat is extremely sensitive in the range of 70% to 97% humidity while being almost maintenance free. This humistat is tied into the hydraulic and pneumatic mist systems by relays and solenoids and operates either, or both, as needed. The hydraulic system is under the bench and is capable of maintaining a humidity of

80%, when used by itself. The nozzles are Flora Mist and spaced 4 by 8 feet with an operating pressure of 90 pounds. This system uses 75,000 gallons of domestic water per day which, for economy, is recirculated through sand filters.

The pneumatic system cost is about ten times that of the hydraulic system but it was necessary in order to maintain a humidity above 80% on summer days. This system will maintain a relative humidity above 95% at all times and greatly reduces the hand-watering of flats. It also reduces the constant moisture associated with an intermittent mist system. The pneumatic nozzles are placed overhead in the walkways to prevent drip on the flats. These nozzles are Spraying Systems Co. pneumatic 1/4" atomizers. This system uses 1/2" O.D. plastic tubing for transporting the 50 p.s.i. water and the 60 p.s.i. air. This combination seems to give the most efficient fogging.

The air temperature can be maintained at 75° F. during the hottest days by using evaporative coolers with the capacity to change the air once each minute. By keeping the air temperaures low, preferably between 60° and 70° F. and providing air movement even on cold, cloudy days, fungus problems can be controlled and excessive top growth is reduced.

Heating requirements are met by circulating warm water in a copper tube grid system placed in concrete, insulated benches. This direct-contact heating, conserves 83% of the fuel as compared to indirect heating. Direct heating also keeps air temperatures down which makes it easier to control the humidity. Rooting media temperatures are generally maintained at 65° to 75° F. depending on the cuttings.

This house was constructed with pipe, steel, concrete and plastic. It has less maintenance than if wood and glass were used. Epoxy paint was used and appears to be in good condition after 5 years even under high humidity conditions.

One of the most important considerations in the propagation of any plant is providing the correct amount of light to aid in disease control and for the plant to carry on photosynthesis. When photosynthesis exceeds respiration (consumption of carbohydrates), the plant will accumulate carbohydrates, hormones, and other necessary organic compounds for proper root initiation. However, excessive light causes heat and transpiration problems within the plant, especially when the humidity cannot be properly controlled. For this reason, we use fiberglass sheets that transmit approximately 1/3 of the light available. In our area, this results in 1500 to 2400 foot-candles of light on the cuttings throughout the year. Over the last five years the fibers have raised on the panels, which have discolored, and collected dirt. This has lowered the light intensity to 500 to 800 foot-candles, causing a considerable increase in disease problems.

I would like to discuss at this time, some of the rooting results obtained in the house, and the techniques used to achieve them. In making these tests, an equal number of cuttings were placed at the same time inside the house and in the hot frames.

In the propagation of junipers, thirty varieties were tested with a total of 53,000 cuttings involved. After one resetting we had 45% rooting inside and only 18% in the hot frames. Our standard practices were used in propagation: cuttings were made in the middle of January using firm wood, cut ¼″ below the node, or heel cuttings were used, with quick-dip in 3000 ppm IBA. The cuttings were placed in sterilized flats of 1:3 peatmoss—perlite. Cuttings were then placed inside the plastic house with bottom heat of 70° F., air temperature of 75° F. and relative humidity of 94%. Others were placed in hot-frames with bottom heat of 70° F and with variable air temperature and relative humidity. Some of the varieties tested and rooting results obtained are: *Cupressus sempervirens 'Glauca'*: inside 67%, hot frames 3%; *Juniperus scopulorum* 'Table Top Blue': inside 33%, hot frames 6%; *Juniperus chinensis* 'Hetzi Columnaris': inside 33%, hot frames 12%.

Tests were also run on camellias and it was found that those inside the house had a rooting percentage of 89% while those in the hot frames had a rooting percentage of 67%. This test was run on nine varieties comprising 80,000 cuttings. For the camellias, relative humidity was maintained at 96% inside the plastic house.

Other ornamentals that we propagate in this house are azaleas, with 90 to 95% rooting, as well as genista, ericas and leucothoe.

To sum up the advantages of propagating in a plastic house with a controlled environment:

1. Rooting percentages are increased
2. Heating expenses are reduced
3. Humidification and cooling are readily controlled
4. Whitewashing, hand ventilation and rolling of curtains is eliminated and watering is reduced
5. Maintenance of the structure, painting, glass breakage, etc., is reduced or eliminated
6. Light is increased (2500 foot-candles compared to 500 foot-candles in the hot frames), with a decrease in fungal infections and an increase in photosynthesis.

By eliminating the frames, production was increased 5 times by greater utilization of area and increased rooting percentages. This increase justifies the cost of construction, which was $6.00 per square foot for 14,500 square feet of house.

I would like to thank Mr. Conrad Skimina, Research Director at Monrovia Nursery, for the use of research reports in preparing this talk.

In conclusion, I would like to mention the summer trainee program Monrovia Nursery has for students interested in the wholesale nursery industry. This program runs for ten weeks starting the middle of June and exposes the student to all aspects of a wholesale nursery, including sales, propagation, shipping, supervision of a crew, etc. while 20 hours of lecture are presented by supervisors and management. I would like you to strongly urge any students you know who are interested in the wholesale nursery industry to attend this ten-week summer course.

PRESIDENT KRAUSE: Thank you, Bruce. Continuous misting is our next topic, by Rudy Wagner. Rudy:

CONTINUOUS MISTING

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Propagating under continuous mist has limited use and depends upon the plants and type of cutting to be propagated. The location is also very important to consider as it is most useful in outdoor propagation.

We are using continuous mist for summer propagation of ornamental broadleaf evergreen and deciduous stock. We also propagate some fruit rootstocks by softwood cuttings under continuous mist: *Prunus besseyi, P. tomentosa* and some other plum rootstocks. One must be selective as there are a few species that do not tolerate continuous mist. Since our mother stock block is near our lathhouse, we moved our propagating benches right into the lathhouse to avoid drifting mist-and to provide some shade from the hot sun. The benches are 30 inches off the ground, four feet wide with eight inch sides. The water is brought in through a one-inch line that runs along the base of the bench's front side with a ¾ inch outlet every four feet. This gives every four square feet of bench space an individually operated line using a 100 Mister nozzle that sprays approximately nine gallons of water per hour at 25 lbs. pressure. The nozzle is manually turned on and off by a ¾ inch gate valve. After the benches were constructed and the pipes laid, ½ inch holes were drilled in the bottom, then they were filled with 2 inches of gravel and 5 inches of sharp sand. This gives good drainage and the sand is an excellent medium for continuous mist.

When making the cuttings it is very important to avoid wilting. Once they wilt it is almost impossible to revive them. I am referring to very soft cuttings. The best time to bring in the material is early in the morning before sun-up. The cuttings are at once rinsed in cold water and dipped in a weak solution of Morten's Soil Drench, ½ oz. to 20 gallons of water.

In preparing the cuttings, we remove the bottom leaves and pinch out the center. This helps keep the cuttings from wilting and saves later pinching, especially in shrubs. The cutting is then cut below a node and dipped in a 1-20 Jiffy Grow solution as a 5-second dip. When sticking the cuttings we always try to complete a 4-foot square with one nozzle so that the