water can be turned on to stay on without interruption during the entire callusing and rooting period. This usually takes 12 to 18 days depending on the weather. As soon as there is a slight showing of roots, the water is turned off for the night. When fully rooted, the water is turned off completely and only a light hand-watering is required once in awhile.

As sand produces very brittle roots, the cuttings should be left sitting in the benches to mature some before potting. The cuttings are then potted in 2½-inch black, whale-hide pots and set in cold frames to be lined out the following spring. Most of these liners make the 18-24" size the first year. For larger plants they are grown for one more year.

Producing plants by this method is undoubtedly one of the least expensive and most trouble-free ways of propagating.

PRESIDENT KRAUSE: Thank you, Rudy. Next on the program is Ron Klupenger who will talk on misting in storage, Ron:

MISTING IN COLD STORAGE

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There have been many problems in cold storage of nursery material in the past, such as plants drying out, plants left in the cooler too long without lights, etc.

I think that misting has helped in solving some of these problems. It eliminates dehydration and drying-out of plants. With misting you don't have to be "Johnny on the Spot" with watering. There has been a great deal of loss without humidity control. We have experienced this over a number of years in precooling azaleas. It was all due to lack of knowledge of misting in cold storage.

Our first experience with misting came a few years ago when we had to rent cooler space and there were humidifiers in them. We were using the coolers for summer chilling, giving the azaleas six weeks of cold storage to produce late September and early October bloom. After the plants were in these coolers for six weeks, we could tell the difference in forcing. They came ou with more lush foliage and dseemed to react better to forcing. Also, we didn't have to watch the watering as closely while they were in the coolers. It does not work to put plants in coolers with mist that are showing colored buds, or in bloom. We tried this also. The flowers bleach out, fungi develop, and very few, if any, of these plants are saleable. So it is very important to pick off all colored buds and flowers before putting the plants into cold storage.

We have now narrowed down the time for summer precooling to a minimum of four weeks at 42° to 44° F. with mist plus 12 hours of daylight (about 18 to 20 foot candles). If the

plants are watered when put into high humidity cold storage, they can go for the full four weeks without being watered.

When chilling at temperatures of 36° to 38° F. it is not necessary to use lights, but it is necessary to continue the misting. The misting cycle is the same for summer or winter precooling.

Misting can be accomplished by mist nozzles or by use of a humidifier. We use the Bahnson mister manufactured by Bahnson Company, Winston-Salem, North Carolina. It has a ¼ H.P. motor.

The misters should operate from ⅓ to ½ of the time while precooling. This can be regulated either by a time clock — 1 hour on and 1 hour off — or by a humidity web control which holds the cooler at about 90% humidity. Our misters are controlled with the web control. We have found this to be very successful because — with this control — you don't over or under mist. However, I have seen the one-hour on and one hour off precedure — with a time clock — used very successfully on some types of nursery stock. The Bahnson unit which we use puts out a fog vapor at 3½ gallons an hour. We have two units in a 32′ x 60′ cooler.

PRESIDENT KRAUSE: Now, do we have some questions for these gentlemen?

RAY BURDEN: I would like to ask Al if he has done any work with *Libocedrus* cuttings?

DR. ROBERTS: No we haven't. Our work thus far with conifers has been confined to Douglas Fir. The information referred to regarding Taxus is from work being done at Michigan State.

RAY BURDEN: I have done about 50 or 60 experiments with *Libocedrus* cuttings, and have been 100% unsuccessful so far.

ANDREW LEISER: Al, I noticed in your cutting storage periods that you used 32°F. In storage to overcome seed dormancy, it often appears that somewhat higher temperatures are more effective. Have you made any comparisons between 32°F and say 40° or 45°F as to how soon this chilling requirement of the cuttings is filled?

DR. ROBERTS: This is a good question and is of interest to me also. Dr. Westwood at Oregon State finds the chilling requirement for pear seeds is quite close to that of the buds, and 40°F is near the optimum for both. We find the vernalization optimum for lilies is near 40° F also. Dr. Lavender in Forestry at Oregon State has shown that 120 days at near 40°F is optimum for breaking the rest of Douglas fir. However, we find it difficult to store evergreen material for long periods in dark storage at 40°F because of respiration and depletion of reserves, hence our use of 32°F storage for these long periods. You noticed, however, that we are trying cool (40°-45°F air temperature) rooms, with lights, and bottom heat of 70°-75°F as a rooting environment. Our reasoning here is that bud dor-

mancy will be broken sufficiently to release rooting factors for mobilization at the base where, hopefully, root initials will be formed.

STAN WALTERS: Dr. Roberts, you made reference to a preliminary report regarding Taxus. This year I was a little bit behind schedule in making cuttings. About April 15 we made cuttings of a couple of varieties of Taxus; they already had an average of an inch of new shoot growth. We put them in cold storage in plastic bags until May 30, and then stuck them in the usual way for Taxus cuttings. They are now rooted, which is to me quite interesting in the sense that, although I got behind, I could hold them in cold storage and still come out with good rooting.

DR. ROBERTS: This is the reason we have been closely following Dr. Hartmann's work with dormant pear cuttings at the University of California. It appears we have a compromise in attempting to release root promoters from the buds for stimulating rooting but before bud dormancy is broken and shoot growth becomes competitive. We would like to keep the buds dormant while root initiation is taking place. Once rooting has occurred there is the problem of achieving terminal dominance in the cutting again. We find that considerable "push", whatever that means, from the roots is required to re-establish terminal bud dominance. It is similar to tree budding. We cut the stock back to a single bud in the spring, and with a 2-year-old rootstock force a vigorous whip from this single scion bud. So, we are trying to root the cuttings in the fall and have a fairly well-established root system before the cuttings start breaking bud in late winter or early spring and put the cutting under stress.

EUGENE BACIU: In regard to the lateral cuttings you made from the conifers, do you find that in some species the new plants seem to refuse to form a trunk and become a tree, and tend to grow laterally for many years?

DR. ROBERTS: This phenomenon is what the botanist refers to as topophysis, or the cutting persists in its phageotropic habit of growth. Spruce, Douglas fir and many other species present a problem in vegetative propagation because of this lack of terminal dominance in the cutting or graft. We can return apical dominance to Douglas fir in 2-3 years by pinching, pruning, staking, etc. This is as much a problem as rooting in some of these species and is another reason we are going to fall-rooting of cuttings. We feel that the "stress" needles formed on the first growth flush in the rooting bench before or after rooting is due to lack of certain substances from the roots at a critical time. This growth flush under stress will usually not form a strong terminal bud and in some cases it will abort. The fact that terminal buds also have a higher chilling requirement than lateral ones may also present a problem if the cuttings have not received adequate chilling. This may complicate further our ability to get a strong growth flush and terminal

bud formed on the newly rooted cutting. As a result, we often see the lateral buds near the base of the cutting breaking ahead of the terminals. Does this mean that something other than water and mineral nutrients are needed from the roots to establish strong terminal dominance to the cutting?

EUGENE BACIU: Would there be any hormones or nutrients that you could feed them to overcome this?

DR. ROBERTS: Of course, one thinks of such things as GA_3 or benzyl adenine, etc. We have trials underway, but haven't been too successful so far. I think our problem is getting the right material at right concentrations into the cutting at the right time. You see, in rooting a cutting one must first mobilize everything to the base first. After one has initiated roots at the cutting base then one has the job of re-orienting the cutting completely, that is, returning acropetal orientation.

MARGARET FLEMING: Dr. Roberts, you mentioned polarity being important. Would you describe, in handling the cuttings, just how important it is.

DR. ROBERTS: We have had to change our ideas about a lot of these things; for instance, I have always thought of timing the taking of cuttings as a matter of tissue age and maturity. Now we think physiological events more than physiological age may be the important thing. Regarding polarity, I have been impressed by comments made in a recent paper I received from Dr. Gorter of The Netherlands. She says that polarity is not induced in the shoot until it is severed from the plant. Even where we have preformed root initials, as in willow, she finds these organized systematically through the internodes. It is only after the shoot is severed that we find an accumulation of certain materials at the base and a concentration of initials developing in that zone. I think these observations are highly significant, and are reasons we are studying the cold treatment of Douglas fir cuttings on the tree as against in storage after severing. We find we can double shoot rootability by giving the cutting cold treatment in storage rather than on the tree.

BILL WIND: We have long observed, at least in Douglas fir cuttings, that quite often the roots come out from one side at the base of the cutting. Would you give us your thoughts on preventing this by some initial treatment of the cutting, or describe what can be done after such roots have been formed.

DR. ROBERTS: A German forester who visited us this last week, and I think he is at this meeting today, has observed this problem you speak of. We have also observed the same thing and find it is a problem in some clones. If we wound the cuttings up the sides, some will root nicely along the wounds while others will root only at the base. Others will root only at the base, and when the first root forms no others appear and this

one root will elongate for great distances without branching. Root pruning or breakage in transplanting will encourage root branching and formation of more root initials. Workers in New Zealand report similar results. This may be much like terminal dominance in the shoot and needs study as a horticultural practice.