Novel Methods of Applying Rooting Hormones in Cutting Propagation©

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BACKGROUND

Auxins as root-promoting chemicals (often commonly referred to as "rooting hormones") are most frequently applied to stem cuttings using a basal quick-dip in a concentrated solution, a powder (talc) application, or an extended basal soak in a dilute solution. Liquid formulations offer the advantages of flexibility by allowing dilutions to various final concentrations and uniform application to the base of the cuttings, while powder formulations require no additional preparation prior to use. Registered products in the United States include IBA (indolebutyric acid) and IBA/NAA (indolebutyric acid / naphthaleneacetic acid) combinations in the form of liquid concentrates, water-soluble tablets, and powders.

The basal quick-dip is the most popular method of auxin application in nursery propagation. Historically, commercial propagators have found quick-dips to be the quickest and most economical method as a limited amount of material can be applied directly to the basal region of the cuttings where adventitious root initiation and development will take place. The concentration of the auxin formulation can be modified to produce optimal rooting of the cuttings. Powders are the next most common method of applying auxins, but propagators are limited to certain concentrations. Some propagators may subject cuttings to an extended basal soak, which typically requires the bundling of cuttings along with additional time and space for the treatment process. Other methods of auxin application that have been investigated include forced entry of auxins into cuttings using a vacuum, insertion of auxin-treated objects (such as toothpicks) into the cutting base, immersion of cuttings in an auxin solution for varying lengths of time, and treatment with auxins in a lanolin base (Blazich, 1988). Some of these uncommon methods remain of interest in the history of cutting propagation, while others still find use under certain circumstances with specific crops.

One method of auxin application that has received limited investigation is a foliar spray application, although many other liquid plant growth regulators and pesticides are applied as a spray under production conditions. Another method that has not been investigated is application of auxin to stem cuttings via the rooting substrate (medium). Substrate containing auxin is used in other methods of propagation, particularly tissue culture.

REVIEW OF LITERATURE

Foliar Application of Auxin. In the late 1930s, physiologists at the U.S. Department of Agriculture recommended applying a fine foliar spray of auxin as an aqueous solution or an emulsion to the tops of cuttings of herbaceous perennials after they had been inserted into the rooting substrate (Hildreth and Mitchell, 1939). Spray treatment with an emulsion of IBA resulted in a greater number of roots on cuttings in comparison to untreated cuttings of bean, marigold, coleus, marguerite,

and carnation. A similar concentration of IAA or NAA was also effective on cuttings of carnation and coleus. Compared to a dilute basal soak, the spraying technique was reported to be easier to apply, was less likely to cause injury to cuttings, and permitted repeat applications without disturbing cuttings. However, the spray technique was noted to be somewhat less economical and no more effective than some of the dilute soaking treatments.

Kroin (1992) reported that certain cuttings could be rooted by spray treatment of cuttings. The "spray drip down method" was recommended for treating cuttings of azalea (*Rhododendron*), carnation (*Dianthus*), chrysanthemum, *Begonia*, *Dieffenbachia*, heath (*Erica*), *Hibiscus*, and various herbaceous species using IBA at concentrations generally lower than those recommended for a basal quick-dip.

Stoutemyer and O'Rourke (1945) sprayed plants of *Pachysandra* and 12 species of woody ornamentals (including *Buxus*, *Cornus*, *Ilex*, *Ligustrum*, *Rhododendron*, and *Weigela*) with 2,4,5-trichlorophenoxyacetic acid or its sodium salt prior to taking cuttings and determined that the rooting responses were essentially the same as for cuttings treated by conventional methods.

Anuradha (1993) found that coffee cuttings rooted better using a foliar dip in IBA in comparison to a basal dip. Van Bragt, et al. (1976) determined that cuttings of *Berberis*, *Cotoneaster*, *Lavandula*, *Prunus*, *Pyracantha*, and *Viburnum* rooted better when immersed in a solution of auxin for 2 min in comparison to a basal dip in an auxin powder. McGuire (1967) compared terminal dips of 1% IBA and basal dips of 0.2% IBA on cuttings of *Pachysandra* and 11 woody ornamental cultivars (including *Acer*, *Euonymus*, *Juniperus*, *Picea*, *Rhododendron*, and *Viburnum* cultivars). Rooting was significantly greater using the terminal application on three cultivars, lower on one, and not significantly different on the other seven.

Substrate Application of Auxin. In tissue culture propagation, microcuttings of some species are rooted in a Stage III (root induction) medium containing specific types and concentrations of organic and inorganic chemicals, often including at least one type of auxin (Kyte, 1987). Microcuttings to be rooted in tissue culture can receive either a short (acute) or prolonged (chronic) application of auxin, depending upon the requirements of the particular species (George, 1993).

Stabilized organic substrate that has been treated with auxin has been used to successfully root tissue culture microcuttings *in vivo*. In a series of experiments, Malavasi and Ranieri (1987) transferred microcuttings of a clonal peach rootstock into small plugs composed of peat and a proprietary binder, having pretreated the plugs with 0.1 ml of IAA, IBA, or NAA solutions at 10 to 500 ppm. Although auxin was not essential for rooting, root formation was increased using 25 to 100 ppm auxin in comparison to untreated controls. Treatment of microcuttings with an auxin dip was also examined, but was not investigated further because it seemed to demand more labor as compared to pretreating the plugs with auxin.

Auxin-treated substrate has also been used for layering. Wells (1986) described the air-layering process utilized at Monrovia Nursery Company for propagating *Mahonia aquifolium* 'Compacta' in which sphagnum moss was treated by soaking in a dilute solution of auxin (60 ppm IBA) and used in creation of the air layer.

SUMMARY OF RESEARCH

Trials were recently conducted at Auburn University to evaluate two alternative methods of applying auxin to stem cuttings of selected ornamental crops: (1) cut-

tings were sprayed to the drip point with an auxin solution after inserting cuttings into the rooting substrate; and (2) auxin was applied to the base of cuttings by inserting cuttings into a stabilized organic substrate (plugs) that had been pretreated with auxin. Results were compared to a conventional basal quick-dip.

In trials with landscape ornamentals (Blythe et al., 2003a), cuttings of *Ajania pacifica* (syn. *Chrysanthemum pacificum*) sprayed with Dip 'N Grow® at 50 + 25 ppm IBA + NAA or 0 to 50 ppm K-IBA showed similar root development compared with a basal quick-dip; 10 ppm K-IBA produced greater total root length. Sprayed and quick-dipped cuttings of *Forsythia ×intermedia* 'Lynwood' (syn. 'Lynwood Gold') were similar in root development, but cuttings sprayed with Dip 'N Grow® at 0 + 0 to 10 + 5 ppm IBA + NAA exhibited greater shoot growth 80 days after insertion compared with quick-dipped cuttings. Root and shoot development were similar or lower with cuttings of *Abelia ×grandiflora*, *Hydrangea paniculata*, and *Lagerstroemia* 'Natchez' sprayed with auxin compared to a basal quick-dip.

In trials with cuttings of tropical ornamentals, number of roots and root length on cuttings of *Aglaonema modestum* sprayed with auxin were similar or less than with a basal quick-dip. Cuttings of *Gardenia jasminoides* (syn. *G. augusta*) 'Radicans' exhibited the greatest rooting responses with the basal quick-dip and with IBA + NAA spray treatments at rates ≥ 25 ppm + 12.5 ppm compared with untreated cuttings. Rooting responses with cuttings of *Ficus benjamina* and *Hedera helix* 'Ivalace' receiving spray treatments were similar or less than cuttings receiving no treatment or a basal quick-dip.

In five trials using single-node cuttings of *Rosa* 'Red Cascade', cuttings sprayed with 0 to 50 ppm IBA + 25 ppm NAA, 0 to 50 ppm K-IBA, or 0 to 50 ppm K-NAA exhibited rooting and shoot growth responses similar to or less than control cuttings; exceptions being cuttings sprayed with 0 to 0.5 ppm K-NAA which exhibited greater shoot length. Addition of 1.0 ppm Kinetic organosilicone surfactant to spray treatments increased root and shoot development. Repeated sprays (daily up to seven consecutive days) had no or negative effects on root and shoot development.

Initial trials with single-node cuttings of *H. helix* and *Rosa* 'Red Cascade' inserted into auxin-treated plugs suggested that a low rate of auxin (below 100 ppm) could provide results similar to cuttings receiving a basal quick-dip, while higher rates were detrimental (Blythe et al., 2003b).

In subsequent trials, cuttings of 11 woody species were inserted into plugs that had been soaked in water, 15 to 75 ppm K-IBA, or 15 + 7.5 to 60 + 30 ppm K-IBA + K-NAA. Rooting responses for cuttings rooted in auxin-treated plugs were similar to or greater than with a basal quick-dip; lesser results were obtained in a few cases, primarily with K-IBA + K-NAA. Initial shoot development responses for cuttings rooted in plugs treated with K-IBA were similar to cuttings receiving a basal quick-dip in K-IBA, while cuttings rooted in plugs treated with K-IBA + K-NAA exhibited similar or lesser results compared to a basal quick-dip in K-IBA + K-NAA.

CONCLUSIONS

Results from these recent trials indicate that the effectiveness of the foliar spray application method depends on the species, auxin formulation, auxin concentration, and use of surfactant. Other factors could also potentially affect response, including type of cutting, size of cutting, leaf area, age of tissue, and environmental conditions during propagation.

Cuttings of some species appear to respond better to a foliar spray application of auxin compared to untreated cuttings, while responding to a similar or lesser extent compared with cuttings receiving a basal quick-dip. The decision by a propagator to use the foliar spray method for applying auxin to cuttings in a commercial setting should be based on trials with the specific species and types of cutting being grown, with trials conducted under the standard production conditions utilized in the propagation process, and results compared with current methods of application.

Results from our trials also indicate that auxin can be effectively applied to stem cuttings via a stabilized organic rooting substrate. Positive response to the substrate-treated auxin method appeared to be more consistent over a range of species than the aforementioned foliar spray application method. Results suggest that exposure of cuttings to low levels of auxin in the substrate provided auxin over a longer duration than did a basal quick-dip in a more concentrated solution.

With selection of an appropriate auxin formulation and rate, application of auxin to stem cuttings by way of the substrate can produce results comparable to or, in some cases, greater than with cuttings treated using a basal-quick dip. It can be noted that, while the basal-quick dip treatments were applied using a common rate (e.g., 1000 ppm K-IBA), a different rate could have produced greater or lesser results for comparison with the substrate-applied auxin treatments. While positive responses were more common with the use of IBA (as K-IBA), there may be some species that will respond better to a combination of IBA and NAA, as is the case with the conventional basal quick-dip method of auxin application.

The diversity of horticultural crops propagated vegetatively throughout the world calls for diversity in the methods utilized in their propagation, often requiring the selection of both established and new techniques based upon the species (or cultivars) to be propagated and available resources. Changing conditions in the business environment of nurseries also call for continuing reassessment of modern nursery processes in order to maintain efficient and profitable operations. The alternative methods of auxin application investigated in this report could, in at least some part, assist propagators in obtaining these objectives. Safety, convenience, and potential costs or savings should be taken into account when considering a change in methods of application, along with sound horticultural judgment.

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Controlling the Propagation Environment with a Computer©

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A computer can help you with many aspects of propagation, including accuracy, trouble-shooting or fine-tuning efficiency. I will be talking to you about controlling the propagation environment with a computer.

First I would like to tell you about where I work and then how we use our computer. Some interest was expressed in explaining how we use Remay and later I would like to spend some time to share our experiences.

The family operation grows and sells ornamental landscape plants as well as florist azaleas on over 250 acres of land and in over 70 acres of greenhouses in Woodburn, Oregon. Millions and millions of cuttings are propagated in a 4-acre, Dutch-style propagation house. The computer in the propagation house is connected to controllers that manipulate the vents, heating, shade curtains, energy curtains, and horizontal air flow, as well as many other components. It is connected to the traveling booms for misting, the overhead misting, and the ebb and flow system. The computer also has the ability to control the pH and EC in the ebb and flow reservoir tanks.

The whole system works with many sensors and controllers; it automatically makes adjustments based on the computer settings.

The amount of water being misted on the cuttings is critical in successful propagation. The computer controls the irrigation with a light sensor; it can be set to run at particular times or intervals. When we start sticking, we set the computer to mist every 10 or 15 min during the day. It automatically switches to our night setting, which is every 3 h at night during the summer, just to make sure the soft cuttings are standing in the morning. Then we cover our cuttings with Remay and change the settings. We set the computer to accumulate light within a set time window (300 $W \cdot m^{-2} \cdot h^{-1}$ are the settings). So now the computer will start accumulating light starting at 30 min after dawn and will accumulate light until it reaches 300 $W \cdot m^{-2} \cdot h^{-1}$. It will send water every time it reaches that setting until it reaches the end of the windowed time, which is 30 min before dusk. With this computer setting, the frequency of the mist will be automatically adjusted to mist less when clouds are present and more when we have bright skies. We are misting more in the middle of the day than in the mornings or evenings. The frequency of mist will be changed automatically. If a grower uses a time clock, the grower usually will not adjust the clock several times a day and will naturally set the mist for more than was required.