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MIST SYMPOSIUM

DISCUSSION

DR. HESS: Jim, at what time do you start the hardening off process?

JIM WELLS: It's impossible to answer precisely; this is where common sense comes into the picture. I do believe that most cuttings are improved by a gradual reduction in misting as rooting develops. I think that you need to have a small bunch of roots on the bottom of the cuttings, 6-10 roots possibly, an inch or more in length beginning to become attached to the rooting medium. That is the cutting is beginning to establish itself again as an individual. About this time I think that a modest reduction in mist application is adopted. And this [reduction] needs to be slowly increased in amount as the plant develops over a period of 2 or 3 weeks.

Now the difficulty in doing this lies particularly with the type of control such as a timer. It requires an on the spot interpretation of conditions by someone and this is almost impossible. Here is a real value of the electronic leaf control. One of the simple, very nice things which I think the control from England has is the sensing unit which has 2 carbon electrodes imbedded in a block of plastic. The sensing unit can be placed in any position in the bed in relation to the misting head. This provides an infinite variety of positions available to you in relation to the mist coming from the jet and landing on the sensing unit. I don't think there's any hard and fast answer to your question, Charley. I think the plant has to become essentially established on its own roots and then it requires a gradual tapering off.

MERTON CONGDON: I don't think I have anything to add to what Jim Wells has said, but in our operation we go by the general appearance and condition of the cutting as we reduce the mist. We have not found under our open air mist propagation that the reduction of mist in the hardening off process has been any problem.

DR. HESS: How do you handle cuttings which have different rates of rooting?

MERTON CONGDON: This is taken into consideration in planting the beds.

PETE VERMEULEN: In our case we handle this by dividing the bed into segments in which the mist is put on at different rates. We can move the cuttings from one section of the beds to another. This is predicated on the fact that the cuttings are stuck in flats or pots and so they therefore can be moved.

HARVEY TEMPLETON: We control all of our mist beds from one electronic leaf and we harden the cuttings off by using a series of timers. The first step would be a little bit before Jim recommends it. That is before all the cuttings are quite rooted. We don't want to wait too long because cuttings deteriorate very rapidly under mist once they have roots on them. The quicker you harden them off the better. The first step is to change one electrical connection on each bed and switch it over to a time circuit, which is one minute of mist every 15 minutes limited to the daylight hours. In the summertime this is from about 7:30 in the morning to about 5:00 in the afternoon. Now that may be surprising but the fact is that as the temperature cools off in the afternoon, cuttings just won't need much mist; just cut it off a whole lot earlier than you think you can. Then after placing them under that regime for 3, 4, or 5 days, we shift them over to another control circuit giving one minute of mist every 30 minutes limited to an even shorter interval in the middle of the day and eventually they are shifted over to one minute of mist every hour. And then the mist is cut off entirely. We now do this by the book based on our experience with the cuttings in previous years.

JAMES WELLS: I would just like to add something to what Harvey said about records. This may seem far removed from misting but it isn't. The important thing that I would urge you to do is to take clear records so that you can recreate in your mind, 5 years from now if you want, exactly what you were doing five years back. We have run into a lot of problems in rooting rhododendrons from time to time and this last summer I decided to throw out everything we had been doing and go right back to where we were 7 years ago. I went back to my records, found out what we were doing, duplicated exactly what we did, and we got beautiful results this year. I don't know whether that says very much for the last 7 years, but it does say something for records.

HANS HESS: I would like to make just this comment about how we harden off our cuttings. All cuttings are in boxes. When they're at the point where 75% have initiated roots, we pick them up from the mist which is in full sunlight and put them in a storage frame with sash and shade on them and with 2 hand syringing a day we can harden them off without any loss whatever.

DR. HESS: This question is directed to Harvey. You said

that you did not use your electronic leaf for hardening off.

HARVEY TEMPLETON: Yes, that's right because in principle you couldn't possibly harden a cutting with an electronic leaf because it's designed to keep the leaves wet at all times. Now of course Jim's McPinney Weaner unit is a very good deal. I should dream one up and use it in place of my timers. The only reason I haven't done it is that all our records are based on the use of the timer and I don't want to start all over again using the Weaner.

DR. NELSON: We have never used hardening off at all. We transplant right into the field or seed beds and particularly in the field we got good results as long as we could put sprinkler irrigation on for 5 minutes 3 or 4 times a day. This doesn't even wet the ground; it just keeps the foliage wet a bit. We did this at Ottawa.

DR. WAXMAN: I didn't hear anyone mention the light operated interval switch. It has a control on it with which you can regulate the amount of mist applied. In this way you can very easily reduce the amount of mist during the hardening off period.

MARTIN VAN HOF: The way we do it is this: we shut off every other fog nozzle, we keep the time the way it is and that's all there is to it.

LEONARD SAVELLA: I would like to ask Sid Waxman if there was any difference in growth in the field of the pink dogwood which was rooted under lights as compared with natural day length.

DR. WAXMAN: In this particular group they were kept indoors and lighted and were not put out in the field. But I do have data on a group that was rooted under lights, kept in a greenhouse for a year, and then planted in the field and growth was fine. We have had cases, however, where there has been a delay of growth. If you light them until spring and put them in the field, you will get a delay of growth. If you light them to say November or December, turn the lights off and put them through a cold period and then they will grow normally.

DR. SNYDER: Dr. Mahlstede called to my attention an omission I made in my paper. I did not recognize the tremendous effort made by the field trials committee and many members of this organization on mist trials and the reports that were presented. This occurred in, I think, 1955 or 1956.

JIM WELLS: I would like to ask Sid Waxman a question. I was a little confused with the slides this morning. I would like it very much if he would run through what the light did and of what advantage it was to the cuttings.

DR. WAXMAN: The cuttings that were taken early in June are no problem — they root quite well. But once you get beyond June and into July only those cuttings that were lighted formed a decent number of roots.

JIM WELLS: The lighting of the cuttings in July enabled the leaves to be retained longer than on cuttings that were not lighted. It that right?

DR. WAXMAN: That's right. There were no additional growth but the leaves were retained.

PETER VERMEULEN: Was there not a paper on the use of lighting on deciduous azaleas given at the Western Region meetings last year?

BRUCE BRIGGS: Yes, the experiment station at Victoria has worked with Bill Goddard for over two years. The work that they have done has shown a much increased growth response with the use of lights but after the second year they didn't give that tremendous surge of growth with lights. Another thing I'd like to mention is in regard to the early and late cutting. For example, Exbury azaleas taken early root very well, but taken later in the summer they root poorer. With an increase in fluorescent light you help the rooting. But at the same time you can take azaleas that have been put in the greenhouse and stimulated to grow and you can take your cuttings even late on towards the summer and they'll root tremendously fast and retain their foliage and be equal to the cuttings taken in early spring. So there again you have a condition maybe of food, of co-factors, maybe condition of tissue, maybe it's a lot of factors involved.

DR. HESS: Bruce, were the plants in Goddard's experiments given a cold exposure between the first and second years?

BRUCE BRIGGS: No, he kept them growing year round; no rest period at all. He kept the temperature up at 60 or 55° F. because below those temperatures there is absolutely no influence of light.

HARVEY GRAY: A further comment on this and I direct my remarks to Sid. This is in regard to seedlings of Naphill azaleas rather than to cuttings. The seed was sown on the first of January and these plants were brought along rather rapidly without any additional light until the 20th of June when the day length begins to shorten by 2 minutes each day or whatever that happens to be. Now we followed this along in the greenhouse and were careful not to let the temperature drop below 60° F. The lights were carried on a continuous basis rather than intermittently or by a flashing system to bring the light up to a period of 18 hours. However, the control plants that were away from this particular exposure were equal some 3 months later to those which received the light. Now I would like to ask Sid, how you explain that?

DR. WAXMAN: Well, to go back to my talk, there are some plants that respond to photoperiod and others that do not. I have never worked with Naphill azaleas so I can't tell for sure. But if it was a plant that didn't respond to photoperiod, then there would be no difference between the treatment and the control.

DR. HESS: Sid, do you feel that the azaleas should be given a rest period or can you bypass this with long days?

DR. WAXMAN: You can bypass the rest period but you end up with a leggy plant. It's far better to get a certain amount

of growth and be content with that, turn off the lights, let them get dormant naturally on short days, give them a cold period and then you get a better plant. You'll have more buds breaking all around. If you keep the plants under long days continuously, you will find the terminals growing but not the lower lateral buds.

VOICE: Is there any difference between incandescent, fluorescent, or mercury vapor lamps?

DR. WAXMAN: I have never worked with mercury vapor but I do not see why it should not be just as good. It seems to be more efficient than the incandescent lamp. It has a higher intensity and the wave lengths are similar to the fluorescent lamps.

GEORGE GOOD: I would like to ask Dr. Waxman what is the effect of long photoperiods on the hardening off of the cuttings.

DR. WAXMAN: Anyone who is ready to use long days on his cuttings must also be prepared to protect these cuttings after they are rooted. You have a time lag before you can subject the cuttings to low temperatures. If you have a plant in long days and suddenly give it short days, it may keep growing for about three weeks. Then you need some more time under short days to harden off the plant. So if you use long days you must be prepared to protect the cuttings from freezing weather for a longer period of time than they ordinarily would if they didn't light the plants.

E. STROOMBEEK: I would like to mention something about leaching under mist. For two years I have been following the practice of spraying the mist bed twice a week with fertilizer, about a tablespoon to the gallon, and there was less chlorosis on evergreen azaleas and cottoneaster cuttings as compared to unsprayed cuttings.

PETER VERMEULEN: The problem of light on reducing hardiness also raises one on nutrient mist as I think was borne out in my discussion this morning when we had difficulty with a rather severe frost. Have others had similar problems?

JOHN WOTT: We have not had experience in this area as the cuttings were kept in the greenhouse over the winter under natural photoperiod after being removed from the mist.

DR. HESS: Have you encountered any problem of algae growth under nutrient mist?

JOHN WOTT: This has been a problem that we have encountered. The algae appears to like the nutrient mist as much as the cuttings appear to like it. Therefore, the algae appears much faster and grows better under nutrient mist. We have not experimented with any controls for the algae as yet.

PETER VERMEULEN: That was indoors. Outside with higher light intensity, we had less algae.

JOHN WOTT: This could be; we haven't done this.

VOICE: In relation to hardening off has anyone used some of the B-9 or Phosphon materials? We harden them off with the growth retardants before moving them out into the cold. I

was wondering if a lower application of these growth inhibitors wouldn't help alter the carbohydrate-nitrogen relationship and harden the plants off pretty well.

DR. HESS: We'll have a paper on the effects of growth retardants and hardiness from Dr. Conrad Weiser.

JIM WELLS: I'd like to make a brief comment on that. We've tried two or three of these chemicals on rhododendrons and then having done so just filed the information away. In relation to this hardening off, we grow a variety called *Roseum superbum* which is a very vigorous growing variety, completely hardy in our area but it does have a tendency to make a late growth in September. If we apply a dose of either CCC or B-9 in early June when the first flush of growth is being made on the plant it will stop it making the third flush of growth in September. The plant makes two perfectly normal flushes of growth and then stops. You have to be critical, of course, as to the concentration, but it doesn't apparently effect the plant in any other way except stop that late growth.

BRUCE BRIGGS: A comment that I'd like to make in regards to some research done in Western Washington Experiment Station. They have done some research on rooting of blueberries. They studied the effects of fertilizer upon rooting. He found that a dry application in the rooting mix of a basic fertilizer was of much advantage in final output of your rooted cuttings. It didn't help the percentage that rooted but it did help the final results and the plants were larger, uniform and the leaflets did not die.

DR. HESS: Pete, have you considered the incorporation of a fertilizer in your rooting-growing medium?

PETE VERMEULEN: I wouldn't say we haven't considered it, we have considered it, but we haven't looked too favorably upon it. Several years ago we tried to incorporate nutrients into the media at rooting but not in relation to rooting in containers. We found no appreciable value from it; we did after rooting do some fertilization on cuttings, and we did get some appreciable benefit. The question was raised this morning as to whether or not these new slow-release fertilizers would have some benefit. We haven't used them in the "PROPICON", but we have used them in growing established plants in containers and we've had some rather disastrous results from it when we used them in the greenhouse. Outdoors we have had very good results. Apparently when we use them in the greenhouse we had a much more rapid breakdown of the fertilizers than is normal under outside temperatures. Therefore we had a high nitrogen buildups which was detrimental to the roots and actually killed them. Other than that I haven't any other comments.

DR. SNYDER: A great deal of florist crops are propagated in peat pots in the mediums in which the plant is growing. They commonly use ⅓ peat and ⅓ perlite and ⅓ soil to which is added certain of the mineral materials. In other words they use for propagation the same rooting medium including some

fertilizers as they use in the final potting up of the materials. They do not add any additional fertilizer, though, until they have been potted up or panned and are growing along. So with florists crops they do incorporate some fertilizer in the "PROPICON."

DR. HESS: Just a kind of a summary statement here. So far the application of nutrients in mist has not accelerated root initiation for most plants. The question is then, what happens to the subsequent growth of the cuttings after they have rooted. Here positive results have been obtained in that those cuttings which have been fed seem to take off better. But as far as initiation per se, I haven't seen any consistent, real clear-cut evidence that the process has been accelerated by the use of nutrients. As John pointed out, it is a question now of when to apply nutrients during the rooting period.

Now let's turn to another area, that of light intensity. I mentioned that you can use higher intensities under mist under outdoor propagating conditions. Should full light intensity be used or should there be a light shading? Harvey, what are your opinions on this subject?

HARVEY TEMPLETON: When we started off years and years ago with a humidistat and timer control. the control was very, very poor. So we felt that we had to shade the cuttings. We used 46% saran shade. That worked all right but after we got our better control, we concluded that they didn't have enough light because with certain plants we would get fungi in the bed. Now my experience is that you can correct that problem completely by giving the plants more light. So we took all the shade off the plants and grew them under just one sheet of 2 mil. polyethylene. And that eliminated the trouble.

Now we still use shade on some plants. My guess is that with the exception of a few plants like this dwarf cypress and male *Ginkgo* and a few others, we would be better off with a higher light intensity. No shade at all or at least very little.

HANS HESS: We started out by using about 50% shade and we thought this was quite the thing. In the fall we took the Saran off and one season we were short on time, so we planned to put the Saran on later and we never did put it on. We found out that we had better success with the full light as Harvey brought out. We have no shade whatsoever until we harden the cuttings off then we shade them as I mentioned before.

JAMES WELLS: I'd just like to comment on the use of this Saran material. We are convinced that there is a real difference in the quality of shade. When you apply shade through a Saran cloth it seems to me you are reducing the total light intensity by about 50% depending on the mesh that you use. Now when you use a lath shade, you are applying bars of shade which is quite intense and between each bar of shade there is of course an equally intense bar of direct light. This bar of direct light is moving across the plants quite rapidly. We have not measured it, but we have observed it closely and it is in fact moving across

the plant. I think that if it moves across fast enough so that the plant material does not heat up before shade appears again from the next bar of shade we are having sufficient light intensity to stimulate the plant to continue normal photosynthesis. I believe that there is a real difference in the system you use to apply shade.

DR. HESS: What about heating cables under mist conditions?

PETE VERMEULEN: I would like to mention first that there are a number of different types of saran and we use one that gives about 20% shade.

BOB BODDY: We grow a considerable number of plants under in Southern California. In the last two years we switched from wooden lath to saran shade. I don't know the exact effect of this on plants, but I've noticed an effect on people — under the wooden lath in the summer time, it's quite cool and very pleasant, under the saran shade in the summer time it is uncomfortable and it's hot. Also we found dust accumulates on the saran and you have a very close feeling. In the winter time under wooden lath at night time when we have frost it will be warmer under the wood lath and it will be colder under the saran. This is the effect on people. The plants seem to do equally well under both conditions, but I do believe that it gets hotter under the saran in the summer time when we are trying to keep it cool.

DR. HESS: I believe a light shade, no more than 20%, will allow sufficient light through for photosynthesis and at the same time reduce the amount of mist that has to be applied. Reducing the amount of mist reduces leaching and drainage problems associated with large amount of mist. Also, the shade will help contain the mist when it is on and reduce uneven distribution because of wind from any one direction.

HARVEY TEMPLETON: In regard to the question of whether plants will grow better under full sunlight or saran screen, I just remembered an experience I had about five years ago. I built a semi-circular quonset type shade house, 108 feet long and about 14 feet wide. We filled it in early summer with plants in polyethylene plastic bands. We were trying it out so we used all the plants we had, a few hundred of each. We started with all of the plants under saran which gave 46% shade. When it came to about July, I had the good sense to wonder if these plants would grow in the full sun or not. In order to see what the effect of full sun would be, we took off every other 10 foot section. Sixty days later you could stand at one end of the house, look down it, and see just a series of stair steps. In every case the growth was better under the full sun as compared to the shade. Now that's in Tennessee in the middle of the summer.

DR. WAXMAN: I recall some work Bill Snyder and I did with the rooting and growth of Taxus that were rooted under shade, lath, and full sunlight. It was not so much on rooting as on the survival and growth.

DR. SNYDER: That goes back quite a long time. The cuttings were rooted and then brought out in the full sun or high light intensity and low light intensity. The plant material under the shade for the first two years had higher survival and were larger plants. That carried through to the fifth year out in the field. One other point I would like to make. There are a number of plants that are known to do better in the shade or very poorly in full sunlight. Many tropical foliage plants, e.g., cocoa and *Hevea*, have rooted better with the light intensity reduced up to 50%. I think plants which do not grow well under full sunlight will do best if shaded while under mist.

HARVEY TEMPLETON: In my opinion and what I can read, most plants — not shade plants now — but field crops and so forth grow best with at least as much sunlight as they get in central United States. This compares with a set of figures that show that alfalfa in England grows best at 250% of available light in the summer.

DR. WAXMAN: Tomorrow I will discuss our experience with blueberry cuttings propagated under a range of light intensity.

DR. HESS: Let us go back to the question of bottom heat and mist, Pete.

PETER VERMEULEN: We have had some experience with heating cables. In our area in North - Central New Jersey we get some periods during the middle of the summer when we have some relatively low temperatures and the medium temperature drops below the optimum of 65 - 70° F. Therefore, we tried some heating cables. These experiments were on jumper varieties with the heating cable 6 inches below the top of the medium. We had exceptionally good results. The following year we put heating cables under the entire frame and extended the range of plant material tested. We feel, very frankly, that we can not get optimum rooting unless we maintain the medium temperature at 65 - 70° F. There is also a side benefit from using the heating cables for propagation. That is by using the same frames for winter storage — we close the frame and cover it with polyethylene and turn on the heating cables. We pot our cuttings and put them back in the frames. We actually get a very low air temperature which is good for plant establishment while the medium temperature is warm enough for good root development.

THURSDAY AFTERNOON SESSION

December 9, 1965

The afternoon session convened at 1:00 p.m. A question and answer session led by the mist symposium panel was held at the beginning of the afternoon session. The discussion is included in the Thursday Morning Session of the Proceedings. At the conclusion of the mist symposium discussion, Vice President Peter Vermeulen introduced Mr. David G. Leach who served as moderator for the balance of the afternoon session.

MODERATOR LEACH: We have three talks this afternoon with five minutes for questions after each talk. Our first speaker this afternoon is Dr. C. J. Weiser from the University of Minnesota. Dr. Weiser is a plant physiologist who specializes in problems of plant hardiness and as we all know he comes from about as tough a section of the country as anyone in this Society.

PRINCIPLES OF HARDINESS AND SURVIVAL AS THEY RELATE TO NEWLY PROPAGATED PLANTS[1,2]

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Plant survival at low temperatures has been a vexing problem since man first gathered the fruits of the fields to provide sustenance for himself. Today a nurseryman in the Great Plains or an orange grower in Florida would both agree that low temperature injury is a most serious problem. In fact on much of the earth's surface low temperature is the single most limiting factor to plant growth and survival.

In the discussion to follow, we will attempt to provide a basis for the panel discussion to follow. I will emphasize research at the University of Minnesota, not because it is necessarily the best but because time is limiting and it is most familiar to me.

There are a number of factors which complicate the study of plant hardiness. Winter damage can be caused by several different environmental stresses. For example, desiccation, early fall or late spring frosts, rapid temperature changes, and extreme low temperatures in midwinter can cause damage either individually or in combination. It is obviously necessary to establish what type of stress is causing injury before you can intelligently cope with it. Unfortunately the cause of injury may be quite different in different years or in different parts of the same plant.

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[1]Scientific Journal, Series Paper number 5860 of the Minnesota Agricultural Experiment Station
[2]The author expresses his gratitude to Bailey Nurseries, Newport, Minnesota for cooperation on some of the studies reported here and to the Louis W and Maud Hill Family Foundation for support of the research