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MODERATOR JAMES WELLS: It's a wonder someone hasn't borne down on this problem yet. It is a wide open field for someone. The last and by no means the least, but in my opinion the most difficult subject for our panel to cope with, is weather. And Al Fordham of the Arnold Arboretum is going to do that.

## WEATHER AS IT CONCERNS THE PRACTICE OF CUTTING SELECTION

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Although the literature abounds with information regarding cuttings, few references are directly concerned with the relationship of weather to cutting selection and these are usually generalized or sketchy. Weather and the seasons, or timing, are difficult to separate in this context and many of the references give approximate dates with qualifying remarks such as, "depending on the season", or, "varying with the weather".

Two references dealing with the collection of lilac cuttings recommend that cutting wood be taken when the blooms first begin to open (1), and just as the terminal buds are formed (2). The dependence of these development stages upon the weather is shown by the lilac flowering dates at the Arnold Arboretum which reveal that propagators in the Boston area, using these stages as guides, would find variance up to three weeks in different years depending on the weather.

Bos (3) observed that warm days in early spring led to a start in growth on his stock plants of *Philadelphus coronarius aureus* which were later damaged by periods of cold rain or light frost. Cuttings made after this damage led to a 50% propagational loss no matter how carefully they were handled. He recommended that such stock plants be protected.

Zorg (4) in discussing Juniper cuttings pointed out the difficulty of selecting the time when cuttings were in proper condition. It was self-evident that weather had a great influ-

ence on cutting material, for during periods of heat and drought plants would cease growing and ripen off, while during seasons of well spaced rain and favorable temperatures the ripening would take place at a later time.

Leach (5) states that it is not the time of year which is important but the condition of the plant tissues as they mature under the influence of rainfall, temperature and their inherent constitutions. This factor has been the origin of endless controversy in the propagation of Rhododendrons. For the occasional year when an exceptionally hot, dry summer hastens the maturity of the tissue or an unusually warm moist autumn delays it, the period when cuttings are taken should be advanced or postponed according to the condition of the plants.

He also recommends that if there has been drought, it will pay to irrigate the stock plants the day before the cuttings are taken. Furthermore it is a good practice to remove the clippings in the early morning, or on an overcast day, so that none of their turgidity will be lost.

Wells (6) has drawn attention to the fact that weather and the season are related and have to be considered together. A wet spring and lack of sunshine will delay maturity and keep young plants in a soft condition so that the collection of cuttings may have to be put back two or three weeks. In a hot dry spring, the converse is true.

He says weather is also important for cuttings which are taken in a condition of relatively inactive growth. There are well authenticated results which show that most hardwood cuttings of conifers, taxus, etc., root more readily after they have been subjected to one good stinging frost. Similarly, (7) the varieties of juniper which can be propagated from cuttings give the best percentages only after the stock plants have been subjected to some hard frosts. This usually means that we do not take cuttings of this kind until December or January.

There has been much controversy concerning the collection of propagating material in cold weather, I would like to say that on a number of occasions when there was no choice, we, at the Arnold Arboretum, have gathered cuttings and scions during periods of extreme cold. Detrimental effects in the ensuing propagants have never been noticed. Perhaps the shrunken appearance of some frozen propagating wood, together with the fact that it may have been winter-injured, led to the opinion that it is unfit. However, we do follow a procedure with frozen cuttings and scions. On returning to the greenhouse they are sealed in polyethylene plastic bags and placed in a 40° F. refrigerator to thaw slowly. After a day or two of such treatment the wood resumes a normal appearance and is ready for use.

Those who are dismayed by the unkind manner in which weather may deal with their propagating material should ponder the plight of Dr. Richard H. Washburn (8) our fellow member from Palmer, Alaska. He reports some of his weather problems as follows: Even with the hardiest woody materials more prob-

lems are found in winters of heavy snowfall than in mild ones with practically no snow. When the snows pile up in the mountains the moose descend to the valleys and eat the terminals on many of the well-adapted shrubs and trees. But they seldom prune in a desirable manner; they may stand up on their hind legs and break down the centers of tall trees just to get the tender terminal growth. Unfortunately, last winter the mice were active under the snow, so that some six-foot trees were entirely debarked from ground level to the tips of their branches. Porcupines seem to confine their feeding to raspberry canes. These hazards associated with weather appear to have solved Dick Washburn's problem, for it would seem that after some winters he has no cuttings left to be concerned about.

Getting back to the topic of this paper, the effects of weather and climate, one may conclude with the thought that plant propagation, in this aspect, is more an art than a science. For a propagator must rely on his own skill and judgment based on a true understanding of the plant's condition.

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MODERATOR JAMES WELLS: Thank you very much, Al. There was a fifth item on this program entitled "etc," by James Wells. I just meant to try and pull this together briefly and turn it over to you for discussion. Obviously timing is of extreme importance and we have a number of well documented articles on this — Sid Waxman's article on Japanese umbrella pine, *Larix*, and deciduous azaleas. The position is important as to the type of plant produced. All of us are aware of the fact that you take terminal cuttings to get *Taxus capitata* and you get spreaders if you take cuttings from the side of the plant. The same is true on cuttings of the Norfolk Island Pine, *Araucaria* — you have to take terminal shoots in order to get a symmetrical plant. Juvenility hasn't been mentioned, but the physiological age of the cutting is important — cuttings from cuttings and the type of cutting you would take say from a Juniper *excelsa stricta* with the sphaeroblasts on the stems, these are cuttings from the base of the plant rather than from higher up. I think the weather is one of the most difficult things to consider, to be precise about, because it effects the condition of the wood very much and it brings into full force the skill and judgment of the propagator. The water content of the soil and

the temperature of the soil affect soil bacterial and the release of nutrients and that affects the balance of the carbon-nitrogen ratio, whatever that is, or it affects the squeeze-ability of the cuttings which I do understand a little. The affect of frost on cutting wood and preconditioning — incidentally in regard to taking cuttings at very low temperatures — when I was out in the midwest, just for fun one day at Jack Hill's I took some *Taxus* cuttings at 15 below zero and walked straight in and stuck them in a bench of 75° F. And they rooted beautifully. On nutrition, I was very surprised to learn that so little was known about it — only one other thought, we have found, in rooting rhododendrons that a very high calcium level seems to be desirable. Now when I say fairly I don't really know what I'm talking about. The tests probably should indicate a level of calcium of 1000 or 1200 lbs. to the acre. Also, you can get better results if you apply the calcium in the form of gypsum which will not effect pH but which will increase the available calcium to the plant. We haven't considered any of the techniques, which we have considered in detail these last four days; mediums, which I consider to be very important, inspite of Dr. Chadwick's disapproval, I feel there is an absolute void or vacuum of knowledge of the effect of mediums and it was high lighted by the work of the fellows in the state of Washington who are rooting cuttings in the air. I didn't touch on wounding — that's been covered pretty thoroughly I think. There are a few other subjects that should at least be brought into our general thinking on this whole problem — the care of stock plants, the time to gather the cuttings, the condition of the cuttings on the stock block, and whether we should water stock plants before taking cuttings and so on, the care of cuttings while they are being processed — here is something I feel a lot of people fail miserably on, light intensity and I think we have learned a great deal at this meeting on that. So much for the "etc" and now I welcome discussion, comments, and questions from the floor.

JOHN ROLLER: Did I understand Al to say that it was desirable to have frost on *Juniper* cuttings before they are taken?

MODERATOR JAMES WELLS: I think it is desirable and I think you get better rooting from cuttings taken from stock plants after they have been subjected to 2 or 3 frosts. Am I right, Al?

AL FORDHAM: Well this is what is said in your book.

MODERATOR JAMES WELLS: If that's so I substantiate this in that the work we had done at Dundee seemed to indicate this, John.

JOHN ROLLER: Then how do you account for the high percentages of some of the field stuff in late summer or September in the Southern states? Pfitzer juniper for instance.

MODERATOR JAMES WELLS: I think that the answer to that is because they are taking older wood. More mature wood. We are talking, I think, about frost effects upon current season's growth.

BILL FLEMER: These field cuttings remain through the winter in the ground and get their cold there. They are not rooted by the time winter comes along.

JOHN ROLLER: Some are rooted before the winter.

HANS HESS: I hate to dispute your theory, but we make a lot of *Juniper* cuttings in the summer time. They do fine in the open mist in full sun light. They haven't had any frosts on them.

MODERATOR JAMES WELLS: I can see it's time I brought out a revised edition of my book.

BILL CURTIS: I would say the majority of *Juniper* cuttings taken in California, from plants grown in California never even know what a frost is. And they have real good rooting. Thousands and thousands of them all rooted in the summer time, potted, and chances are by next spring they are saleable plants. They never have a frost on them.

CASE HOOGENDOORN: Will they live in the East?

PETER VERMEULEN: We have had a chance to compare this. For the past several years, we have been sticking *Juniper* cuttings in the rooting-growing medium in the summer. We have found that the *J. chinensis* varieties tend to root rather poorly. We did get a very high take the first time we tried them. This year we tested 250 each of the various *J. chinensis* varieties we grow and compared them with the *J. squamata* varieties and the *J. horizontalis* varieties. We found that the *J. chinensis* rooted very poorly whereas the others rooted very highly. I would also like to make a comment, in view of the papers that were presented at this meeting on the rooting-growing media, I would consider your remark that there is an absolute void on this subject to be rather challenging.

MODERATOR JAMES WELLS: I seem to be challenged in all directions!

VOICE: I have worked in the New York Botanical Garden, propagating woody plants and I found that the tighter I packed the sand [rooting medium] the better were the rooting results.

MODERATOR JAMES WELLS: In defense of myself, I would like to come back to a quote somebody made that we have to treat each plant as an individual. I really do think we are dealing here with specifics about particular plants. The generalities which were stated in my book and quoted by Al seem to hold true for a broad spectrum of plants we grew while I was in Dundee. That is, if we stuck cuttings of *Junipers* prior to Christmas or prior to a hard frost, we would get rooting, but we would not get the quality of rooting and the percentage of rooting which we would get if we waited until later.

HARVEY GRAY: Jim Wells, could you or some other member of your panel give me a little guidance on this, which I will briefly state. Many years ago, when I got into the subject of propagating plants, I visited many English gardeners and superintendents of estates and I was aware of the fact that they and their difficult plants to root such as for an illustration,

flowering guince, were done in very late winter, brought into the greenhouse, caused to develop soft growth, and it was with this according to them, they got their best rooting of these cuttings or in many instances cuttings rooted where they were never able to root them otherwise. Now, is there any explanation of this point. I know it is a fact, I have practiced it, it works, now is there an explanation?

MODERATOR JAMES WELLS: I don't know the explanation, do you Dick?

DICK FILLMORE: I have no explanation, but I will mention a few things which are obvious. When one compares the outdoor and the indoor climatic condition, that is out of doors versus a greenhouse, one finds right away that ultra-violet and some other qualities of light do not come through the glass used on those greenhouses and propagating structures. That's number one, there is a different quality of light. There is generally a lower intensity of light. There is generally a higher night temperature and less difference between day and night and extremes of temperature in a greenhouse. In the greenhouse there is likely to be, even from the workman's breath, a significantly higher level of carbon dioxide. There is also likely to be in the greenhouse some little bits of combustion products or from a man smoking a cigarette adding a little ethylene. And don't think plants aren't sensitive, they are. Now I would like to see an analysis in the same area of these various factors within a greenhouse and without a greenhouse at the same season and make some more definite determination of this sort of thing.

MERTON CONGDON: In addition to what has been said here, I think there is a whole range of plants whose cuttings should be taken when they are in a flush of growth. And this, of course, is what I hear mentioned under timing. Now, *Philadelphus aureus*, is a perfect example. Many members have had trouble with this plant. I can't say at the beginning of the year when I'm going to make my *Philadelphus aureus* cuttings in June or July or possibly even August, due to the fact that I want to catch them in that flush of growth when I can get the soft, long cuttings that I desire. And I think perhaps in the *Chaenomeles* that this is one of the plants that fall into this category also.

MODERATOR JAMES WELLS: Incidentally on the *Chaenomeles* the treatment with the 1% potassium salt of IBA is almost specific for it.

BRUCE BRIGGS: Just to confuse the issue a little bit more, a couple of questions, maybe someone could answer. We have at times secured in Southern California "Tams" [*Juniperus Sabina tamariscifolia*] lining out stock in August for long runners. We have taken these cuttings off, put them into the medium and in less than a month they have rooted readily. The temperature may be 80 - 90° F. The same thing, we've seen *Rhododendron*, not with us but with many others, commercial growers, they have taken cuttings from Southern California brought them

North and they're much superior to anything we can take off, they root much better, much faster than our cuttings. *Camellia* cuttings taken off under the same conditions in California brought North, put in our greenhouses root and are much superior to anything that we can grow. Also going back to the work with "Tams", the most peculiar thing is that those cuttings taken off in California, when stuck in California did not root as good as under our conditions. The same was true for *Rhododendron* and *Camellia*.

VOICE: It must be the smog.

MODERATOR JIM WELLS: I would suggest to future program chairman that more time be allotted for discussion. I wish to thank the panel very much for their participation.

PETER VERMEULEN: I would like to introduce the moderator for the next portion of the program, Mr. Michael Johnson.

MODERATOR JOHNSON: Each round table moderator will be allowed six minutes to summarize what went on in about an hour or an hour and a half of discussion. Our first moderator is John B. Hill.

## **AUTOMATION AND/OR MECHANIZATION IN PROPAGATION NEW TOOLS, PRACTICES AND TECHNIQUES**

JOHN B. HILL, *Moderator*  
THOMAS WHEELDON, *Recorder*

I believe that I can sum this up rather quickly by saying that the consensus indicated at the conclusion of our round table was that actually there were precious few new tools, new in the strict sense of the word. The solution to our problems lay not so much in sitting back and waiting for a latter day Cyrus McCormick to develop for us sophisticated complicated equipment to aid us in propagation or field culture, but rather to adopt the equipment we do have to do the best possible job. I define a machine as any tool we use — very simple tools such as knife or a relatively complicated piece of machinery such as the device for measuring the average CO<sub>2</sub> content of the air in a propagation house as we saw at Wooster. I'm not sure that as practical propagators we need be concerned nearly so much with the acquisition of complicated sophisticated equipment as we do better utilization of the tools we already possess. A very quick study of the understandable desires and needs to mechanize the propagation part of any nursery operation, let alone the field or container operation leads to the following thoughts. Quickly, to bring this around to one hang up point, that is in common with all food and fiber agriculture, we nurserymen are denied the single principle which Henry Ford is given credit for developing, and that is the very simple thing of bringing the work to the worker. It is impossible to put a propagation bench on an assembly line, and let the workers sit at one place and have the work pass in an orderly way. The same applies to any field