2. Dig as early in fall as possible to enable the plant to overcome shock before severe cold weather sets in; I prefer from September 20th to October 10th. However. in the case of ilex, I prefer no later than September 15th.

3. Draw poly over houses about November 1st. Late coverage can result in dehydration of the plants.

4. Keep well watered on days when the soil in containers is not frozen. Ventilate well while watering, so that the plants will not freeze while covered with water.

5. Any time during storage, houses should be ventilated whenever excessive heat builds up due to sunshine. Otherwise, keep as air-tight as possible.

My comments so far may sound as if we have no problems. I must emphasize that whenever the 5 points I outlined were followed, our success was excellent. Our firm is probably no different from hundreds of others, and when something looks promising we have a tendency to stretch our luck. Sometimes we dig too late in the season, and at times we have left some houses uncovered too late. These were the instances where we experienced the most damage. I also mentioned earlier that ilex did not store well. However, when dug in late August, or early September and plunged into sawdust, results were excellent. They will not winter setting on top of the ground.

Most all of the evergreens we have stored were field-potted either with the Jiffy Balling machine or by hand. Though we did store some B & B, but found it very difficult to keep the ball wet unless plunged into some sort of mulch. Therefore, our experience was much more successful with potted plants than B & B.

MODERATOR HESS: Our next topic is one in which many people are very interested. The "Cold Storage of Softwood Azalea Cuttings" will be discussed by Andrew Adams, Jr.

"COLD STORAGE OF SOFTWOOD AZALEA CUTTINGS"

ANDREW N. ADAMS, JR.
Ten Oaks Nursery & Gardens, Inc.,
Clarksville, Maryland

Back in the middle of June 1964, while trimming our azaleas for the last time of the season, one of our men mentioned what a shame to throw away all those good cuttings. They were really too soft to stick and we still had lining out to do and just did not have the benches ready nor the time to stick cuttings. Azalea cuttings are normally ready here in Central Maryland anytime after the 4th of July, depending of course on the season.

We have a cold storage room 8′ x 7′ x 50′, built of concrete block with one 5-ton refrigerator unit and two circulating

fans cooling the structure. The structure is under ground with 3′ of soil on top, so it carries a temperature close to 55° year round. We keep the temperature set at 38°F, which means it will run between 35° and 40°F. It is used primarily for pre-cooling azalea plants brought in in September for the Christmas season and also for holding azaleas back from blooming too soon, for late Easter and Mother's Day. Being empty in the summer, we thought it ideal for storing cuttings until we were to stick. At first we collected our cuttings and stored approximately 500 cuttings in large poly bags, but found after several weeks they mildewed and our losses were quite high. The following year, after our initial experiment, we merely layed our cuttings out on damp burlap on racks and sprayed once a day to prevent any drying out from the circulating fan in the ceiling. Cuttings have been stored as long as six weeks, but we like to get them in the bench from two to three weeks. The results are in the 90-95% range, with the crop being between 150,000 - 225,000 stuck per year over the past three years.

We find the cuttings, being cut green, tend to harden up and are much more turgid when stored, plus the fact our rooting percentage on soft wood has been much better and we no longer bother with any hormones, which saves a lot of labor in time as well as the expense of the I.B.A. itself. On stored cuttings the foliage is much easier and faster to strip off plus the buds snap out faster.

It is now standard practice at Ten Oaks to store all soft-wood cuttings at least 24 hours at 38°F before bringing them to the bench for sticking.

MODERATOR HESS: We now have time for a question and answer period.

CASE HOOGENDOORN: John, you said you had difficulty with your balled and burlap material drying out. Do you pack them in any mulch such as sawdust?

JOHN ZELENKA: Case, perhaps I did not make myself clear. It isn't any more difficult to store balled and burlap plants than potted material except that the work involved is just so costly that we do not do it. We just store container grown material.

PETE VERMEULEN: I would like to ask Harrison Flint if he found any association with the vigor of the top growth with the root damage that he observed?

HARRISON FLINT: No. However, we do know that if a plant is actively growing, it is not hardy, and therefore its root system is not hardy.

PETE VERMEULEN: I am not only speaking of vigor in terms of actual growth but also the nutritional status of the plant.

HARRISON FLINT: There still remains a fair amount of confusion about the nutritional status and hardiness. There remains a lot of work to be accomplished in this area.

RALPH SHUGERT: I would like to bring up a point in re-

lation to John Zelenka's talk. I think the key to his success is location. In our area where we have a lot of low temperatures but also a lot of clear weather and sunshine compared to the more cloudy area by John Zelenka we have run into quite a lot of problems. For example, with junipers wherever the foliage from one plant touched another, the whole area was dead. We used a plastic covered shade house which was very tight. When it was necessary to ventilate we came back and watered to keep the humidity high. Under these conditions we had a reasonable degree of success with the taxus but we had a lot of losses and needle drop with spruces and I have already mentioned the problem that we had with the junipers. In contrast the material in containers came through with good color and good condition.

BILL FLEMER: Mr. Zelenka, do you use the clear or the milky polyethylene to cover you houses?

JOHN ZELENKA: We use the clear plastic with relatively good success. However, I am sorry that we have not tried some of the milky polyethylene because I think there may be some additional merit in using it.

VOICE: I would like to address a question to Mr. Zelenka. What type of irrigation system do you use in the poly houses?

JOHN ZELENKA: We have a main line going in front of all the poly houses with an underground spur running right through the middle of the poly houses. There are risers in the houses with Rain Bird nozzles that deliver a square pattern. This reduces the amount of overlap. The entire system is equipped with automatic drains so that when the pump is shut off the water drains automatically under the soil. We try to avoid watering whenever the containers are frozen but at those times when they are completely thawed out, we take the opportunity to water them. When they have had a sufficient amount of water we shut off the system. It automatically drains out and there is no problem of freezing of the irrigation pipes.

ROBERT FARMER: I would like to ask Harrison Flint if he has worked out a quantitative method of determining root damage and does he differentiate between chilling injury and freezing damage?

HARRISON FLINT: We have used the electrolytic method of determining the electrolytes which are released from the tissues damaged by freezing. This seems to work quite well with the species that we have tested. I have not differentiated or studied chilling injury.

MARTIN USREY: I would like to ask Andy if you have observed any difference in the rooting of the cuttings which you have held over?

ANDREW ADAMS: We find that the percentage rooting is better on the cuttings which have been held in the cold storage. In fact we now store all our cuttings for at least twenty-four hours. There seems to be less problem with wilting after the

storage. They seem to be in a more turgent condition.

DICK STADTHERR: Andy, are the cuttings which are stored given any artificial light?

ANDREW ADAMS: We have a string of incandescent lamps in the storage area which does provide a very small amount of light.

JAMES WELLS: I would like to make a comment on the storage of cuttings. One year we ran out of space when we were making taxus and arborvitae cuttings. This was sometime in the middle of February. We continued making the cuttings in the normal way, treating them with hormones, and packed them in deep flats on a bed of sphagnum moss. The moss was packed around the base of the bundles of cuttings. The flats of cuttings were placed in a cellar which had a few incandescent lamps much as Andy Adams described. The lamps were switched on during the day and the cuttings were given an occasional sprinkle of water. The cuttings stayed in the cellar for about eight weeks. At the beginning or middle of April they were taken outside and inserted direcly into cold frames in sandy soil where they rooted quite rapidly.

VINCE BAILEY: I would just like to add to Jim Wells' comments. We have been storing conifer cuttings in the dark in refrigerated cold storage with humidity control on a regullar basis for the past ten years. We have had very good success storing the cuttings for periods of four to eight weeks.

VOICE: I would like to ask Mr. Wells if there was any sign of callus formation at the time he stuck the stored cuttings?

JAMES WELLS: Yes, not only callus but young roots were present.

BILL FLEMER: Last winter we lost all of our Japanese cherries, three inch in caliber, and up because of bark kill on the sunny side of the trunk. I would like to ask Dr. Flint if we had whitewashed the trunks of these trees, particularly on the sunny side, if this would have prevented the injury?

HARRISON FLINT: It might have prevented the injury although I do not want to make a flat statement. It depends upon how severe the conditions actually were.

CHARLEY HESS: It was difficult year for trees in New Jersey because of a very warm spell of 70 degrees in January and March followed by some temperatures at 6 degrees above zero. Peach growers who did whitewash their trees reduced the injury that was experienced with trees which had not been whitewashed. Work is continuing to find materials which will reflect the sunlight better or provide some insulation. By using thermocouples it was possible to measure the temperature under the bark during the past winter. In January when we were experiencing the 70 degree weather the bark on the south side of the tree reached a temperature of 90 degrees. In March there was a period when the bark temperature went up to 70 degrees during the day and 6 degrees above zero at night. This

places a tremendous stress on the plant and it is questionable whether whitewash alone would have helped.

BRUCE BRIGGS: We did a little work on containers this past year trying to keep the soil temperature uniform within a bed of container-grown plants. We used foil paper on the outside of the blocks of container-grown stock. The foil paper did an excellent job of keeping the temperature more uniform.

RALPH SHUGERT: The moderator for the second symposium of this afternoon's program is Dr. Ken Reisch.

KEN REISCH: I would like to bring greetings from Dr. Chadwick who was not able to come this year but wishes everyone well and hopes to be present at next year's meeting.

ROOTING MEDIUMS

K. W. REISCH
Ohio Agricultural Research and Development Center
Wooster, Ohio

Rooting mediums for cuttings have been discussed for centuries and probably originated when prehistoric man first thrust a spear into the ground. Innumerable materials have been used for this purpose and vary from field soil to sophisticated mixtures of organic and inorganic substances. Included among those which have been mentioned in the literature are sand of various types and particle size, peat moss of different forms, ashes, cinders, flue dust, sawdust, pumice, ground bark, sphagnum moss, soil, rice hulls, coffee, parchment, cocoa fiber, vermiculite, perlite, styrafoam, clacine clay, BR-8 blocks (processed wood fiber), water, and air.

A rooting medium should fulfill the following objectives:

1. Maintain the cutting in a properly oriented position.
2. Minimize moisture loss from the submerged portion of the cutting.
3. Provide a suitable environment for the elongation of roots.

Although there are various schools of thought on the characteristics of a good rooting medium, the following should be considered.

1. Inexpensive
2. Readily available and reproducible
3. Uniform and long lasting
4. Free from disease, insects, nematodes, and toxic substances
5. Easily managed
6. Well drained and with desirable air-water relations
7. Uniform temperature

Matkin (25), noting the importance of the free porosity or air space in the medium, indicated that 1) The medium should have as high a free porosity as practical under the cir-