Use of Root-Promoting Products for Vegetative Propagation of Nursery Crops

Naturally occurring and synthetic plant growth regulators (auxins) are used by commercial nursery growers to initiate root formation on vegetative cuttings (Figure 1). Auxins increase rooting percentage and roots per cutting, encourage root development and uniformity, and stimulate rooting of difficult-to-root species. Commonly used auxins include indole-3-acetic acid (IAA), indole-3-butyric acid (IBA), and 1-naphthaleneacetic acid (NAA). Over the years, growers have used the potassium (K) salt of IBA (K-IBA) to prepare water-based IBA solutions. Technical grade K-IBA is not registered for this use, but other IBA formulations are available, including water-soluble salts, diluted concentrates, powders, and gels (Table 1).

Figure 1. Root-promoting compounds are recommended for the commercial cutting propagation of many plant species.

Product choice depends on the crop, required rate, number of cuttings to be treated, cost, and grower preference. Some prefer alcohol-based solutions, which disinfect and enhance the plant's ability to absorb solution. Others choose water-based solutions when IBA alone is recommended and alcohol evaporation is to be avoided. Powdered IBA may be a good choice for those who lack time or equipment to prepare auxin solutions, or when high concentrations are needed. For optimal results across a variety of crops, growers can use multiple forms of auxin.

Water-soluble salts can be used at the same or slightly lower concentrations as technical grade K-IBA. A lower concentration can be used when substituting a solution prepared from an IBA+NAA concentrate because NAA is more potent. To prevent damage, growers should test the new concentration on a small sample of stem cuttings, being careful not to exceed the recommended rate. Too much auxin can promote callusing and may hinder rooting. Burn associated with alcohol-based solutions is typically due to an excessive rate of IBA + NAA or poor-quality cuttings, rather than the alcohol. If powder is used in place of K-IBA, a similar or higher concentration of IBA may be needed. IBA may not be absorbed as readily from the powder even though it remains in contact with the base of the cutting longer. Preliminary testing on specific crops is recommended when switching from technical grade K-IBA to an IBA+NAA concentrate, water-soluble salt, or IBA powder.

Use sterile water to mix IBA solutions. Well water and pond water can harbor fungi and bacteria that feed on hormone solutions. Municipal tap water may contain chlorine or a pH buffer that could unintentionally harm crops or change hormone solution efficacy. Purified, distilled, or reverse osmosis (R.O.) water is ideal. It is available at drugstores along with isopropyl alcohol for alcohol-based dilutions. Ethanol for alcohol-based solutions can be purchased from chemical supply companies. IBA solutions should be stored in a dark bottle and refrigerated after preparation. Hormones are photosensitive, and fungi/bacteria are less active in cool, dark locations.

Make safety a priority when working with auxin-containing products. Labels specify personal protective equipment to be worn by applicators and other handlers, which includes long-sleeved shirts, long pants, shoes, and socks. Water- or chemical-resistant gloves may also be required, depending on the product.

IBA Formulations

IBA (technical grade; acid form): In acid form, IBA is insoluble in water. It must be dissolved in an organic solvent such as alcohol or chemically modified to become water-soluble. Technical grade IBA is *not* registered for use by growers.

Water-soluble IBA salts: IBA that has been formulated to dissolve in water. A pH buffer is also an ingredient in the commercial products listed in Table 1.

Liquid concentrates: Alcohol-based formulations that can be diluted to produce the desired concentration of IBA. Commercial products registered in the United States contain both IBA and NAA.

IBA powders: Dry talc products in which IBA has been chemically affixed to talc particles. Registered, commercial products are available only in certain concentrations.

Gels: Viscous auxin solutions prepared with a thickening agent, which is typically derived from cellulose.

K-IBA: The potassium (K) salt of IBA, which is soluble in water. Technical grade K-IBA is *not* registered for use by growers.

How to Use Liquid Formulations

Basal Quick-Dip Method

Dip the basal part of the vegetative cutting, usually ½ to 2 inches, into a solution for 1 to 5 seconds (Figure 2) before inserting into the rooting medium (Figure 3).

Advantages: Fast, uniform results; high success rate.

Disadvantages: Preparation requires experience and care; solution concentration may change over time due to alcohol evaporation or the addition of water (Blythe et al., 2007).

Foliar Spray Method

After inserting cuttings into the rooting medium, spray to the point of runoff with a dilute auxin solution.

Table 1. Root-promoting products [a] registered by the EPA for commercial use with corresponding percentages of IBA, NAA, and where they can be purchased.[b–g]

Commercial product	IBA (%)	NAA (%)
Powder (talc) formulations (IBA)		
Hormex[b] Rooting Powder No. 1	0.1	—
Hormex Rooting Powder No. 3	0.3	—
Hormex Rooting Powder No. 8	0.8	—
Hormex Rooting Powder No. 16	1.6	—
Hormex Rooting Powder No. 30	3.0	—
Hormex Rooting Powder No. 45	4.5	—
Hormodin[c] Powder 1	0.1	—
Hormodin Powder 2	0.3	—
Hormodin Powder 3	0.8	—
Rhizopon[d] AA #1	0.1	—
Rhizopon AA #2	0.3	—
Rhizopon AA #3	0.8	—
Liquid concentrates (IBA + NAA)		
Dip'N Grow[e]	1.0	0.5
Wood's® Rooting Compound[f]	1.03	0.66
Water-soluble salts (IBA)		
Hortus IBA Water Soluble Salts[d]	20	—
Rhizopon[d] AA Tablets	20	—
Gels (IBA)		
Clonex[g] Rooting Compound Gel	0.3	—

[a] As of publication date all were in compliance with the Federal Insecticide, Fungicide, and Rodenticide Act (http://iaspub.epa.gov/apex/pesticides/f?p=PPLS:1). See page 4 for a list of suppliers.

Advantages: Less time and expense because many cuttings can be treated at once. Lower concentrations of auxin are needed compared to a basal dip.

Disadvantages: Concentrations must be carefully determined to prevent auxin from inhibiting growth from lateral buds (Blythe et al., 2007).

Dilute Soak Method

Place the basal portion of the cutting into dilute auxin solution for 2 to 48 hours at 68° F in a shaded or reduced light location before inserting into rooting medium.

Advantages: Extended exposure allows greater uptake.

Disadvantages: More time and space required for treating cuttings; solution uptake will vary with environmental conditions (Blythe et al., 2007).

Figure 2. Dip the basal portion of the vegetative cutting into auxin solution for a few seconds.

Figure 3. Inserting the treated cutting into growing media.

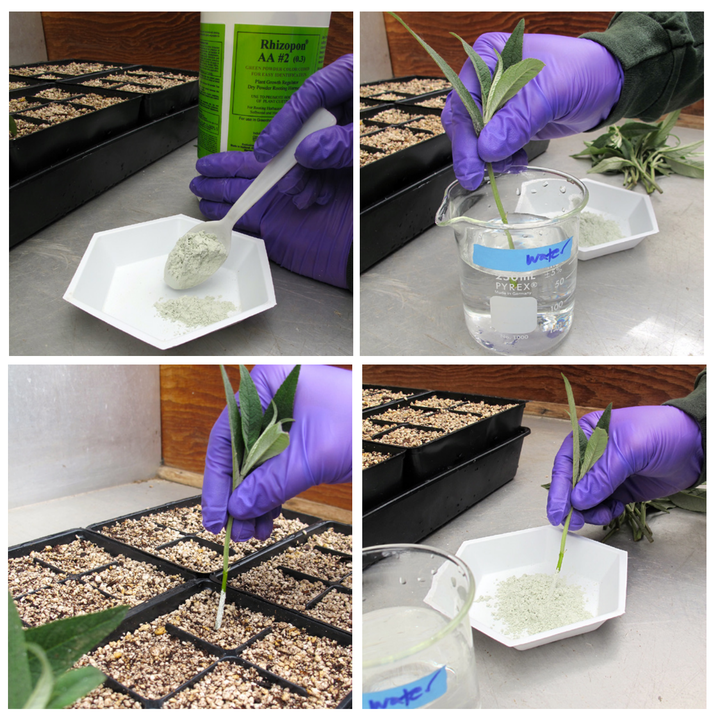

Figure 4. Propagation using talc powder-based formulations (clockwise from top left): measure powder into a sterile container; premoisten the cutting; coat the base of the cutting in the powder; dibble a hole in the media and insert the cutting.

How to Use IBA powders

Powder (Talc) Application Method

1. Premoisten the cutting base for better adhesion (Figure 4).
2. Dip the cutting base into the powder. Lightly tap to remove excess.
3. Dibble a hole in the substrate.
4. Insert the cutting into the rooting medium.

Advantages: Requires no dilution, easy to store, and application is visible.

Disadvantages: Higher cost than liquid, powder loss as cutting is inserted into the substrate, and less uniformity.

How to Use Gels

Gel Application Method

1. Prepare a gel using an auxin solution and a thickening agent (see Preparing Gels, page 4) or use a commercially available gel formulation.
2. Dip the basal end of the cutting into the gel at the desired depth, remove, and then insert the cutting into the rooting medium.

Advantages: Fast; uniform results; less chance of spillage than with a liquid solution; can use lower rates because cuttings are exposed longer.

Disadvantages: A limited number of concentrations are available as commercial formulations. Preparing gels takes time.

Preparing IBA+NAA Solutions Using Liquid Concentrates

Examples: Dip'N Grow, Wood's Rooting Compound

1. Determine desired concentration and desired volume (container size; V_2) of the final solution.
2. Determine volume of concentrate using the formula:

$$\frac{C_2 \times V_2}{C_1} = V_1$$

C_2 = final concentration of IBA to be applied
V_2 = final volume of diluted product (container size)
C_1 = concentration of IBA in the concentrate
V_1 = volume of concentrate needed

3. Dilute to the final volume using a 50% alcohol solution. When preparing solutions for a basal quick-dip, dilute with both alcohol and water to prevent auxin from precipitating (crystallizing) out of solution. A final solution containing 50% alcohol is common. Dilution with water alone is fine for solutions containing low concentrations of auxin, such as those used for foliar spray application or dilute basal soak.

Equivalencies

parts per million (ppm)=milligrams (mg) / liter (L)
1% concentration=10,000 ppm   1 L=1,000 ml

Example: Butterflybush (*Buddleja davidii*) requires 3,000 ppm IBA solution for cuttings taken in June, July, or August (Dirr and Heuser, Jr., 2006).

Dip'N Grow: 1.0% IBA (10,000 ppm), 0.5% NAA (5,000 ppm) (Table 1). Final desired volume: 0.5 L

$$\frac{3{,}000 \text{ ppm} \times 0.5 \text{ L}}{10{,}000 \text{ ppm}} = 0.15 \text{ L}$$

Measure 0.15 L (150 ml) of concentrate into a container and fill the remaining volume (0.35 L in this case) with a 50% distilled water: 50% isopropyl alcohol mixture until you reach the final desired volume (0.5 L).

Preparing IBA Solutions Using Water-Soluble Salts

Example: Hortus IBA Water Soluble Salts (which form K-IBA when dissolved in water)

1. Determine the desired concentration (ppm) and volume of the final solution.
2. Using Table 2, find the grams of active ingredient (ai) needed in the final solution based on the desired concentration (ppm) and final volume (from Step 1).
3. Find the percentage of a.i. on the product label and divide by 100% to obtain the (decimal) proportion.
4. Divide the value in Step 2 by the proportion of a.i. in Step 3 to determine grams of product needed.
5. Add water to obtain the final volume and mix thoroughly until the product is dissolved completely (Figure 5).

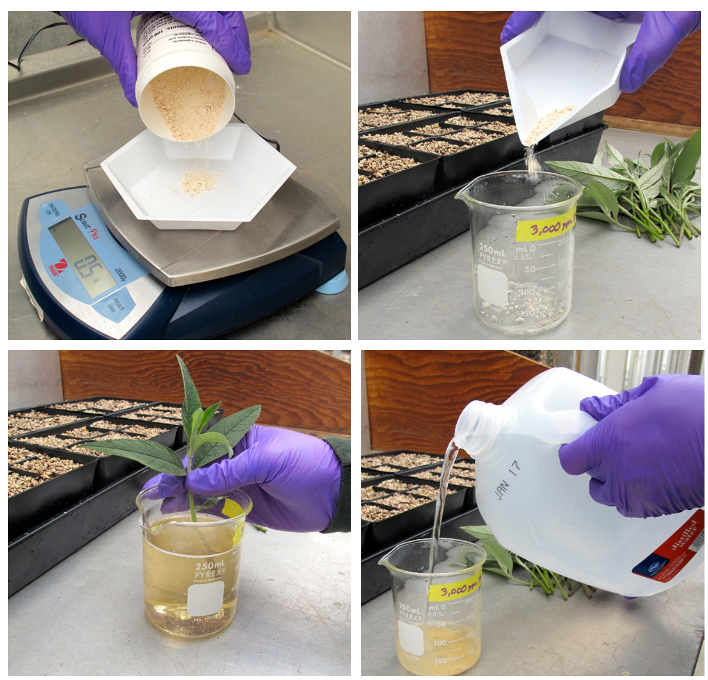

Figure 5. Steps for using water-soluble salts (clockwise from top left): measure grams needed per steps above; pour salts into final container; add distilled water until final volume is reached; dip cutting into solution.

Table 2. Grams of pure IBA (ai) needed to prepare desired final volume of solution with a desired concentration in ppm.

	Final volume of solution (ml)						
Conc. (ppm)	100	300	500	1,000	2,000	3,000	4,000
	Grams of pure IBA (ai)						
100	0.01	0.03	0.05	0.1	0.2	0.3	0.4
200	0.02	0.06	0.1	0.2	0.4	0.6	0.8
500	0.05	0.15	0.25	0.5	1.0	1.5	2.0
1,000	0.1	0.3	0.5	1.0	2.0	3.0	4.0
2,000	0.2	0.6	1.0	2.0	4.0	6.0	8.0
3,000	0.3	0.9	1.5	3.0	6.0	9.0	12.0
5,000	0.5	1.5	2.5	5.0	10.0	15.0	20.0
10,000	1.0	3.0	5.0	10.0	20.0	30.0	40.0
20,000	2.0	6.0	10.0	20.0	40.0	60.0	80.0

Example: Butterflybush (*Buddleja davidii*) requires 3,000 ppm IBA solution for cuttings taken in June, July, or August (Dirr and Heuser, Jr., 2006).

Hortus IBA Water Soluble Salts: 20% IBA (200,000 ppm) (Table 1)

1. Desired concentration = 3,000 ppm, final volume = 0.5 L or 500 ml
2. Grams of active ingredient needed in the final solution (Table 2) = 1.5 g
3. Percentage a.i. on label = 20%, divided by 100% to get decimal: 20/100 = 0.20
4. Divide step 2 by step 3 to get grams of product needed: 1.5 g/0.20 = 7.5 g
5. Place 7.5 g of product into a 1 L container and fill with water to the 0.5 L mark. Mix until product is dissolved.

Preparing Your Own Gels

1. Prepare an auxin solution to the desired final concentration and volume using water-soluble salts or an alcohol-based liquid concentrate.
2. Weigh the required amount of sodium carboxymethyl cellulose (NaCMC; also known as sodium cellulose glycolate, SCG). Research from Auburn University (Blythe and Sibley, 2010) showed that adhesion of solutions to bases of vegetative cuttings is maximized using 13.5 grams of NaCMC per liter of solution; however, users can determine preferred viscosity.
3. Slowly add NaCMC to the solution, stirring constantly.
4. Cover the solution and leave overnight to allow the NaCMC to dissolve completely.

NaCMC is available from chemical suppliers in food grade and commercial grades and as the product Dip-Gel from Dip'N Grow (Clackamas, Ore.). Some states, such as California and Washington, require agricultural adjuvants to be registered before they can be sold.

Suppliers

Visit these websites for more information on products listed in Table 1.

[b] http://www.hormex.com
[c] http://www.ohp.com/Products/hormodin.php
[d] http://www.rooting-hormones.com
[e] http://www.dipngrow.com
[f] http://earthscienceproducts.com/products/woods-rooting-compount.html
[g] http://hydrodynamicsintl.com/clonexmain.htm

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