raised to 23°C and then lowered to 20°C after 70% germination or rooting. The atmosphere is enriched to the economic optimum of 1500 ppm CO_2 during daylight hours by injection into the air circulation system.

All climate control is done with a computer from Dansk Gartneri Teknik of Denmark. Sensors monitor all climatic factors continously and record them every 15 minutes. An office terminal allows instant screen readout and printed records of accumulated daily and weekly data files. Should the programmed limits for any environmental factor be exceeded, sensors linked to alarm systems will detect the changes.

When winter crops of seedlings or rooted cuttings of Norway spruce are large enough, they are transferred to outdoor holding areas for overwintering. Though temperatures fluctuate below the freezing point during the long winter, only a minimal amount of protection is necessary. The growing frames are close to the ground and are pushed closely together. Salmon netting is stretched over the frames to support a spun fiber fabric which is sealed along the sides of the frames. This, along with snow fence protects the plants from wind and allows irrigation to continue throughout the winter.

Though plants may be transported on the growing frames, they are usually shipped in container sets in corrugated boxes with 120 plants per box. A variety of Hiko machine and hand-planting equipment is available that conforms exactly to the particular dimensions of the plug and top size of the plants. Though the equipment is designed for reforestation, it can be easily adapted to the outplanting of nursery liner stock.

Further information on the Hiko System and the greenhouses mentioned herein may be obtained from the author in the United States, or from the following address:' Hilleshog Forestry AB, 789 Don Mills Road, Suite 700, Toronto, Ontario, M3C 3L6, Canada.

QUESTION BOX

The Question Box Session was convened at 8:40 a.m. with Ralph Shugert and Joerg Leiss serving as moderators.

MODERATOR LEISS: Question for Dale Deppe. What is your misting nozzle?

DALE DEPPE: A Spraying System 1/4 E10. We operate it at 70 psi. It is available from Spraying Systems.

MODERATOR LEISS: Why do such outstanding nurseries, such as we saw Wednesday, hold to cow manure instead of chemical fertilizers; to hoeing and mule cultivation instead of

machine and herbicides; and hand digging instead of machine?

RON ST. JAMES: The reason Rhode Island Nurseries uses mules is because they plant very close together and could not cultivate with a tractor. Van Hof Nurseries still uses hand weeding but also has a herbicide program.

MODERATOR SHUGERT: To any Newport, Rhode Island *Taxus* grower. Why do you pound (beat) the sand in your propagation benches?

RON ST. JAMES: Because it works and we see no reason to change.

MODERATOR SHUGERT: Question for Dale Maronek on his paper. Was that a 1:1 v/v haydite-peat moss mix? Did the haydite in the mix affect overwintering of the rooted cuttings?

DALE MARONEK: Yes, it was a 1:1 mix. I cannot answer the haydite question in full. We had problems with perlite in our peat-perlite mix during overwintering under microfoam. We wanted to cut the high porosity down and hopefully increase survival.

MODERATOR SHUGERT: Question for Dale Maronek. What is the size of the slate granules used in your planting medium? Can any other aggregates be used, such as granite?

DALE MARONEK: Around ⅜ in. particle size for one gallon and up. The smaller material lines up with perlite and is a blend of sizes that range from about 1-4 mm. With regard to the granite, I would recommend that you use whatever is readily available close by that is cheap and learn to grow in it. You will save yourself a lot of dollars. You can use almost anything. I was talking to one grower who grinds up used Ivory soap containers and puts it in his mix. Use what is economical in your area.

MODERATOR SHUGERT: When one sprays young rooted cuttings with fungicides such as Subdue, Zineb, Terrachlor, Captan, and other fungicides, what happens to the root mycorrhizal fungi?

DALE MARONEK: I cannot address Subdue. There is a wide variety of sensitivities of mycorrhizal fungi, but basically most are tolerant of the fungicides we use. You may knock the population down some but they will come back. In fact some, such as Benlate, appear to stimulate their growth. Therefore, some stimulate, some inhibit slightly, but there are only a few that have a devastating effect.

DICK BIR: In work with Subdue on Fraser fir to supress *Phytophthora*, we have found that it does not harm the mycorrhizal population. In fact, the mycorrhizal population increased.

MODERATOR SHUGERT: Would you see a problem in blending Subdue and Benlate together?

DALE MARONEK: I have not blended the two together and do not know if you would have phytotoxicity problems. Subdue does have problems with some products.

MODERATOR LEISS: Question for Dr. Marcotrigiano. Do you believe a graft chimera can be initiated in subjects such as *Acer*, *Cornus*, *Fagus* and *Magnolia* and, if so, what is the recommended technique?

MICHAEL MARCOTRIGIANO: In woody plants there are few cases in which graft chimeras have arisen because forming adventitious shoots from a graft union is not that common. The only ones that have occurred by accident that I know of are *Laburnum* and *Cytisus*, *Pyrus* and *Cydonia*, and *Crataegus* and *Mespilus*. This is an area with few studies.

MODERATOR LEISS: Question to Ed Kinsey. What is your fertilizer program for *Kalmia* seedlings?

ED KINSEY: For seedlings in flats it is a 20-20-20 every two weeks at about 400 ppm.

MODERATOR LEISS: What would it cost for a home tissue culture lab equipped and supplied for modest initial entry into micropropagation?

LEN STOLTZ: I have a paper in the *Proceedings* that addresses that very point. (Editor's note: See *IPPS Proceedings* 29:375.) Today I feel that you could get started for about $2000.

MODERATOR LEISS: How do you root *Euonymus alata* 'Compacta' during the winter months?

ED LOSLEY: The cuttings are taken in November-December; they are 6 to 8 in. long and from heavy current season's growth, single wounded, and dipped in 2% IBA powder. Incubate in a box with damp sphagnum moss and when you see callus, place in sand so only the top 2 to 3 buds show in a minimum heat house.

MODERATOR SHUGERT: Can *Myrica pensylvanica* cuttings be rooted?

CLAYTON FULLER: We root them from softwood cuttings about the third week of July. Use Hormodin #2 and take the cuttings from the soft growth of container-grown plants. We obtain about 70% rooting.

MODERATOR SHUGERT: What rule of thumb could you use in timing the kill of the companion grass in seed beds?

RALPH SHUGERT: I would think that Wayne Lovelace is looking to that last danger of frost.

MODERATOR LEISS: What are the pollination require-

ments of *Ilex verticillata*?

ELWIN ORTON: The plant is dioecious so you need a male plant for pollination.

ED LOSLEY: Some cultivars flower earlier than others and you would need a male that flowers at the same time as the female.

MODERATOR LEISS: Question for Peter Del Tredici. Will a cutting taken from a grafted specimen of a dwarf conifer clone exhibit the coarser growth of the grafted plant or the slower growth of the original clone?

PETER DEL TREDICI: I can only address this from my experience with the *Tsuga* cultivars 'Nana' and 'Cole'. Cuttings from the more vigorous grafts reverted back to the slower growth. So, you could use grafting to increase your stock material for dwarf plants.

MODERATOR SHUGERT: Question for Len Savella. What is rotten rock?

LEN SAVELLA: It is a local stone that has decayed over the years. People in our area use it for driveways. It is a very coarse but sharp material and we screen it before putting it in our propagation benches. It is an excellent material for rooting rhododendrons and the roots come off like hair on a dog's back. For those that are growing some of the fragile rooted rhododendrons I would recommend that you try it.

MODERATOR SHUGERT: Question for Mike Young. When you were evaluating the gelling strength of various agars, what pH did you use?

MIKE YOUNG: The pH was 5.7

MODERATOR LEISS: Is there a consistent way to root cuttings of sweet gum?

BILL FLEMER: We are not rooting them now but did some years ago. We made the cuttings about August 1st, placed them under mist, and used Hormodin #2. We had a problem overwintering them and had to place the rooted cuttings in a cold house that did not go below freezing. Freezing will cause stem cracking.

MODERATOR SHUGERT: Question for Dr. Waxman. How do you apply sucrose to cuttings and what concentrations are used?

SID WAXMAN: As a 10% solution to the base of the stem for 24 hr.

MODERATOR SHUGERT: Question for Dr. Waxman. What time of the year do you propagate your pine cuttings?

SID WAXMAN: January through April.

MODERATOR SHUGERT: Have you ever seen witches' brooms on deciduous trees, shrubs, and Virginia pine?

SID WAXMAN: I have seen them on Japanese maple and heard about black walnut. There are many others caused by diseases and I am not interested in those. With the Japanese maple I have grafted it and it reverted to an upright leggy plant; however, there are others who have grafted Japanese maple brooms that have remained as brooms. Richard Wolff might address this point.

MODERATOR SHUGERT: What is the dilution rate for Dip-N-Grow compared to powders, i.e. Hormodin? For example, is a 1:10 Dip-N-Grow equivalent to Hormodin #3?

ED KINSEY: A 1 to 10 dilution is equivalent to 0.8% IBA.

MODERATOR SHUGERT: Is there a dictionary of propagation terms and words? If so, what, where and how can I get one?

VOICE: The propagation book by Hartmann and Kester would be a good source.

MODERATOR SHUGERT: Can hardwood cuttings of *Forsythia ovata* be rooted?

JOERG LEISS: It is just about as hard to root as *Syringa*. You have to get it early as a softwood and it is still hard to root. We have a cultivar, 'Ottawa', that is also difficult. *Forsythia ovata* 'Robusta', which I think is a hybrid, is easy to root.

MODERATOR SHUGERT: What is the difference between *Tsuga canadensis*: 'Sargentii' and *T. canadensis* 'Pendula'?

PETER DEL TREDICI: I recognize that 'Pendula' is a clonal name that applies to a group of plants that has been grown from cuttings and seed, and there is a large number of plants that are readily recognized as 'Sargents' hemlock. I consider 'Pendula' to be the correct name.

MODERATOR LEISS: Has anyone used the probe type automatic soil pH testers? If so, how accurate are they compared to chemical testing methods?

FRANK GOUIN: Several years ago we ran a comparison and found that if the medium is on the dry side they will read too high, while a wet medium will read a lower pH. If you put them close to a granule of Osmocoat or sulfur-coated urea they will drop down to about pH 2. A soluble salt content of 700 to 1000 ppm is also required to give an accurate reading. In artificial media I would say definitely not, but in soil it would be more accurate except if placed in a fertilizer band. We prefer a regular pH meter.

MODERATOR LEISS: Question for Mike Young. What are

the current prices of the gels in your study?

MIKE YOUNG: I will include the prices in my paper.

MODERATOR LEISS: Are you or do you know of anyone propagating witchhazels using tissue culture?

STEVE McCULLOCH: We have overcome the contamination problem. They are very hairy which causes problems with contamination. They also are different in that they just want to elongate and we are working on that problem.

MODERATOR SHUGERT: Question for Dr. Jaynes. Has work been done on interspecific hybridizing of *Kalmia* to incorporate dwarf and hardy genes of *K. polifolia* or *K. angustifolia* into *K. latifolia*?

FRASER HANDCOCK: I asked Dr. Jaynes and he said he has not had any luck getting any fertile first generation plants.

MODERATOR LEISS: Question for Dixon Hoogendoorn. How do you root and flush *Hydrangea petiolaris*?

DIXON HOOGENDOORN: We have a stock block that we prune hard to force growth for cutting wood. Take the cuttings about the third week of June, treat with 5% Jiffy, and place in outside mist beds. They are rooted by September. We overwinter in our refrigeration unit at about 35°F because if they get any frost they will split. We also protect them from frost the second winter. The ones that you saw in the greenhouse were rooted last year and potted up.

JOERG LEISS: Once they set a flower bud you cannot root them.

BRUCE BRIGGS: Pick them off as soft as you can and as early as you can. If you see any browning on the stem you are too late. Another way is to collect your own seed, which is an excellent method.

MODERATOR LEISS: Question for Dixon Hoogendoorn. Please summarize your *Helleborus* production. Also discuss double dipping cuttings with respect to rooting hormones.

DIXON HOOGENDOORN: We collect our own seed about the third week of June before they drop to the ground. Dry the seed in the greenhouse for a short time, give it a warm stratification period in sand until around the end of September, and then plant it in outdoor seed beds. It is usually the first plant to come up — around the first of March.

For certain plants that are difficult-to-root for us, such as *Taxus baccata* 'Repandens', we dip in Jiffy (4:1) liquid and follow, after drying, with Hormodin #3.

MODERATOR SHUGERT: Question for Henry Hughes. Can the plug foot planter be adapted for planting other sized

rooted plugs or even bulbs?

HENRY HUGHES: Yes, it can be modified for other sizes.

MODERATOR LEISS: What is the address of Agritech?

EDITOR'S NOTE: Agritech, Inc., P.O. 33083, Raleigh, NC 27606.

MODERATOR LEISS: With the etiolated cuttings in Brian Maynard's paper, do you wound the stem before you put the band on the stem?

MICHAEL DODGE: No, the Velcro wounds the stem.

MODERATOR LEISS: What is the name of the material applied to the etiolated stem?

JOERG LEISS: Velcro — and it should be available from any sewing store.

MODERATOR SHUGERT: Question for Dr. Stimart. You stated that fertilizer is bad for overwintering cuttings which did not grow. What about those cuttings which did have new growth? Did fertilization also reduce their overwintering survival?

DENNIS STIMART: I am suggesting that you stay away from the nitrogen because some of the plants that grow, such as parrotia, have an overwintering problem that results in bark bursting. We are trying to figure this out.

MODERATOR SHUGERT: Question for Dr. Stimart. Which is killed first, stems or roots of overwintered cuttings? At what temperature does killing occur? What causes stem splitting?

DENNIS STIMART: My understanding is that roots are killed at a much higher temperature than shoots.

HAROLD PELLETT: I have not worked with newly-rooted cuttings but working with older roots of some of the hardier species one finds that the maximum hardiness potential is around 0°F and with less hardy plants it can be around 20 to 25°F. Stem tissues would be more hardy in all cases. With rooted cuttings which have younger tissues they are going to be less hardy.

FRANK GOUIN: With root hardiness you have to look at primary versus secondary roots. There can be as much as a 10°F difference in hardiness between the two.

With stem splitting you have to look at the maturation of the cells close to the ground that are the last ones to mature. We have seen this with some azalea work on the eastern shore. When you fertilize too late on a young plant they will burst. On an older plant you can hold some heat close to the ground and the stem will mature.

ART DEWITT: There was a report in the *Proceedings* a

number of years ago in which stem splitting was related to the weather. We had three weeks of warm weather in the spring and this was followed by a drop to 10°F one night. I can remember *Thuja* 'Pyramidalis' split a foot high.

PETER VERMEULEN: There is a direct correlation between stem water and splitting. One year we had a dry summer that was followed by a wet fall. That year we had some Gable azaleas that made most of their growth late in the season and were still lush when we had an early hard frost that resulted in 80 to 90% splitting. A technique of old time azalea growers in our area when such a condition existed was to break the feeder roots with a fork to check growth and harden off the plants.

MODERATOR SHUGERT: Question for Dr. Stimart. In your work, for cuttings which grew, did the amount of new growth per cutting seem to correspond with percent survival? That is, did cuttings that grew a lot survive better than those with only a small amount of growth?

DENNIS STIMART: We have not seen a correlation between the magnitude of growth and overwintering survival. It is not how much growth occurs but that they break bud and grow.

MODERATOR LEISS: Question to Richard Bir. Could you supply more information on olivine, such as composition, availability of magnesium, source, and cost?

RICHARD BIR: It is a mineral that is mined in our area and is used in the steel industry. Availability is from International Minerals Corporation which has an office in Spruce Pine, NC. They are bagging it in 100 lb bags of 100 mesh and it cost just slightly more than a bag of lime. You can arrange for bulk shipments.

MODERATOR SHUGERT: Can anyone tell us about *Pseudomonus* attacking Japanese maples and other plants? What fungicide can be used to control it?

CHARLES FINDLEY: There is no fungicide that would be effective against *Pseudomonus* because it is a bacteria. You need a bacteriacide.