Getting The Most Out Of Cuttings

Researchers at North Carolina State, Clemson and Michigan State Universities provide insight on handling cuttings from arrival to hardening in the first of this 2-part series.

By Roland Leatherwood, Amy Enfield and Roberto Lopez

Pictured are good examples of high-quality New Guinea impatiens cuttings. (Photos: Roland Leatherwood)

Increasingly, new annual varieties are released to growers as cuttings rather than seed. This assures consistency in final product and increased production but requires a different set of skills from growers than what is required with seed.

From 1994 to 2005, the wholesale value of cuttings imported by U.S. greenhouse growers increased 350 percent. In 2005, 495 million zonal geraniums, poinsettias and New Guinea impatiens sold in the United States had a wholesale value of $494 million. In this case, a single cutting represented $.99 in potential revenue. Understanding the environmental requirements of unrooted cuttings and how to handle them will help ensure successful rooting and a high-quality finished plant.

Part one of this series features cultural and environmental techniques that will ensure successful propagation. Next month's article will focus on how to prevent pathogens and disease and include information on light and temperature requirements for creating an ideal propagation environment

Before They Arrive

As a grower, your attention and efforts are most often, and appropriately, focused on the production cycle from the time cuttings arrive to the finish week. It is easy to forget that important components of producing finished plants should occur well before cuttings are stuck.

Storage Temperature Guidelines*

Storage Not Recommended	Tropical (55-65° F)	Temperate (35-50° F)
Bracteantha bracteata	*Angelonia angustifolia*	Achimenes hybrids
Campanula species	*Antirrhinum majus*	*Argyranthemum frutescens*
Fuschsia hybrids	*Begonia x hiemalis*	Calibrachoa hybrids
Helichrysum microphyllum, *H. petiolare* and *H. thianschanicum*	*Clerodendrum paniculatum*, *C. x speciosum*, *C. thomsoniae* and *C. ungandense*	*Chrysanthemum x morifolium*
Heliotropium arborescens	*Crossandra infundibuliformis*	*Dianthus caryophyllus* and *D. carthusianorum*
Lantana camara and *L. montevidensis*	Dahlia hybrids	Diascia hybrids
Lobelia erinus	*Euphorbia pulcherrima*	*Hatiora gaertneri*
Portulaca oleracea	*Evolvulus glomeratus*	Nemesia hybrids
Sutera cordata and Jamesbrittania hybrids	*Exacum affine*	*Osteospermum ecklonis*
	Hibiscus rosa-sinensis	Pelargonium species and hybrids
	Impatiens walleriana and *I. hawkeri*	*Petunia x hybrida*
	Ipomoea batatas	Plectranthus species
	Lysimachia congestiflora and *L. nummularia*	Rhododendron hybrids
	Pentas lanceolata	*Scaevola aemula*
	Sanvitalia procumbens	Solidago species
	Schlumbergera truncate and *S. x buckleyi*	*Verbena canadensis*, *V. x hybrida*, *V. rigida*, *V. tenera* and *V. tenuisecta*
	Solenostemon scutellarioides	
	Torenia fournieri	
	Tradescantia species	

* *From* Cutting Propagation: A Guide to Propagation and Producing Floriculture Crops. *1st ed. Dole & Gibson.*

Figure 1. In general, provide high relative humidity and the lowest temperature hardiness allows when storing cuttings. Shown here are the storage temperature guidelines for tropical and temperate species.

Prepare the propagation and handling areas by cleaning and disinfecting all the tools, surfaces and equipment. Check that the environmental controls in the propagation area are working properly. Verify there will be enough clean flats and pathogen-free substrate on hand. Lastly, make sure there will be enough help available when the cuttings arrive to finish sticking within a day.

Arrival And Storage

When your cuttings arrive, immediately check the shipment for damage. Growers and shippers work hard to ensure the quality of cuttings that arrive at your door, but occasionally, there are problems. Cuttings that are off color, watery, mushy, yellow or have a lot of abscised leaves may be beyond saving. When contacting the supplier, be ready to describe the symptoms and have the order details at hand. If you decide to stick poor or damaged cuttings, keep in mind the possibility of losing cuttings during propagation, which may ultimately cost more than waiting for a replacement shipment. Sometimes it is worth waiting for new cuttings to arrive. Regardless of condition, make sure the supplier batch sticks stay with the cuttings. Doing so will help resolve any problems that may arise later.

Even the best-quality cuttings will degrade quickly if not handled properly after arrival. It is best to stick cuttings immediately, because the better the cutting condition when stuck, the quicker they root and are ready to be transplanted. Realistically, this is not always possible. For the vast majority of species, holding cuttings in their packaging for a few hours in a cool, dark place is almost never a problem.

For longer-term storage, it is important to remove the cuttings from their packaging and layer them in damp papers. Make sure they are not wet, since wet cuttings are very susceptible to Botrytis and bacterial rot during storage. Tropical and chill-sensitive species can be stored at 55-65° F, while temperate species can be stored at 35-50° F (see Figure 1, left). In general, provide high relative humidity (80-95 percent) and the lowest temperature hardiness allows. For some species, storage is not recommended under any circumstances.

Rooting Considerations

Rooting compounds, such as IBA, mimic plant hormones, improve rooting uniformity and promote greater root mass. They are sometimes applied after cutting harvest and before shipping but frequently must be applied by the grower. Rooting compounds can be applied as a powder, dilute soaking solution or concentrated quick dip. The quick-dip method allows bundles of cuttings to be treated together, thereby shortening the treatment time (see Figure 2, below). Commonly used concentrations are in the 1,000- to 3,000-ppm range. It is important that the concentrated hormone dip only comes into contact with the stem and not the growing tip, as it can cause twisted and distorted growth.

Rooting media is a critical component of propagating unrooted cuttings and has several important functions. The substrate should hold the cutting in place, provide moisture to the cutting while being well drained and provide air exchange around the base of the cutting. Rooting media is composed of organic and mineral components, usually peat and perlite, vermiculite, pumice, polystyrene or rockwool. The key is aeration. Soggy media will rot cuttings, and water films on cutting bases can hinder rooting.

For some crops, foliar fertilization through a mist system is useful. Some growers choose to fertilize with every other watering. Others elect to provide constant liquid feed at 50-ppm nitrogen through the mist system throughout propagation. Though convenient, constant liquid feed via mist can lead to excessive algae growth on walkways and benches. It may be easier with small batches of cuttings to apply fertilizer with a sprayer in the evening after the mist is off for the night. When direct sticking cuttings, it is often useful to incorporate slow-release fertilizer into the rooting media. The slow release will not promote root initiation but will boost root development.

The Ideal Environment

Many growers find changing weather conditions create a challenge in managing the propagation environment. The ideal environment will provide adequate moisture to maintain cutting turgor, minimize environmental stresses, provide high humidity, prevent disease and promote rapid root formation. Balancing these factors against the weather can be tricky. One must provide:

- Enough mist without saturating the soil.
- As much light as possible without raising temperatures.

Top: *These boxes contain newly arrived cuttings ready for sticking.* ***Bottom:*** *These New Guinea impatiens cuttings were damaged during transport.*

Preparing an IBA

	IBA (per liter of solution)			NAA (per liter of solution)			Stock concentrate and dilution		
Final Concentration	ppm	mg	g	ppm	mg	g	Hormone concentrate	50% Ethanol	Final Solution
250 IBA : 125 NAA	250	250	0.25	125	125	0.125	25 ml	975 ml	1,000 ml
500 IBA : 250 NAA	500	500	0.5	250	250	0.25	50 ml	950 ml	1,000 ml
1,000 IBA : 500 NAA	1,000	1,000	1	500	500	0.5	100 ml	900 ml	1,000 ml
5,000 IBA : 2,500 NAA	5,000	5,000	5	2,500	2,500	2.5	500 ml	500 ml	1,000 ml
10,000 IBA : 5,000 NAA	10,000	10,000	10	5,000	5,000	5	1,000 ml	0 ml	1,000 ml

The hormone concentrate (HC) is the stock solution (1% IBA + 10,000 ppm : 0.5% NAA + 5,000 ppm). To make 1 liter (1,000 ml) solution of 250 ppm IBA : 125 ppm NAA, use the formula:
Concentrate HC X Volume HC = Concentrate solution X Volume solution
10,000 ppm IBA (HC concentrate) X Vol. = 250 ppm X 1,000 ml;
25 ml of HC concentrate stock solution + 975 ml 50% ethanol = 250 ppm IBA : 125 ppm NAA in one liter.

Figure 2. Varying concentrations from 250 to 10,000 ppm of IBA and NAA are used in commercial plant propagation depending on species. To have the correct concentration on hand, the hormones are sold as concentrates to be diluted when needed by the grower. Shown are volumes of commercial hormone concentrate to be blended with a 50-percent-ethanol solution. The resulting concentrations of IAA and NAA are given in ppm, mg and grams. Use an EPA-approved end-use formulation (e.g., Dip 'N Grow [1% IBA + 0.5% NAA]). Duration of basal dip should last 3 to 5 seconds.

• Media and air temperatures that encourage rooting but are not high enough to stress the cuttings.

• Limited air movement.

There must be adequate moisture, light and air movement control so the cuttings are optimized during cool, rainy days as well as sunny, hot ones. In the ideal environment, most unrooted cuttings will root in 2-3 weeks.

Moisture Maintenance

There are many methods for providing moisture to unrooted cuttings during propagation. The idea is to provide cuttings with enough moisture to minimize wilt and keep humidity as high as possible, thereby reducing transpirational water loss. However, a slight degree of stress is useful in encouraging root initiation and development.

You never want to see wilted cuttings, but they should be kept right on the edge of it. This is most often achieved by providing a luxuriant amount of moisture during the first few days after stick, then reducing the frequency of application during subsequent days, particularly after callus formation. This approach has the advantage of not only alleviating the moisture stress encountered during shipping but also avoiding the soggy media problem and Botrytis rot.

The most common watering system used in propagating unrooted cuttings is intermittent mist. Mist lowers leaf temperatures through evaporative cooling, which reduces transpiration. Fungal spores of some pathogenic species are unable to germinate on wet leaves, so fungal diseases are reduced, but strict attention to cleanliness is required. Foliar application of mineral nutrients is also possible through mist systems. However, mist systems can quickly saturate the media, so they must be monitored carefully and adjusted when too much water is applied.

Fog systems are similar to mist systems but produce a much smaller water particle under higher pressures. These systems maintain high relative humidity with less chance of saturating media and can be used for evaporative cooling of cuttings. Fog and mist systems are susceptible to clogged nozzles due to poor water quality, so provide adequate filtration.

Poor water quality can damage cuttings. Electrical conductivity, pH and hardness should

Hanging mist lines are a common method of irrigation in propagation.

Irrigation (Mist) Water Guidelines*

Category	Maximum Tolerable Reading
Electrical Conductivity (EC)	0.75 mS/cm
pH	5.5 – 7
Alkalinity	1.5 me/L (75 ppm $CaCO_3$ equivalent)
Hardness	3.0 me/L (150 ppm $CaCO_3$ equivalent)
Calcium & Magnesium	3-5 ppm per 1 ppm magnesium
Specific Elements	
Sodium	50 ppm
Chloride	70 ppm
Chlorine	2 ppm
Iron	4 ppm
Manganese	0.5 ppm
Zinc	0.3 ppm
Copper	0.2 ppm
Borate	0.5 ppm
Fluoride	0.5 ppm
Lithium	0.5 ppm

**Also see North Carolina Cooperative Extension Service Horticulture Information Leaflet 557:* Water Considerations for Container Production of Plants. *Baily D., Bilderback T., & Bir D. www.ces.ncsu.edu/depts/hort/hil/pdf/hil-557.pdf*

Figure 3. Water quality can have an enormous impact on cuttings. Shown here are recommended guidelines for irrigation water quality.

all be checked before installing either system. High concentrations of dissolved minerals such as iron can precipitate onto surfaces in dedicated propagation areas. Bacteria in mist water can cause an outbreak of disease. Suggested maximum tolerable values of the most important factors are listed in Figure 3, left.

The System Works

Fog and mist systems are unique among methods of providing moisture because they can lower temperatures during high heat situations. While it was mentioned previously that air movement should be limited during propagation, air movement is sometimes essential to balance light, heat and moisture under high heat conditions.

This is how the system works: The fog or mist system is operated continually or as frequently as possible without saturating the media. The air temperature is monitored. When it reaches a preset maximum, the vent fans are turned on, and moisture is evacuated from the greenhouse. The resulting evaporation can drop cutting temperatures as much as 10-15° F. This is a tricky way to drop temperatures, so monitor carefully. Check with other growers who have used it before trying it on a whole crop.

Other methods of providing moisture are far simpler than mist or fog systems. Non-misted enclosures of white plastic tents can be erected over the cuttings on the bench. Once or twice a day the interior is misted to keep the humidity high. This works well for species that do not tolerate excessive moisture but require careful monitoring for disease and excessively high temperatures.

Perhaps the simplest method of maintaining moisture around cuttings is contact systems. Usually cuttings are stuck and then watered in. A non-woven fabric is laid over top and periodically dampened as necessary. Contact systems have the advantage of not requiring dedicated space for propagation, and the cuttings, if direct stuck, can be grown on in place. Monitoring cuttings and diseases can be a problem with contact systems. GPN

W. Roland Leatherwood is a Ph.D. student in the Department of Horticulture Science at North Carolina State University. He can be reached at roland_leatherwood@ncsu.edu. Roberto Lopez is a Ph.D. student in the Department of Horticulture at Michigan State University. He can be reached at lopezro4@msu.edu. Amy Enfield is a Ph.D. student in the Department of Horticulture at Clemson University. She can be reached at aenfiel@clemson.edu.

Author's note: The authors wish to thank cutting suppliers, greenhouses and suppliers that support cutting research at North Carolina State University, Clemson University and Michigan State University.

LearnMore
For more information related to this article, go to www.gpnmag.com/lm.cfm/gp110604