## TECHNICAL SESSIONS
### Tuesday Morning, December 8, 1980

The thirtieth annual meeting of the Eastern Region of the International Plant Propagators' Society convened at 8:15 a.m. in the ballroom of the Copley Plaza Hotel, Boston, Massachusetts.

PRESIDENT LOVELACE: Welcome to the thirtieth annual meeting of the Eastern Region of the International Plant Propagators' Society. This is shaping up to be one of the largest meetings this group has ever had. Our registration right now stands at 528 which I think speaks well for everyone who has been involved in planning this meeting and the site that was selected. We want to certainly thank the people here in Boston, particularly Wayne Mezitt and his crew, who have worked so hard to make our stay here in Boston a pleasure. At this time I would like to introduce to you the person who has to do all the hard work at these meetings, your program chairman and vice-president, Dr. John Wott.

VICE-PRESIDENT WOTT: It certainly is gratifying to see so many of you so early this morning. I would like to welcome you to your program. This is your program. It was put together based on the responses and ideas you gave me and other people on the Executive Committee. One of the things I would like to have you keep in mind as we go through the meeting is — if you get an idea please let the Executive Committee, and particularly John Sparmann, know. We really do need your help and it is an asset to us if we can know what you want. The other thing is that this program is for you and we want your participation. This has always been one of the strong attributes and one of the things the Society has been known for. So again, it was my pleasure to put this program together for you and to be here with you. I will now turn the program over to our first moderator, Don Shadow.

## ROOT INITIATION: A SURVEY OF CURRENT LITERATURE[1]

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Initiation of adventitious roots results from the interaction of numerous interrelated physiological and anatomical factors. In a summary of the subject in 1974, Snyder (32) reported that such an event depends upon the presence of cells capable of dividing

[1] Contribution No. 1979 of the Rhode Island Agricultural Experiment Station

and differentiating as root initials as well as the presence of favorable internal and external environments. In other words, a cell must be living and undifferentiated.

It has been known for many years that auxin (IAA) or one of its derivatives is a major controlling factor, but we still do not know specifically how auxin exerts this control over cell function. We know it stimulates root initiation in a manner similar to *cytokinin, polyphenols, gibberellins, carbohydrate, boron, nitrogen* and a host of other organic compounds. We know also that it is not the absolute amount of plant hormone that exerts this action but rather the relative amounts of each in proportion to the other. Most recently it has been suggested auxin may be just another cofactor functioning in electron transfer (2). We know the morphology and anatomy of the plant part is critical as well as that of adjacent parts, since translocation and storage of the organic stimulants play a part in initiation or obstruction of roots. Obstruction can be caused by fiber cells and disruption of newly formed initials may be caused by resin-producing cells.

Newly expanding leaves and actively growing buds, as well as dividing cells in the vascular cambium synthesize auxin which is translocated through phloem tissue to the crown of the plant. Not all buds are critical for root initiation. Wareing (36) found that dormant buds are not required for rooting, since removal of them did not inhibit rooting. Also, Biron (6) found that removal of the actively growing shoot tip and buds of dahlia increased rooting. He claimed that removal of the leafy shoot reduced competition for metabolites needed at the site of root initiation. Propagators have followed a similar line of reasoning when they removed flower buds from cuttings. In a related practice propagators conserve carbohydrates in cuttings by keeping above ground portions of cuttings cool while allowing photosynthesis to take place. Hess (16) demonstrated this through increased rooting with intermittent mist as a carbohydrate conserver.

The influence of fiber cells as an inhibitor to root development has been debated. Sachs, *et al* (26) believe proper cutting treatment and manipulation of environment could overcome any physical barrier. Girourard (14) also found sclerenchyma was not a barrier to adventitious root initiation in his studies with adult *Hedera helix* Yet, Howard (17) found that wounding to remove some physical barriers to root initiation consistently improved rooting. Edwards (12) further reported that wounding allowed for horizontal emergence of roots. He suggested that wounding may also allow for the free diffusion of root promoting substances and gases and that it allowed the root initials to make vascular linkages.

The dimorphism observed in the juvenile growth form and the correlated physical and biochemistry of juvenile growth forms have long been known to be linked to ease of rooting (3,4,5,13). However, it is a broad subject and too large to be summarized in this paper in depth. Only some recent findings will be discussed.

Kester (19) mentioned that the adult phase of *Hedera helix* could be reversed to the more easily rooted juvenile form by grafting the adult form to juvenile shoots and by the use of gibberellins and auxin. Roberts (24,25) has done extensive work on juvenility and time of taking cuttings of Douglas fir. He found changes in the meristem from one phase to another results in a change of metabolites being transported to the growing points. He noted that while the practice of shearing stimulates growth that is easy to root it does not result in morphologically altering growth. It does, however, alter the C/N ratio, auxin distribution, inhibitor-promotor balance and relative levels of cytokinins and gibberellins. He suggests the practice be referred to as "invigoration."

The interrelationships of morphological, anatomical and physiological factors are so tightly interwoven that they cannot actually be separated.

Albert (1) demonstrated the need for boron in root elongation. He pointed out that many root initials may never be seen because they cannot develop with insufficient boron. This conclusion was supported by Weiser (37). Further, Bojarczak (7,8) used borate in a talc formulation to increase root number and root length in lilac.

Numerous studies on environmental factors, primarily light and temperature, as they affect rooting, have been conducted. The influences of $O_2$, $CO_2$ and humidity on this process have also been investigated.

The advantage of conserved carbohydrate was mentioned previously as was the manipulation of removing competing plant parts during rooting. Propagators have also used differential heating or bottom heat to encourage root initiation while retarding top growth. Nelson (23) studied this topic extensively. He found few papers that actually demonstrated direct beneficial value in using bottom heat. Albert (1) reported that the optimum temperature for root growth is 20 to 25°C, and that higher temperatures can be detrimental. It is quite possible that the optimum temperature for root initiation is not the same as for root development. Dykeman (11) found a temperature of 27 to 30°C best for root elongation for many species.

Lamb (21) found that alternating temperature in the rooting medium was beneficial. He used higher temperature at night while keeping the air temperature cool. While many propagators are using bottom heat in the range of 25°C, several researchers have found lower temperatures to be beneficial. Van Elk (35) found that the temperature of the rooting medium should be maintained at not more than 20°C for rhododendron cuttings. Sanders (27) also reported that 20°C was optimum for *Rhododendron*, *Mahonia* and *Ilex*.

The light requirement for rooting is quite complex. Light is required for photosynthesis and carbohydrate accumulation. Light duration and quality also have a direct controlling influence on photoperiodic stimulus and many other factors of plant growth and rooting, such as phenolic and hormonal content.

Perhaps of more significance, is the absence of light and resultant etiolated growth. Etiolated portions of stems appear to be easier to root (9,10,20). Moreover, cells developed in the absence of light are physiologically different. Krul (20) found that 2,4-DNP stimulated rooting and that higher levels of this are conserved in etiolated cells or the phenol was not metabolized to an inactive form when stems were etiolated.

Bojarczuk (7,8) found a positive relationship between the presence of phenol and the ease of rooting in lilac. Krul (10) speculates that wounding of cuttings may be beneficial to rooting because the action of wounding releases phenols from injured cells

Instead of physically wounding stems it has been suggested recently that chemically treating the stem base may also stimulate rooting Lee (22) found that soaking basal stem portions in either strong acid or base improved rooting. This was supported by Gray (15) who applied the acid soak to a fall crop of *Rhododendron* cuttings. However, Ticknor (34), using this method on bearberry, could find no benefit. We have followed Gray's procedure on summer cuttings of the same rhododendron cultivar and no beneficial results were found. Lee (22) believes the acid soak may break acid labile bonds, loosen cell walls, and facilitate absorption of applied auxin.

The effects of growth retardants and ethylene are at present under extensive study. Kawase (18) found ethylene stimulated rooting on willow. Swanson (33) suggests ethylene treatment may alter levels of various metabolites and may increase the number of endogenous root promoting substances or decrease inhibitor levels. He suggests repeated treatments may be necessary for difficult to root plants.

The possibility of repeated treatments or gradual changes in treatments is one that warrants a more serious look in the future. It has been suggested that environmental changes should be made as the cutting goes from the root initiation stage to root development. Several researchers have suggested that repeated applications of chemicals might be beneficial. One even suggested the formulation of slow release plant growth regulators

Further evidence for such an approach can be found in a series of papers by Sircar (28,29,30,31). He found five stages of meristematic development during adventitious root initiation. The effect of application of gibberellins or IAA was more or less effective depending upon which stage the gibberellins were made A concentration of auxin or gibberellins applied at one stage may be inhibitory, while at another stage it may be a stimulant.

Another aspect of plant propagation often overlooked is environmental treatment of the stock plant prior to taking the cutting.

Roberts (25) summed it up well when he said that timing the taking of cuttings to coincide with their achieving maximum potential is still one of the goals of the plant propagator.

*If we add to this that best results will be obtained from the proper timing of application of treatments and formulations of growth regulators and regulations of environmental factors, we may yet achieve our goal of asexually propagating all clones at maximum efficiency.*

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VOICE: I would like to know what you find in relation to pH and rooting. Does pH act differently during different stages of the rooting process?

JOHN McGUIRE: From the little work that has been done on this subject it is difficult to separate the reported effects into the various stages of root initiation. My own personal feeling is that with some plants that are particularly dependent on an acid or basic medium that there would be a difference. I think I have seen it in some plants, particularly clematis, where we have found that you do not get root development if you use an acid medium.

RICHARD FENICCHIA: I would like to comment on juvenility and rooting. Juvenile cuttings possibly root better because they store more hormone which is important in root initiation. You also have to have the nutrients present to help in the development of roots.

GUSTAV MEHLQUIST: I noticed that you mentioned rhododendrons several times in your presentation. I would like to suggest that you refer to what kind of rhododendrons you are discussing. There are 1800 or more species comprising several sections which grow quite differently and would have to be treated quite differently. I have noticed that in previous meetings that red flowered rhododendrons have been referred to as being hard to root. This may be true for *Rhododendron catawbiense* but not necessarily for other red species.

JOHN McGUIRE: In my own work I did refer to R. 'Nova Zembla'.

MARTIN MEYER: I would just like to comment on bottom heat. If you read Nelson's work on bottom heat he reported that 6 species gave a favorable response and I think he had 66 species that showed no response or a detrimental one. So, if a person is thinking of using bottom heat, one should start on a small scale.