How to Improve Cuttings Propagation Using Water-Based Indole-3-Butyric Acid Rooting Solutions©

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INTRODUCTION

The present studies were done to guide growers on successful cutting propagation from cuttings using water-based Indole-3-butyric acid (IBA) rooting solutions. The following four studies: (1) the time of foliar treatment after sticking, (2) the effect of alcohol or wetting agents in the solution, (3) the effect of cold temperature at time of treatment, and (4) the use of basal long-soak method on cuttings which are seasonably difficult to root. The present studies used two foliar and one basal method to apply aqueous IBA rooting solutions. Foliar application is only done to leafy cuttings taken during the growing season.

HORMONE APPLICATION METHODS

Spray Drip Down (SDD) Method. In this method:

- Cuttings are inserted into the propagation medium.
- Cuttings are hydrated and misted as required.
- Misters are turned off.
- The aqueous IBA rooting solution is sprayed onto the leaves until the liquid drips down with solution on both the top and bottom of the cuttings.
- Misting is resumed after the solution dries on the leaves or after about 45 min and misting is done as required.

Total Immerse (TI) Method. In this method:

- Leafy cuttings are totally immersed in the aqueous IBA rooting solution for about 5 sec.
- The cuttings are drained and kept hydrated until sticking.
- Cuttings are inserted into the propagation medium.
- Misting is done as required.

Basal Long-Soak (BLS) Method. In this method:

- Aqueous IBA rooting solutions are made and put into a tray with hormone solution about an inch deep.
- The basal ends of cuttings are immersed in the solution for 24–48 h.
- Cuttings are inserted into the propagation medium.
- Misting is done as required.

Questions to Be Answered

Foliar Application. The first study addresses treatment of cuttings soon after sticking with cuttings treated 0 (at sticking) 3, 5, or 7 days after sticking. When using the SSD method growers usually stick during the same day. After the production staff leaves the propagation area one person does the treatment. The question asked is what happens if the cuttings are not treated the same day?

Total Immerse Method. The second study addresses the inclusion of alcohol or wetting agent in the hormone solution. Two questions are addressed: (1) What happens to the cuttings, using the SSD method, if the IBA rooting solution is made with alcohol and does the alcohol cause toxicity? (2) What happens to the cuttings, using the SSD method, if the aqueous IBA solution includes a wetting agent and does the cutting better absorb the solution?

Basal Long-Soak Method. The third study addresses treatment of cuttings at cold (45 °F) compared to warm (78 °F) temperatures. The question asked is what happens when propagation, using the SSD method, is done in a cold versus warm propagation area?

Foliar Versus Basal Long-Soak Application with Difficult-to-Root Cuttings. The fourth study addresses treatment of cuttings with an aqueous IBA solution (at a moderate concentration) using TI method compared to a low concentration BLS- treatment method. The question asked is can cuttings be successfully rooted at a time of the year when they are normally considered difficult to root? Can cuttings which are difficult to root by other methods be better treated?

RESEARCH STUDIES

Trial 1. This study compares foliar treatment of cuttings at time of sticking (Day 1) with a one-time treatment at either 3, 5, or 7 days after sticking.

Foliar applied aqueous IBA rooting solutions are used to propagate annual, perennial, and woody leafy cuttings during the growing season. Growers often stick cuttings and foliar treat in sequence. Scheduling may require treatment done at a later time. The current study compared untreated (control) cuttings with treated cuttings using a single aqueous IBA rooting solution treatment at time of sticking (Day 1), versus Day 3, Day 5, or Day 7 after sticking.

Plant Material and Dates. Plant cuttings: *Begonia ludicra* "red wing"; leafy cuttings from actively growing plants; dates: 21 July–21 Aug. 2010 (duration 31 days).

Hormone Treatment. The aqueous IBA rooting solution used Hortus IBA Water Soluble Salts (Hortus USA. Source: Hummert International, 800-325-3055) dissolved in water to make a rooting solution at 100 ppm IBA.

Procedure.

- All cuttings were inserted into the propagation medium at the same time to eliminate sticking time solely being responsible for treatment effect.
- Foliar-treated cuttings had aqueous IBA rooting solutions applied by the SDD method.

Treatments included the following: untreated control cuttings, Day 0 (at time cuttings are inserted into the propagation medium), Day 3, Day 5, and Day 7.

Comparative Trials. Dr. Fred Davies performed plant physiology studies on *Ficus pumila* that included foliar application of aqueous IBA rooting solutions at time of sticking and a few days later. Studies included the plant physiology. Dr. Davies' results, as shown on the attached chart, are consistent with the present study. (Davies, 1978; Davies and Joiner, 1980; Davies et al., 1982; Davies, 1984).

Observations. In this study, and prior studies, foliar applied aqueous IBA rooting solutions were useful for the propagation of leafy cuttings during the growing season. Results from the aqueous IBA foliar treatment applied at time of sticking or later days is shown in Tables 1 and 2.

- In this study all foliar-treated cuttings had the highest number of roots and greater root mass compared with untreated control cuttings.
- Cuttings foliar treated near the time of sticking produced better rooting compared with untreated control cuttings.
- Rooting was diminished for cuttings foliar treated on the 3rd day after sticking but slightly increased on cuttings foliar treated on the 5th or 7th day.

Table 1. Foliar-applied IBA rooting solutions used to propagate plants from cuttings as affected by treating once at time of sticking, at 3, 5, or 7 days after sticking (duration 31 days).

Group treatment	Roots/cutting (avg. no.)	Root quality	Leaf observation	Results
		Untreated cuttings		
Untreated control	18.9	Good	New leaf shoots	Lower number of roots formed compared to all foliar treated cuttings
		Time of foliar treating cuttings		
At time of sticking	27.2 *	Good	New leaf shoots	Highest number of roots and root mass
Day 3 after sticking	20.7 *	Thin		Lowest number of roots and root mass
Day 5 after sticking	22.0 *	Thin		Lower number of roots and lower root mass compared with cuttings foliar treated at time of sticking. Higher number of roots and greater root mass
Day 7 after sticking	22.1 *	Thin	Original leaf loss. No leaf shoots.	compared with day 3 foliar treated cuttings.

*Treated cutting groups had higher number of roots and greater root mass compared with un-treated control cuttings.

Table 2. Foliar-applied IBA rooting solutions used to propagate plants from cuttings as affected by treating once at time of sticking and at several days after sticking. Comparison of present *Begonia ludicra* trial with *Ficus pumila* (Davies and Joiner, 1980).

	Begonia diera (present study) At 100ppm IBA		Juvenile at 1000 ppm IBA		Mature at 3000 ppm IBA		
Day Foliar Treated	Avg. no. roots/cutting (Day 31)	Root quality (Day 31)	Roots/cutting (avg. no.)	Root quality**	Day foliar treated	Roots/ cutting (avg. no.)	Root quality**
Untreated cuttings							
Untreated control	18.9	Good	0.8	Poor	Untreated control	1.5	Poor
Time of foliar treating cuttings							
At sticking	27.2	Good	11.9	Good	At sticking	13.3	Good
Day 3 after sticking	20.7	Poor	9.5	Good	Day 3 after sticking	13.1	Good
Day 5 after sticking	22.0	Poor	11	Good	Day 9 after sticking	8.6	Good
Day 7 after sticking	22.1	Poor	10.3	Good	Day 15 after sticking*	2.7	Poor

*Root quality note: "Application at Day 15 was beyond the "optimum application window," and there was a deterioration of percentage rooting, root numbers, root length and root quality." (Davies person. correspon.).

**Notation: "Root quality" was standardized between the two studies.

Trial 2. The current study compared untreated control cuttings with foliar-treated cuttings using aqueous IBA rooting solution (IBA dissolved in water only), aqueous IBA rooting solution (IBA dissolved in water only) with a wetting agent added, or IBA rooting solution with 20% isopropyl alcohol content.

Plant Material and Dates. *Ficus benjamina.* Leafy cuttings from the growing season. Dates: 9 Feb–3 March 2011 (duration: 22 days).

Procedure.

- All cuttings were inserted into the propagation medium.
- Foliar-treated cuttings had IBA rooting solutions applied by the SDD method as per group. (One-time foliar treated by the SDD method.)
- All cuttings had leaves water rinsed at 1-w h after treatment; this was done to assure there was no residual effect of the rooting solution remaining on the leaves.
- Trial groups:
  - Untreated control cuttings.
  - Rooting solution at 300 ppm IBA. Aqueous IBA rooting solution with wetting agent (Gordon's spreader sticker at ½ tsp per 5 gal).
  - IBA rooting solution with 20% isopropyl alcohol content (rooting solution at 300 ppm IBA dissolved in water was used to make a rooting solution and adjusted to 20% isopropyl alcohol).

Results. Results from IBA foliar treatment applied with and without wetting agent or alcohol (Table 3, Fig. 1)

In this study cuttings foliar treated with aqueous IBA rooting solutions with wetting agent had similar root formation compared with cuttings treated without the wetting agent.

In this study cuttings foliar treated with IBA rooting solution containing 20% alcohol had high death compared will all other trials. The small percent of rooted cuttings had low root numbers and mass.

Likely alcohol dehydrated the plant cells, thereby causing cutting death.

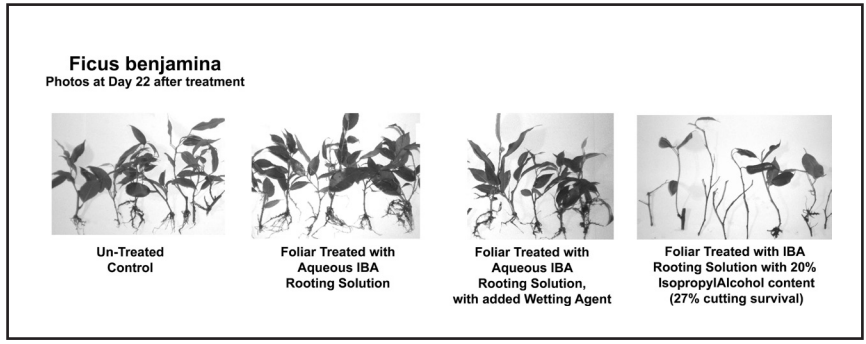

Figure 1. Effect of water wetting agent and alcohol on root initiation.

Table 3. Foliar applied IBA rooting solutions used to propagate plants from cuttings as affected by using an aqueous solution (water as solute only), an aqueous solution with wetting agent, or solution with 20% alcohol content (duration 22 days).

Treatment	Rooting (%)	roots/ cutting (avg. no.)	Roots on rooted cuttings (avg. no.)	Root quality	Leaf observation	Results
Untreated cuttings						
Untreated control	100	7.6	7.6	Good	New leaf shoots	Lower number of roots formed compared to water and water with wetting agent foliar treated cutting
Foliar treated cuttings						
Aqueous IBA rooting solution (water only)	100	9.4	9.4	Good	New leaf shoots	Highest number of roots and greater root mass
Aqueous IBA rooting solution with wetting agent	100	8.9	8.9	Good	New leaf shoots	Similar to an aqueous IBA rooting solution (water only)
IBA Rooting solution with 20% alcohol content	27	0.5	2.0	Thin	Most leaves lost and cutting fatality	Lowest number of roots and lower root mass

Trial 3. This study compares foliar treatment of cuttings at 78 °F (nominal "room temperature") with treatment at 45 °F ("cold temperature"). Cuttings are sometimes put into cold storage before sticking or may be propagated in cold winter houses and greenhouses. Cuttings shipped from off-shore plantations are also refrigerated in transit. The current study compared untreated control cuttings kept at nominal room temperature (78 °F) with cuttings kept and foliar treated at (78 °F) or at 45 °F.

Plant Material and Dates. Plant material: New Guinea impatiens *Impatiens* New Guinea Group (unnamed cultivar), leafy cuttings in the growing season; dates: 27 April–16 May 2011 (duration: 20 days).

Procedure. The aqueous IBA rooting solution used Hortus IBA Water Soluble Salts dissolved in water to make a rooting solution at 100 ppm IBA.

- All cuttings were put into cold storage at 45 °F for 24 h. This was done to ensure cold temperature at time of treatment was the solely limiting factor.

- All cuttings were inserted into the propagation medium.
- After 24 h cuttings lots used as untreated control cuttings and those to be foliar treated at 78 °F were brought up to 78 °F.
- Foliar-treated cuttings had one-time aqueous IBA rooting solutions applied by the SDD method.
- Trial groups:
  - Untreated control cuttings (cuttings kept at 78 °F).
  - Cuttings foliar treated at 78 °F had solutions applied at 78 °F.
  - Cuttings foliar treated at 45 °F had solutions applied at 45 °F. Cuttings were kept at 45 °F for an additional 1-1/2 h, and then brought to 78 °F.
  - At approximately1-1/2 h after treatment all lots had leaves water rinsed at 78 °F. This was done to assure there was no residual effect of the solution remaining on the leaves.

Results. Aqueous IBA foliar treatment applied at warm or cold temperatures (Table 4) (Fig. 2).

In the warm temperature at time of treatment study (cuttings foliar treated at 78 °F) had the highest number of roots and root mass when compared with untreated cuttings. They had much higher survival rates compared with cuttings treated at 45 °F.

In the cold temperature at time of treatment study cuttings had substantial death. Surviving cuttings had low root formation compared with untreated and 78 °F-treated cuttings.

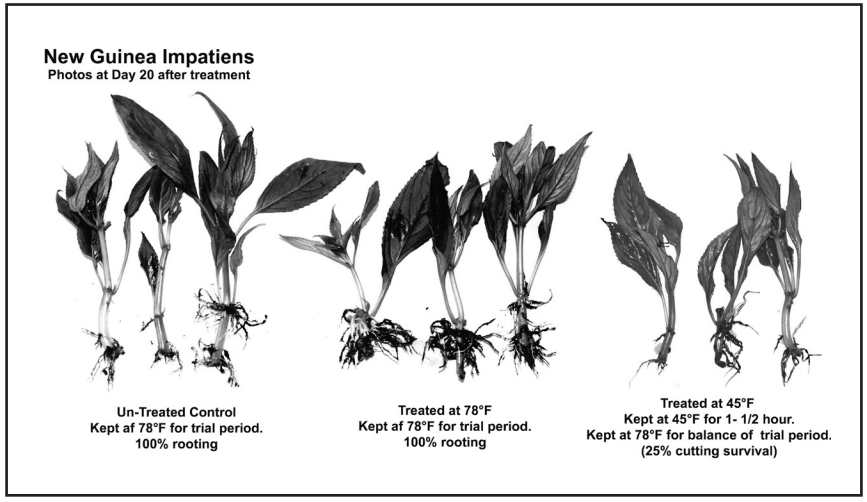

Figure 2. Effects of aqueous IBA foliar treatment applied at warm or cold temperatures on *Impatiens* New Guinea Group (unnamed cultivar).

Table 4. Foliar applied IBA rooting solutions used to propagate plants from cuttings as affected by treating at 78 °F or 45 °F (Day 20).

Treatment	Rooting (%)	Roots/ cutting (avg. no.)	Roots on rooted cuttings (avg. no.)	Root quality	Leaf observation	Results
Untreated cuttings						
Untreated control	100	12.5	12.5	Good	New leaf shoots	Lower number of roots formed compared to 78.8 °F treatments.
Foliar treated cuttings						
Treat at 78.8 °F	100	24.1	24.1	Good	New leaf shoots	Highest number of roots and greater root mass
Treat at 45.5 °F	25	2.4	10.6	Poor	Most leaves lost or cutting fatality	Lowest number of roots and lower root mass

Trial 4. This study compares springtime propagation of *Buxus sinica* (a difficult time to root) by the BLS method with the foliar TI method.

Successful cutting propagation often requires overcoming seasonal variation in rooting. This trial compared the TI and BLS methods on the rooting of cuttings. The current study used cuttings of *B. sinca* from the prior season growth taken in May.

Plant Material and Dates. Plant material: *B. sinica* 'Nana' leafy cuttings from the previous season growth, taken in North Carolina in May 2011. Dates: 20 May–22 July 2011 (duration: 63 days).

Procedure. The aqueous IBA rooting solution used Hortus IBA Water Soluble Salts dissolved in water to make a rooting solution at stated rates.

Trial Groups.

- Untreated control cuttings inserted in propagation medium.
- The TI method:
  - Cuttings immersed in the rooting solution (500 ppm IBA) for 5 sec.
  - Cuttings inserted in propagation medium after treatment.
- The BLS method:
  - Immerse cutting basal end 1 in. in the rooting solution (100 ppm IBA) for 24 h.
  - Cuttings inserted in propagation medium after treatment.

Results. This study compares springtime propagation by the BLS method with the foliar TI method (Table 5) (Fig. 3). On the basal-long-soak cuttings root formation started after 5 weeks. Up till about 7 weeks, all lots had no leaf loss. At 7 weeks root formation started on the TI treatment and control cuttings. After 7 weeks some leaves on the rooted cuttings started to decay possibly from high humidity. Unable to selectively reduce humidity, the cuttings were pulled on the 8th week.

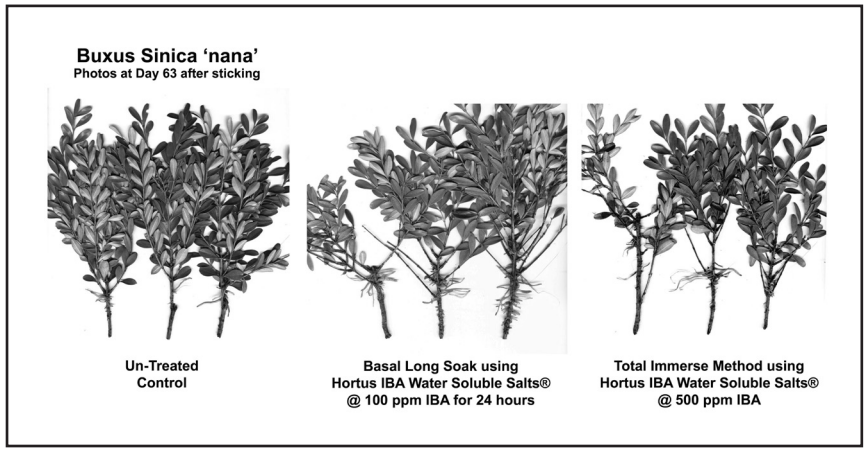

Figure 3. Propagation results of *Buxus sinica* 'Nana' cuttings comparing foliar application by the total immerse method with basal application by the basal-long-soak method

RECOMMENDATIONS

For Foliar Application.

- Apply aqueous IBA rooting solutions to propagate leafy cuttings during the growing season.
- Apply aqueous IBA rooting solutions to cuttings close to the time of sticking in the propagation medium because cuttings treated several days after sticking have reduced adventitious root formation.
- There is no benefit to adding a wetting agent to aqueous IBA foliar applied rooting solutions.
- Do not use alcohol in IBA rooting solutions. It contributes to cutting death.
- Do foliar apply aqueous IBA rooting solutions at nominal room temperatures (such as 78 °F).
- Do not foliar apply aqueous IBA rooting solutions to treat cuttings at a cold temperature (such as 45 °F).

For Hard-to-Root Cuttings. Woody plant cuttings from the prior year growth, taken in early spring may be difficult to root. Also many other types of plants there may be seasonal variations in the ability to form roots, even when applying rooting hormones.

- Do use the BLS method as an effective way to stimulate root formation on hard-to-root cutting even at non-ideal rooting times.

Table 5. Propagation results of cuttings of *Buxus sinica* 'Nana' taken in early May from prior year growth using aqueous IBA rooting solution treatments. Trials comparing foliar application by the total immerse method with basal application by the basal-long-soak method for 24 h (Day 63).

Treatment	Rooting (%)	Roots on rooted cuttings (avg. no.)	Root quality	Results
		Untreated cuttings		
Untreated control	40	4.0	Fair	Lowest number of roots on rooted cuttings. Lowest number of cutting rooted. No significant difference compared to foliar treated cuttings
		Foliar treated cuttings		
Aqueous IBA rooting solution using Total Immerse Method	80	5.25	Fair	Second highest number of roots on rooted cuttings. Same number of cutting rooted compared to Basal Long Soak Method No significant difference compared to un-treated control cuttings
		Basal treated cuttings		
Aqueous IBA rooting solution using Basal Long Soak Method for 24 h	80	14.9	Good	Highest number of roots. Same number of cutting rooted compared to Total Immerse Method.

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