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Auxin Use in Propagation – Then and Now

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Summary

Until the 1930s and 1940s, cutting propagation was limited to those species that were easy to root. With the discovery that auxin significantly enhanced rooting in cuttings, the number of vegetatively propagated species available to greenhouse and nursery producers significantly increased. It is interesting to see the early adoption of "hormones" in commercial practice and how the delivery methods for treating cuttings with auxin evolved. With an increased emphasis on propagation efficiency for modern greenhouse and nursery production, alternative methods are resurfacing as potential ways to deliver auxin to cuttings.

INTRODUCTION

The greenhouse and nursery industry has seen significant changes in the past twenty years. Annually, there is an increase in the diversity of plants offered to an international market. This may be most dramatic in the annual bedding plants where there has been an increase in cutting propagation in an industry that was exclusively seed propagated a few decades ago. Breeding efforts have extended the number of interspecific and intergeneric hybrids that necessitate vegetative propagation. Stock plant management has moved from being predominantly local to being consolidated to larger specialty growers. Local greenhouse and nurseries are increasingly receiving unrooted cuttings to produce plugs and liners. With increased emphasis on efficiencies in cutting propagation, there is renewed interest in auxin and its various application methods. This paper traces the early adoption of auxin for cutting propagation and its current application practices.

Historical background

Fritz Went in 1928 building on the initial research of Charles Darwin (Darwin, and Darwin, 1880) and Boysen Jensen in 1911 developed the first bioassay for detecting hormones in plants based on the bending of grass and oat seedlings to light. Went placed agar blocks containing suspected hormones asymmetrically on decapitated oat seedlings and measured the bending of the coleoptile. Kögl and Haagen-Smit, between 1933 and 1935, found that substances in human urine and various plant extracts were active in Went's coleoptile bioassay. This led to the chemical isolation of "heteroauxin" [indole-3-acetic acid (IAA)] identified as the first plant hormone. Soon after this, Went and Thimann in 1934 developed another bioassay based on the discovery that auxin-induced adventitious rooting in etiolated pea cuttings.

The first specific report of IAA being used to stimulate rooting in cuttings was by William Cooper at the Boyce Thompson Institute in 1935. He applied IAA in lanolin paste to stimulate rooting in lemon (*Citrus*), lantana (*Lantana*), and chenille plant (*Acalypha*) stem cuttings. By 1935, synthetic auxins were developed that were shown to promote rooting in cuttings (Thimann, 1935; Zimmerman and Wilcoxon, 1935). These included the familiar α-naphthaleneacetic acid (NAA) and indolebutyric acid (IBA) compounds still used by modern propagators.

The potential commercial importance of auxin to cutting propagation became evident as researchers at the Boyce Thompson Institute showed the efficacy of auxin in stimulating rooting in cuttings of over 85 genera of plants, including woody plants that had proven difficult to propagate in the past (Zimmerman, 1935).

In 1936, the soak method replaced lanolin paste for auxin delivery. Auxin was made soluble in alcohol and diluted in water. Typical soak durations were 10 to 24 hours (Zimmerman and Hitchcock, 1935). Grace in 1937, developed the method of incorporating auxin in talc to deliver auxin to cuttings that would eventually become the standard commercially. In 1938, Chadwick and Kiplinger (1938) treated over 100 types of woody cuttings with IBA in a soak solution or as commercially available dusts with positive results. The quick-dip method for treating auxin was developed by Hitchcock and Zimmerman in 1939 and later refined by Cooper in 1944.

The Boyce Thompson Institute was granted a patent for use of auxins in rooting and subsequently licensed Merck to distribute Hormodin A for commercial application. By 1947, four commercial companies were offering synthetic auxin formulations in talc for application to cuttings. These included Hormodin (Merck), Rootone (American Chemical Paint Co.), StimRoot (Plant Products Co.) and Quick-Root (Dow Chemical).

In an excellent early review of research in cutting propagation by Avery et al. (1947), they provide a table with references on experimental rooting for over 600 different kinds of woody plants. This provides a great overview of the impact of auxin on rooting cuttings in the era prior to the use of mist by the greenhouse and nursery industry.

Early adoption of auxin in propagation

Although the research on auxin use to improve cutting propagation was very positive, the industry could be reluctant to accept this new technology. In the preface for Wilfrid Sheat's 1948 book on propagation of woody plants, he is skeptical about the use of auxin in cuttings. "I think it is true to say that to date no real commercial advantage has yet been gained by the use of the substance (auxin) for the production of plants by cuttings. As a practical propagator, I would add a word of warning. The use of chemical root-producing materials is no substitute for the exercise of intelligent practice in the art of propagation." (Sheat, 1948).

The early Proceedings of the Plant Propagator's Society provide insight into early adoption of auxin and cuttings by commercial nurseries. In the first issue of the Proceedings in 1951, James Wells discusses auxin as "HORMONE TREATMENTS – There are growers who say that there are no results obtained by the use of hormones which the skilled propagator cannot develop without them. This is an argument to which we do not subscribe. We believe that used intelligently the plant hormones have a most definite place in modern plant propagation and we use them extensively. For our easily rooted varieties we use a powder containing 6 mg/g of indole butyric acid. This is the strongest commercially available powder in this country."

In the same Proceedings issue, Richard Fillmore commented on auxin use in his review of woody plant propagation. "The use of synthetic hormones is a well established and often beneficial practice in rooting cuttings. Assuming that one is thoroughly familiar with the most suitable hormone and the optimum concentration for the species under consideration, hormone treatments will unquestionably promote improved results with a wide variety of plants. When the requirements of this assumption cannot be met, the indiscriminate use of hormones may do more to inhibit than to promote rooting. I do not wish to be misunderstood. I am a pro-hormone man and I have successfully used hormones on dozens if not hundreds of species."

In a wonderfully frank discussion of auxin use by an established nursery propagator, Peter Vermeulen defers to the next generation. "The use of hormones! You know, I never went to high school. I never went to college, and I am awfully dumb in chemicals. I am quite thick-headed as a Dutchman and I didn't want to try a lot of things. I probably should have, but we finally got to the point we are trying chemicals. This year for the first time, we tried some indolebutyric acid, one and two percent. I don't know whether it will work out. I am not alone down there anymore, so they tell me I shouldn't be so old-fashioned, I should try some new things. We have to give in once in a while to the younger generation. So we have!"

Transition from dilute soak to talc and quick dip methods

As auxin treatment of cuttings was becoming accepted, the delivery method was evolving from the original dilute soak method to the talc (dust) and quick dip methods. Again, the Proceedings of the Plant Propagator's Society provides insights into this transition. In 1956, Henry Kirkpatrick provides a very good summary of this transition with his work in lilac (Kirkpatrick, 1956). Indolebutyric acid (IBA) and naphthaleneacetic acid (NAA), alone and in 50-50 mixtures, were used in a range of concentrations. The chemicals were applied to the cuttings by the 24-hour solution soaking method, by the talc powder method, and by the concentrated dip method. The solution soaking method required a 24-hour treatment in solutions containing from 40 to 80 mg active chemical in one liter of water. The solution soaking method has been largely replaced by the talk powder method because of the work and time involved in preparing solutions. The concentrated dip method required concentration from 10 to 20 mg of active chemical per ml of solution (20 to 30 times stronger than used for solution soaking). In preparing concentrations of IBA or NAA in this range, 95 per cent ethyl alcohol must be used to dissolve the chemicals since they are not water soluble."

It is apparent by 1959, that the quick dip method had become a preferred method for treating woody plant cuttings. In the 1959 Volume 9 of the Proceedings there were nine papers discussing the use of the quick dip method including a paper by Charles Hess comparing the quick dip with the powder method (Hess, 1959).

In 1959, the first edition of the reference textbook "Plant Propagation: Principles and Practices" by Hudson Hartmann and Dale Kester was published. It had detailed information on auxin use for cutting propagation. It is interesting to note the understanding of plant hormones at that time. They state that "There are several groups of substances considered plant hormones. These are (a) auxin, (b) traumatic acid, (c) caulines, and (e) vitamins. Auxin appears to act as a sort of "master hormone."

Auxin application methods

Selected auxin delivery systems are outlined in Table 1. The two methods that are most commonly used in greenhouse and nursery propagation are the talc and quick dip methods (Davies et al., 2018). For the talc application, the basal end of the cutting(s) are placed into the talc for a brief period until the powder adheres to the cutting. The available talc preparations come in a range of concentrations that are predetermined by the manufacturer. It is advisable to remove a small portion from the original container for daily use rather than dipping directly into the larger container. A dibble hole in the substrate may prevent talc loss when inserting the cuttings.

The quick dip method is often preferred by larger operations because it tends to give more uniform results as well as the flexibility to control the auxin concentration. Auxin solutions used for quick dips are available as concentrated stock solutions. The concentrated stocks are diluted to achieve the appropriate concentration to treat cuttings. Concentrated stock solutions use a solvent to keep the auxin in solution. Stock solutions for K-IBA are prepared in water. The quick dip application involves dipping cutting bundles into the solution for three to five seconds. The solution is rapidly absorbed into most cuttings prior to and after sticking. An alternative is to include a gel (carboxymethyl cellulose) with the auxin solution to increase the time auxin is in contact with the cutting base (Dip'N Grow, 2024). There are also premade preparations that include this gel and IBA at 3,000 ppm.

With an increasing emphasis on efficiency in cutting propagation, there has been renewed interest in alternative methods for delivering auxin. These include foliar auxin sprays and total cutting immersion. Foliar K-IBA sprays have been shown to be an efficient, cost-effective, labor-saving delivery method for treating cuttings (Dranm, 2007; Martindell, 2019). K-IBA in an aqueous solution is sprayed on cuttings following sticking. It is also a useful way to treat cuttings after being stuck by a robot. An entire day's sticking can be treated with auxin in a backpack sprayer.

Total immersion involves submersing a batch of cuttings for a short period of time. Total immersion can be used to rehydrate cuttings with or without a wetting agent, treat with a biopesticide (like BotaniGard or SuffOil-X), or as an auxin delivery system. It is also possible to combine these treatments before sticking cuttings. For example, cuttings can be first submerged in a wetting agent (like Uptake) for rehydration plus SuffOil-X for insect control followed by immersion for one to three minutes in K-IBA.

There is also interest in combining either wetting agents or growth regulating substances along with K-IBA during spray applications to cuttings. To date with a limited species list, there is little evidence that including a wetting agent to a K-IBA spray improves rooting (Bowden et al., 2022; Geneve, 2023). There are also limited studies investigating growth regulator combinations and root formation in cuttings. In a study using angelonia cuttings, Bonzi was combined with K-IBA to investigate whether this combination would have an impact on rooting and a carry-over effect on plant height or branching post-rooting (Baloh et al., 2022). The combination showed a slight improvement in rooting but there was no impact of plant growth post-rooting. Future studies will determine if batch spray applications combining growth regulating compounds have a positive impact on cutting production.

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