FRIDAY AFTERNOON SESSION
November 22, 1957

The session was convened at 1:30 o'clock, President Vanderbrook presiding.

PRESIDENT VANDERBROOK: The first subject, which is going to be discussed by Dr. A. E Hitchcock, is one in which I am sure the entire membership is going to be very deeply interested. We are all looking for new methods, chemical or otherwise, to cut the production cost of our plants. So at this time it gives me pleasure to introduce Dr. A. E. Hitchcock, of the Boyce Thompson Institute for Plant Research, who will talk on, "The Synthetic Aids to Propagation. A review of hormones and other chemicals in cutting propagation," Dr. Hitchcock.

DR. A. E. HITCHCOCK (Boyce Thompson Institute, Yonkers, New York): Thank you, Mr. Chairman. You know, I am not sure that I should be here today. This is the first time I have given a talk which will not be based on recent experimental results, and as you will note from the title, this is really an assignment

My discussion will be mainly a summary of the work which has been done at the Institute since the time root-inducing substances were used back about 1935.

Dr. Hitchcock discussed the subject of the use of hormones and other chemicals in cutting propagation. (Applause)

THE SYNTHETIC AIDS TO PROPAGATION: A REVIEW OF HORMONES AND OTHER CHEMICALS IN CUTTING PROPAGATION

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Last year you heard from Dr Henry Kirkpatrick whose specific subject was concerned with the rooting of lilac cuttings. As a result of this interesting discussion there are probably many questions in regard to what might be the prospects for the development of new root-inducing chemicals, what is the present status of rooting compounds, and what are the specific uses for these chemicals. As far as I am concerned I think that there is always a use for root-inducing substances in cutting propagation It is true that they will not work on all species of plants, and therefore cannot be considered a cure-all. As for the possible development of a chemical which will produce roots on all species of plants, I doubt very much whether such a chemical will ever be developed. There is a possibility that one might be formulated, or discovered, but I think that it is quite unlikely.

One of the first so-called hormones used to stimulate root production on cuttings was indoleacetic acid However, as other chemicals, closely related to this naturally occurring growth substance were dis-

covered, it was clear that indoleacetic acid was not the best chemical which could be used to induce roots on cuttings. As a chemical it was relatively unstable, and although it could be used to root many cuttings, a higher concentration of the chemical was required than was necessary of other, more commonly used chemicals. One of these highly effective, synthetic root-inducing chemicals is indolebutyric acid. This chemical, in relatively small concentrations was very effective in inducing roots on cuttings and, what is more, it had a fairly wide range over which, you might say, it was safe to use.

As techniques for application were developed, we shifted from the 16-24 hour soak, to talc carrying rooting substances, the latter better known as powders. Again, the usefulness of indolebutyric acid was demonstrated by its relative effectiveness over a fairly wide range without causing injury to the cutting, even though roots were often produced from the uninjured tissues higher up. It was also possible to retard root induction by too high a concentration of certain substances tested. We also noted on rose cuttings for instance, that if we induced 25 roots or more, bud break would be delayed. This is perhaps true, to a lesser degree, with cuttings of other plant species.

As more became known about these root-inducing substances there was a gradual shift from the use of indoleacetic acid to indolebutyric, and naphthaleneacetic acids, and finally to a combination of the latter two chemicals. In general, naphthaleneacetic acid proved to be rather exceptional in inducing the rooting of certain evergreen species. However, as has already been brought out it had a narrow range of effective concentration as compared to indolebutyric acid. Mixtures of chemicals were generally more effective on cuttings than any of the individual substances. In many cases a greater than additive effect was obtained.

As experimentation at Boyce Thompson Institute continued, the relative effectiveness of the various derivatives of a particular synthetic compound was developed. The volatility of the ester forms was pointed out, the insolubility of the amide and ester forms in water was noted, and so forth. At the same time, we synthesized 2,4-dichlorophenoxyacetic acid (2,4-D) in our laboratory and found that it was very active, in dilute concentrations for inducing cell elongaton. Of course, as you all know, this chemical is one of our most potent herbicides, causing considerable foliage modifications in weeds and other plants. In the course of these studies we tested some 60 substituted phenoxy and benzoic acid compounds. We found out that 2,4-dichlorophenoxy-propionic and butyric derivatives were quite active in inducing cell elongation and curvature, but they, unlike the acetic form did not have a formative effect on new organs which developed after the plant was treated. Also, it was evident that 2,4,5-trichlorophenoxypropionic and butyric derivatives acted in a similar manner, but were considerably more effective Although they were effective in only fractions of the amount of indolebutyric acid required to produce a desired result, they had a rather narrow range in which they could be used without causing injury.

Mr. J. S. Wells, formerly of Koster Nurseries was very interested in the idea that some of the substituted phenoxy compounds might prove

useful for the rooting of rhododendron cuttings I believe he tested some 37 different compounds in this general group and concluded that 2,4,5-trichlorophenoxypropionic acid was one of the best This was quite an usual undertaking for a commercial nurseryman, and one which yielded valuable information on optimum concentrations and the rooting of some of the more difficult red varieties of rhododendrons.

If one studies the literature closely he might be puzzled to find that there are often two or more concentrations of a rooting substance recommended for a particular type of cutting I know we have often been criticized by growers and practical people because we have not worked out sufficient practical recommendations for a specific rooting compound. Actually this was not our objective, since we were primarily interested in establishing the relationships between chemical structure and some measurement of physiological activity, or in this case, rooting For many of these tests we worked with privet cuttings, a plant which is considered to be fairly easily rooted. This plant was selected because of the ease of selecting cuttings, which not only are fairly uniform from season to season, but also from year to year. Because of the use of this plant you may ask what use or application do the results have for the more difficult varieties. May I note that regardless of the material, basic responses can be identified and correlated into some type of pattern. From these patterns further experimentation could easily establish the practical aspects of these studies. On occasion we have been influenced to extend these basic studies to find a practical application. One such case was with *Ilex opaca* in which we not only worked out optimum concentrations of root-inducing chemicals, but investigated subsequent rate of growth, after effects of chemical treatment, and growth comparisons between own-rooted and grafted plants. After treated cuttings of this plant have been rooted, transplanted, and finally lined out in the field they make a very bushy and unusual type of growth at first. These can be pruned severely. They will then form leaders and grow rather fast to form a really good specimen

What is the value of root-inducing substances? This is a common question frequently asked of us. Speaking mainly of woody plants, I would say that on certain species you get more and larger roots in any given length of time Practically it permits you to get the rooted cuttings to the transplant bed, pot, band, or field in a shorter time, and often with less loss For example, many times rhododendron cuttings which have not been treated with a root-inducing substance produce a root system that has a single point of attachment You might have a great ball of roots, but unless the operator was particularly careful in handling, the root system would be entirely lost. Treatment, then, on rhododendrons is valuable because more than one or two points of attachment between the root system and the cutting generally results.

Root inducing substances should be looked upon as aids to the rooting of cuttings, not as cure-alls. There are many propagators now-a-days who can root cuttings without these substances. However, by knowing how rooting compounds influence propagation, they can be used effectively and integrated into the regular program. Indolebutyric acid, for example, works well on most yews, broadleaf and small-leaf

hollies require less dosage and are not a problem as a rule One must learn when and how to use root inducing substances if they are to be used to best advantage.

It is generally recognized that there are a number of variables that enter into the propagation of plants by cuttings As season of collecting softwood cuttings influences rooting response, so does the concentration of the root-inducing substance. Although certain concentrations have been established for certain classes of cuttings, there will be differences in response from year to year. For example, between 1937 and 1942 we rooted a number of commercial varieties of apples by means of leaf bud cuttings. We tried to duplicate these results in 1945, but were not as successful as we had been earlier. Lack of disease control in the orchard at the later date was believed to be the principle reason for the poorer results.

From what we have seen at Boyce Thompson, it appears that perhaps misting almost substitutes for the use of growth substances in most cases. The fact that it is possible to keep cuttings in good shape until such a time as they are rooted has offset the advantage of slightly reduced intervals required to root a specific type of cutting. I would say, from the commercial aspect, that there are many species of plants on which you almost had to use root-inducing substances. Now, with mist, it would not be quite so important. Most of what I have said applies to leafy cuttings.

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DR. HITCHCOCK· To discuss the use of root inducing substances on leafless, hardwood cuttings I would like to ask Dr. Chadwick, of Ohio State University to come to the speakers stand

DR. L C. CHADWICK (Department of Horticulture, Ohio State University) : I have only very brief comments to make as far as the use of synthetic growth substances on leafless hardwood cuttings is concerned. I think a good many of you probably have watched the literature closely enough to know what is available relative to this subject. Probably there are some ol you that have tried synthetic growth substances from a practical standpoint on leafless cuttings

The information that is in the literature, some of which I reported in the Proceedings of the Third annual meeting when we covered the subject of hardwood cuttings, would not indicate very favorable results *There have been a lew reports which would indicate considerable* stimulation from indolebutyric acid and some of the other synthetic materials on leafless cuttings There are also a good many reports which would indicate no response whatsoever A good many of the favorable reports, which actually are few in number, I would say were with cuttings ol plants that are compartively easy to root. Dr. Pearse of England, for instance, reported using indolebutyric acid on willow cuttings Cuttings of this plant usually do not give us very much difficulty but he reported considerable stimulation on cuttings of that type. There have been several other reports out of England, primarily from the East Malling Experiment Station on the use of root inducing sub-

stances for hardwood cuttings of plums; particularly those which are used there for understocks. They have also tried them on hardwood cuttings of the Malling, dwarfing understocks and almost without exception these reports would indicate no response from the synthetic growth substances.

There have been several reports, one by Johnston of Michigan, and another by Myhre in Washington, where synthetic growth materials have been used on hardwood cuttings of several varieties of blueberries. Again these reports would indicate very little, if any, response from synthetic materials on these types of cuttings. Bringing Russia into the picture, there was a report by a man by the name of Denza who obtained excellent results with 0.01 percent heteroauxin on hardwood cuttings of the weeping mulberry. He made no great elaboration of his results in the report although he indicated there was a response at least on cuttings of this particular type of plant. I think several of you are probably familiar with the work that Dr Doren of Massachusetts reported on using *Franklinia* and *Magnolia virginiana* cuttings treated with indolebutyric acid along with Phygon XL. His results were very striking as far as stimulating effects are concerned using a combination of the two ingredients A mixture of the two materials gave much better results than did either used alone.

Now, getting down a little bit more to the commercial aspects of this problem, I have talked with a good many propagators in various sections of the country who have tried to use synthetic materials on deciduous hardwood cuttings. I would say the great majority have reported no beneficial results. I think by and large, results would indicate that root-inducing substances have been used to greater advantage on leafy cuttings than on leafless hardwood materials. Those are about all the comments I have to make. Thank you.

PRESIDENT VANDERBROOK: Are there any questions?

MR HOOGENDOORN: I would like to ask Dr Hitchcock a question. This summer was the first time we ran an experiment on misting in an open frame. We tried different rooting powders and different types of plant materals. The normally easy ones were easy to root and the hard ones were still difficult. When we stuck a number of *Philadelphia coronarius* cuttings treated with Hormodin No 2 and No. 3 in ten days the leaves gradually started to turn black and drop off. What did I do wrong or what was the cause of this?

DR HITCHCOCK: Well, I would guess you probably used too high a concentration of root-inducing substance for this species. I would guess that you should use not more than the No 1 powder

MR. HARVEY TEMPLETON: I would like to ask Dr Hitchcock about the comparative effectiveness of the potassium salt, sodium salt and acid forms of indolebutyric acid

DR. HITCHCOCK: The salts were more effective than the acids from two standpoints. One, the salts generally are less critical with any given concentration and we get better results than with the acid. We explained that on the basis mainly of solubility. In other words, the salts are more soluble in water and for any given concentration you

probably would get a little more in your cutting as compared to the acid.

MR. TEMPLETON: Is the salt any more unstable than the acid?

DR. HITCHCOCK: Fully as stable, if not more so.

MR. JACK HILL: Tell me, Dr. Hitchcock, has there been any work, to your knowledge, done along the line of enabling commercial producers to predetermine, on the basis of tissue analysis or otherwise, the optimum concentration of auxin to use for a given plant under a given set of conditions? As you stated earlier, we all know one variety or species of plant will respond differently to root-inducing substances from year to year. Is there any test which will tell us to use two milligrams of indolebutyric acid or to use five, ten or twenty?

DR HITCHCOCK: Not so far as I know. Testing has been done mainly with the carbohydrates or starches and sugars. As far as I know, this has never been actually correlated with the dosage of rooting powder which would be beneficial to use.

MR. VAN HOF· I would like to comment on some experiments I saw at the horticultural gardens in Boskoop, Holland, this past summer. They had displayed some of the hard-to-root cuttings of plants which had been treated wth indolebutyric acid for 12 to 24 hours, stored and stuck out in the spring They had non-treated check plots and treated ones, and really it was marvelous to see the stand they had as a result of treatment.

DR. CHADWICK: What plants?

MR. MARTIN VAN HOF. For instance, they had the Red-leafed plum, *Prunus cistena* and some of the viburnums rooted from hardwood cuttings. I think they had a 75 per cent stand.

PRESIDENT VANDERBROOK: Gentlemen, we will move on to the topic of the propagation and culture of container stock At this time it gives me pleasure to welcome the moderator for this panel, Mr. Frank Turner.

MODERATOR TURNER: I thank you for the privilege of making a few brief remarks before this Society, before bringing on the other two gentlemen who will cover the subject of growing ornamental plants to usable or salable size in metal containers. As our discussions continue, you will notice that there will be a great difference in our levels of experience. The discussions following will be given by men who have accomplished high levels of production in the culture of many and varied plant subjects They have been doing it for a long enough time that their answers to production and marketing of their materials have come from the vital, near unimpeachable field of experience. My own remarks are not derived from a background so well tested

Mr. Turner presented his talk on container culture in the North. (Applause)