the three regular strengths—the same as Hormodin—but also is sold in higher concentrations for harder to root subjects. I think that Hormex costs less than other powders. I have a circular that shows their prices.

I think I should mention that Eastman, Rochester, N.Y. sells basic chemicals for making your own hormone liquid mixtures. I inquired about this a few years back but felt that trying to work out the right method of mixing and using their chemicals was beyond me. However undoubtedly in this august gathering there probably are some who use the Eastman chemicals or might be interested in finding out about them.

HUGH STEAVENSON: Our next speaker, as can be seen from the program, is Bob Fleming.

PHYSIOLOGICAL AND ANATOMICAL EFFECTS OF GIBBERELLIC ACID ON PLANT CUTTINGS

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INTRODUCTION

Gibberellic acid has been tested in various experiments by many researchers with the purpose of determining its usefulness in the field of horticulture. Much has been discovered with respect to the effects on the above-ground parts of plants. Little information was available in 1957 on the direct effect on root promotion as in the case of cuttings or root growth as it is affected by treatments with gibberellic acid. For this reason the following study was carried out. It was conceivable, as in some ways gibberellic acid duplicated the response of plants to treatment with known auxins or plant hormones, that the material might also favorably affect root induction in plant cuttings. The effects of the known auxins were well established, toxicity levels were known, and the inhibiting effect on root growth was known. Little information was available at the time concerning this phase of research using gibberellic acid. From literature available it was evident that gibberellic acid has a low toxicity rating. Responses have been evident on plants with as little as one ppm up to and beyond 1000 ppm with no indication of injury with the exception that, at the high concentrations plant response, where evident, was more pronounced than at lower concentrations.

While much of the literature pertaining to increased growth after treatment with gibberellic acid, showed a decrease in per cent dry weight of roots in relation to top, there is no indication that inhibition has been the cause. Where there is a definite increase in total plant dry weight, weight of roots is greater than in the check plots.

DISCUSSION AND RESULTS

In the treatment of softwood Forsythia and Ligustrum cuttings with Gibberellic Acid, no beneficial results were found. At no time did Gibberellic acid treatment equal or exceed the percentage rooting of the control cuttings with either species used. Indolebutyric acid with ligustrum cuttings gave a better percentage rooting at all but the highest concentration used (120 ppm in solution) at which strength cuttings were permanently injured, many dying, the remainder failing to root. Injury was also noted at the 40 ppm level, in solution, using Gibberellic acid. Of interest is the fact that given further time in the propagating bench, treated lots of the 10 and 20 ppm Gibberellic acid in solution eventually rooted to 90-100 per cent. Of the two lots tested in this way with Ligustrum at 10 ppm Gibberellic acid in solution the extra time required for maximum rooting was 30 days; at 20 ppm in solution — 25 days. Normal maximum rooting for control and Indolebutyric acid treatments 40 and 80 ppm, of the same lots was 27 days and 44 days respectively. A similar result was obtained in two lots of Forsythia. At the 10 ppm Gibberellic acid in solution 44 days were required for maximum rooting (85%) as opposed to 17 days for the controls and Indolebutyric acid treatments. At the 20 ppm Gibberellic acid in solution (Indolebutyric acid 80 ppm) the control rooted 100% in 21 days. Both Gibberellic acid and Indolebutyric acid treatments required an additional 21 days for 100% rooting. In this instance injury to the base of the cutting was obvious in the Indolebutyric acid treatment, rooting generally taking place at the node immediately above the injured portion.

In Forsythia 80 ppm Indolebutyric acid in solution appeared to be the critical point. In the replicate lot of cuttings injury was such that rooting failed to take place completely. At 120 ppm IBA in solution all cuttings were dead or beyond recovery.

At the lowest concentrations used 10 ppm Gibberellic acid in solution and Indolebutyric acid 40 ppm in solution, maximum rooting was obtained in all instances including the control. In the second set of cuttings using the same concentrations Gibberellic acid treated cuttings had failed to root entirely at the time Indolebutyric acid cuttings had attained maximum rooting, but on resetting Gibberellic acid treated cuttings rooted to 85% in an additional 27 days.

At no time was the typical response to Gibberellic acid treatment apparent on cuttings of Ligustrum regardless of concentration used. In contrast to this semi-dormant hardwood cuttings of Ligustrum set December 13, 1957 after treatment with 40 ppm Gibberellic acid in solution for 24 hours showed the characteristic elongation of new shoots within seven days and showed marked elongation within two weeks, but failed to root completely. Softwood Forsythia cuttings failed to show the elongation response at the lowest concentration used (10 ppm in solution of Gibberellic acid) but showed moderate elongation over controls at the 20 ppm concentration and marked elongation at the 40 ppm concentration.

Where the elongation occurred in softwood cuttings rooting was decreased to a marked degree although up to the 20 ppm concentration rooting was carried out to a satisfactory level (85%) after resetting (44 days as opposed to 17 days for the control and Indolebutyric acid treatments).

Hardwood cuttings of Forsythia taken in February 1957 and treated with a 10 ppm solution of Gibberellic acid for 24 hours showed marked elongation of shoots within 7 days — formed a good callus pad at the base of the cuttings and in 41 days had begun to develop a few roots. Indolebutyric acid treatment at 40 ppm in solution gave 100% rooting in the same period, while controls had produced little callus and only a very few roots.

Talc treatments using Gibberellic acid and Indolebutyric acid in concentrations equal to those used in solution, failed to show any significant differences between treatments. This may be due possibly in part to the natural activity of talc and to the fact that concentrations of root inducing substances in talc are usually much higher than those used in this experiment. Rooting was consistently good in all talc treatments. Generally Gibberellic acid treatments at the higher concentrations (20 and 40 ppm in talc) had not reached maximum rooting at the time of removal of Indolebutyric acid and control treatments, but maximum rooting which was generally lower than IBA and control treatments (75-85% as opposed to 95-100%) was obtained within 7-10 days of other treatments.

At no concentration in talc was there any response in shoot elongation to Gibberellic acid treatment.

Microscopic examination of sections of fresh material taken at time of removal from the propagating bench showed no irregularities as to cell formation or arrangement. Primordia were evident on Gibberellic acid treatment lots as well as the control and IBA treatments. Root primordia appeared normal as compared with controls and IBA treatment though possibly not as well developed.

Microscopic photographs of various treatments were taken of cross sectional and longitudinal sections of the rooted portion of stems of both Forsythia and Ligustrum. No apparent differences were visible between one treatment and another. Callus was no more abundant with one treatment than with another with the exception of hardwood cuttings, as already mentioned in which case callus was quite evident on Gibberellic acid treatment while root development is much less than in IBA treatment.

Production of new roots is the most important factor in the ultimate establishment of a cutting provided the cutting itself will remain in a healthy functioning condition during the root initiation period. A count of primary roots produced, that is those originating directly from the stem was made, and an average taken from five cuttings.

In no case, using talc as the carrier was Gibberellic acid superior in number of primary roots produced than either Indolebutyric acid or talc alone. The average of totals of all talc treatments shows Indolebutyric acid as good as or better than other treatments in both Forsythia and Ligustrum while Gibberellic acid treatment average is lowest in both species.

In solution treatments using Ligustrum, in one case Gibberellic acid treatment at the 40 ppm level did give more primordia produced but the average was not consistent, as the replicate showed Indolebutyric acid with the higher level of primordia produced. In Forsythia in the treatments using 80 ppm IBA and 20 ppm Gibberellic acid, Indolebutyric acid treatments produced many more primary roots than either check or Gibberellic acid treatment. In average of total primary roots produced, Indolebutyric acid treatments in the case of Forsythia show much larger figures than either check or Gibberellic acid treatment.

SUMMARY AND CONCLUSIONS

Treatment of softwood cuttings with Gibberellic acid as relatively dilute concentrations (10-20-40 ppm) failed to produce a rooting response as compared with controls or dilute concentrations of Indolebutyric acid (40-80-120 ppm).

Forsythia cuttings were slightly injured at the 40 ppm concentration in solution of Gibberellic acid and the 80 ppm solution Indolebutyric acid. 120 ppm concentration of Indolebutyric acid was highly injurious to both Forsythia and Ligustrum.

The elongation of shoots, normally associated with Gibberellic acid treatment was not evident in any treatment of Ligustrum. At the lowest concentration (10 ppm) Forsythia showed no respose. At the higher concentrations 20 and 40 ppm, elongation of the growing point was evident and most pronounced at the highest concentration.

Both species responded by increased shoot growth when hardwood cuttings were used.

Due to the varied response of plants to treatment with Gibberellic acid it can be stated only that Forsythia 'Spring Glory and Ligustrum ovalifolium are not beneficially affected as to rooting response by treatment with Gibberellic acid. This information supports previous work by Marth, and would lead to a generalization that treatment of plant cuttings with Gibberellic acid has no effect on the rooting ability of the cutting and in some instances may show definite inhibition.

HUGH STEAVENSON: Our next speaker doesn't need any introduction. Bill Snyder has been mixing up some hormone formulations that may become as popular as the Gibson. At Rutgers he is known as synergism Snyder.

HORMONE-FUNGICIDE COMBINATIONS IN ROOTING

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The propagator's search for chemicals to improve the rooting of stem cuttings has been directed primarily along two lines: first, chemicals which increase the rooting response itself; and second, chemicals which reduce the incidence of disease in the propagation bench.

With the discovery, in the mid-1930's, of the stimulating effect of indoleacetic acid and related compounds on rooting, it was hoped that successful rooting of all stem cuttings would be relatively easy. Such a naive idea, however, was soon expelled for, as was soon learned, the cuttings of many plants remained difficult to root even when treated with these chemicals.

There are numerous factors which contribute to a possibility of disease in the propagation bench. The use of soft, succulent plant tissue, the frequent presence of systemic diseases within the stock plant, the everpresent spores of fungi on the plant, in the air and the medium, the use of warm, humid conditions which are equally suitable for growth of both fungi and roots, and even the dipping or soaking methods frequently used to apply root-inducing chemicals to the cuttings — all of these pose a potential threat to successful rooting of cuttings.

It was only logical that investigations would be made involving the incorporation of a fungicide with the root-inducing chemical treatment.

In 1941, Grace (5, 6) and Grace and Farrar (7) added nutritive salts and an organic disinfectant, ethyl mercuric bromide, to the talc containing indolebutyric acid. Their data show that the disinfectant resulted in an increased rooting response with some plants (*Coleus, Chrysanthemum* and *Deutzia*), no effect with some plants (*Symphiocarpus, Lonicera* and *Taxus*), but with an increased mortality of at least one plant (*Weigela*).

Geranium and carnation cuttings are especially susceptible to fungus diseases. White (15) has shown that ferbam (ferric dimethyldithiocarbamate), sold as Fermate, Chromate, Ferberk, etc., used either alone or in combination with a root-inducing chemical not only significantly reduced the