

Smoothing Out the Kinks of Vegetative Annual Production

James L. "Jamie" Gibson, University of Florida-Milton and
 Brian E. Whipker, NC State University

Growers have faced drought, hot and cold weather, and excessive rainfall. Production problems with vegetative annuals are easier to handle. This article highlights production solutions from rooted cutting establishment to the retail bench. Grower-friendly production resources are also provided.

Rooted Cutting Inspection

When rooted cuttings are received from plant suppliers, growers should always conduct a root and shoot survey of the product (Table 1). These factors are very important to the success of cutting establishment.

Roots	Shoots
Are there plants with yellow lower leaves or is the plant wilted which indicates an infection of a root rot pathogen?	Are cuttings exhibiting yellow lower or upper leaves indicating a nutrient deficiency?
Are the cutting roots brown or blackened which may indicate exposure to high fertilizer salts?	Are the cuttings dark green, stunted, and with crinkled leaves indicating that the cuttings have been treated with high doses of plant growth regulators?
Are there plants along the outside margin of the tray which are wilted or showing signs of dehydration, indicating the cuttings received watering stress?	Are there any signs of necrotic leaf spots indicating fungal infection on the plugs?
Are the plugs too old with root wrapping observed?	Are the cuttings leggy?
	Are there damaging insects feeding on the foliage?

If quality problems with the plants are observed, growers must take immediate action with the plant supplier. Waiting weeks or months to inform the supplier of troubles opens up the issue of when damage occurred and who is responsible. Growers should invest in a digital camera so that photographs can immediately be sent to the supplier for proof of damage.

Rooted Cutting Establishment

One of the greatest cutting establishment challenges that growers face is poor root development once trays are received. For example, shoots of argyranthemum, heliotrope, and osteospermum may be perfectly healthy, while rooting is limited. Growers have choices when it comes to improved cutting rooting. (1) Once rooted cuttings are received, the root substrate should be allowed to dry slightly between irrigations. (2) Trays could be placed on heated rooting mats for a few days before transplanting to encourage better rooting. (3) Rooted cuttings should be purchased from propagators who utilize rooting hormones and market cuttings after complete root ball development. (4) Cuttings could be purchased that are rooted in fiber-wrapped plugs or polymer-type substrates. These substrates may provide the advantage of allowing for earlier transplant than when loose mixes are used for rooting because the root ball remains intact even if the cutting is not very well rooted. (5) Unrooted cuttings could be purchased and rooted on-site to meet the needs of the business.

In addition, growers should always remove cuttings from shipping boxes immediately upon receipt to prevent the negative effects of ethylene.

Scheduling

Mid to late-February is normally the critical time to plant vegetative annuals for spring sales. However, with some of the cooler season, frost tolerant vegetative annuals like diascia, nemesia, osteospermum, snapdragon, and verbena, growers should begin to plant by mid to late-January to take advantage of the

Table 2. Suggested Planting Weeks for Popular Vegetative Annuals.*

Plant Type	Pot Size	Plant Week	Finish Week
Cool season Diascia Nemesia Osteospermum	4-inch	7-10	11-14
	6-inch	5-8	11-14
	HB	3-6	11-14
Intermediate Petunia Calibrachoa Fuchsia	4-inch	9-12	13-16
	6-inch	7-10	13-16
	HB	5-8	13-16
Warm season Angelonia Scaevola Sweetpotato	4-inch	11-14	15-18
	6-inch	9-12	15-18
	HB	7-10	15-18

* Includes 1 early week for production flexibility

early spring market. The basic production schedule for most vegetative annuals is 4 to 6 weeks for 4-inch pots, 6 to 8 weeks for 6-inch pots and 8 to 10 weeks for hanging baskets. Table 2 features suggested planting weeks for some of the popular vegetative annuals.

Preventative Substrate Drenches

Drenching the substrate with Aliette, Banrot or Subdue Maxx is a preventative measure for pathogenic infection from *Rhizoctonia*, *Thieleviopsis*, *Pythium* or *Fusarium*. Certain fungicide drenches are only specific for certain species of fungi; reading the fungicide label before drenching is recommended. The application of a fungicide drench should be conducted 4 to 7 days after transplanting. Applying a fungicide at planting may sometimes stress cutting root growth due to the powerful chemical dosage in the formulation. Root systems can sometimes be harmed through chemical burns of the root hairs and secondary roots, which damage the ability of the roots to absorb nutrients and water.

Irrigation and Water Quality

Water management is highly important during the cutting establishment phase because saturated soils can stall growth, introduce disease and nutritional problems, and delay crop time. Spring production in the mid-Atlantic usually involves overcast weather, especially in the months of February and March, therefore growers should limit overhead irrigation to the morning for adequate drying. Spot-watering is

also very effective during cloudy weather in reducing excessive moisture in the greenhouse.

Water quality can be a problem to some mid-Atlantic growers who experience high alkalinity (>180 ppm CaCO₃), as it contributes to a high root substrate pH and subsequently insufficient micro-nutrient availability. Bacopa, brachyscome, calibrachoa, and snapdragon respond better to a low pH (5.5 to 5.8) root substrate. High alkalinity and a high root substrate pH (6.0 to 6.6) can lead to iron deficiency. To combat high alkalinity, growers should apply acidic fertilizers like 20-10-20 to the crop or inject acid into the irrigation water. Please visit http://www.ces.ncsu.edu/depts/hort/floriculture/crop/crop_water.htm to download a free acid injection calculator. Geraniums, strawflower, dahlia, and fuchsia are known for their high pH requirement (6.0 to 6.6) and can develop iron and manganese toxicity symptoms if the root substrate pH is low.

Humidity Control

Not only can high humidity in the greenhouse increase the incidence of disease, but it can also inhibit the translocation of calcium in plants. Another unfortunate result of high humidity is the presence of small bumps on the foliage and stems on certain vegetative annuals such as ivy geranium, princess flower, heather, and sweet potato vine. The problem is termed edema, a plant condition where the uptake of water is greater than the transpiration rate. The use of horizontal air flow fans and limiting irrigation during cloudy periods will help prevent edema.

Root Substrate

Selecting the proper root substrate is extremely important to successful vegetative annual production. An ideal substrate for vegetative annuals should allow for rapid root development, while maintaining good water holding capacity. Mixes which stay too moist may cause shoot growth to become weak and chlorotic due to the lack of oxygen in the substrate. The chances for root rots to occur are greater in substrates which are continually saturated.

Planting

Vegetative annuals can be planted in pots as small as 4 inches, large gallon containers or hanging baskets. Pot size is important for two main reasons: it influences the number of cuttings required per pot and the number of production weeks (Table 2). One plant per pot is recommended for 4-inch pots while 2 plants per

► pot is recommended for 6-inch pots and larger. Rooted cuttings should be planted 1 to 3 inches apart.

Dibbling is an important practice used to establish vegetative annual cuttings more quickly. The size of the dibble hole should not be deeper than the depth of the root ball, nor wider than the root ball. Deep holes made by an aggressive finger will only increase the chances of crop failure. Using one's finger sometimes isn't the greatest tool for dibbling, but then again, a sense of depth for rooted cuttings will enable the dibble to hole to be ideal for cuttings and uniformity of the hole depth will occur for all containers.

Spacing

Once leaves begin to expand laterally beyond the sides of the pot, vegetative annuals should be spaced accordingly to avoid stretch, lower leaf drop, and the possibility of disease from reduced airflow between plants. For most vegetative annual species use 6 to 8-inch centers for 4-inch pots, 12 to 14-inch centers for 6-inch to gallon size pots, and 24-inch centers for hanging baskets.

Plant Growth Regulators

Most PGRs are effective as foliar sprays in controlling height of vegetative annuals. Applications should be made 2 to 3 weeks after pinching or when foliage reaches the pot rim. Foliar sprays of B-Nine at 1,500 to 3,000 ppm or Cycocel at 750 to 1,250 ppm alone or as a tank mix with B-Nine are excellent chemicals to trial initially on vegetative annuals. Trialing a small group of plants before treating entire crops with the triazole type PGRs Bonzi and Sumagic is suggested; check the label for species specific rates and legal mixing information. Please visit the NC State Web page www.pgrinfo.com to download a free calculator to attain accurate application rates. Substrate drenches are also effective with vigorous species such as calibrachoa, petunia, and scaevola.

With the new chemicals, Piccolo and Topflor on the market, researchers at North Carolina State University have conducted several PGR trials on vegetative annuals. Refer to Table 3 for recommended chemical rates for select vegetative annuals.

Florel is another PGR commonly used on vegetative annuals. A 500 ppm concentration is recommended on geraniums with lower rates (200 to 300 ppm) suggested for calibrachoa, diascia, lantana, nemesia, petunia, scaevola, and verbena. Bacopa, double

Table 3. Recommended PGR Foliar Sprays for Select Vegetative Annuals.

Species	Chemical	Rate (ppm)
Angelonia	Sumagic Topflor	10-20 40-60
Argyranthemum	Sumagic Topflor	10-20 50-75
Calibrachoa	Bonzi/Piccolo Sumagic	20-30 10-25
Colcus	Bonzi/Piccolo Sumagic	5-30 10-20
Nemesia	Bonzi/Piccolo Sumagic Topflor	10-20 5-30 2.5-5
Petunia	Bonzi/Piccolo Sumagic Topflor	5-45 20-50 15-60
Scacvola	Bonzi/Piccolo Sumagic Topflor	20-40 30 45-60
Verbena	Bonzi/Piccolo Sumagic	5-30 15-30

impatiens, and New Guinea impatiens respond well to Florel at 100 to 200 ppm. Florel should not be applied to torenia because it delays flowering and with angelonia tip burn can occur.

PGR Overdose Correction

Certain vegetative annuals like New Guinea impatiens can become stunted in the finished container due to the misapplication of PGRs. The gibberellin-containing PGR Pro-Gibb has been shown to reverse the negative effects caused by improper PGR applications. Results vary by crop and the severity of the overdose. Initially trial 1 ppm and repeat applications on a 5 to 7 day interval if needed. On poinsettias, Fascination (a GA + BA combination) has been used at 3 ppm to promote more "controlled" growth. Growers should conduct trials to determine optimal rates for vegetative annuals.

Temperature

Night temperatures prior to pinching for vegetative annuals should be between 63 to 68°F for proper root ►

► establishment. Producing vegetative annuals in houses with the same night temperature requirement should be a common practice among growers. In general there are three groups of vegetative annuals: cool, moderate, and warm (Table 4). In general day temperatures should be set 5 to 10 degrees higher than the night temperature.

Lighting/Photoperiod

Most vegetative annuals are either day-neutral or facultative long day plants. Refer to Table 5 for photoperiod categories of select vegetative annuals. Supplemental lighting (14 to 16 hours) is required for some species like petunia and calibrachoa to achieve earlier flowering. Incandescent lights are typically used to extend the daylength or provide night interruption, unfortunately using this type of lighting increases the incidence of internode elongation and decreased branching. Growers should invest in high intensity discharge (HID) lighting (better light quality) to improve plant quality. Off-peak electricity rates offered by the electric company will reduce night lighting costs.

Pinching and Trimming

Pinching may be required to achieve uniform shoot distribution of the finished plant of some crops. Thin-stemmed crops like bacopa, diascia, evolvus, and nemesia may require multiple pinches to produce dense growth in containers and baskets. Growers should evaluate cutting costs and the time involved in producing a hanging basket crop, because it may be advantageous to install more cuttings in the basket to reach the market date than to pinch certain species multiple times. Pinching usually increases crop time by a few weeks. Thicker-stemmed crops such as argyranthemum, brachyscome, bracteantha, and snapdragon will require a pinch two weeks after planting to ensure adequate root establishment. A sharp instrument should be used when pinching thick stems; sanitize the blade with a 10% Chlorox solution between each plant to prevent disease transmittance.

Fertilization of Crops

For the vegetative plug stage, fertilize with N at 75 to 100 ppm using a constant liquid feed program. During active growth, rotate weekly between 15-0-15 and 20-10-20. By rotating these two soluble fertilizers, growers can provide calcium and low phosphorus amounts with the "Dark Weather Feed" (15-0-15) and adequate micronutrients and ammoniacal-nitrogen with the 20-10-20. Another example would be weekly



Figure 1. Whether large or small, display gardens are an essential component in an effective marketing strategy.

fertilizer rotations of 21-5-20 (an acidic fertilizer) and 13-2-13 (a basic fertilizer). For most vegetative annuals constant liquid feed applications of 150 to 200 ppm N are suitable.

Fertilizers such as 13-2-13, 15-0-15, and 21-5-20 are low in P and ideal for vegetative annuals because high levels of P have been shown to increase stem elongation, promote flowering, and are toxic to some of the native Australian species such as scaevola and argyranthemum, High levels of NH₄-N (> 40%) and/or urea in a fertilizer mix should be avoided to prevent excessive stem elongation.

If crop fertility is not properly managed, nutrient disorders can arise. Please visit www.ces.ncsu.edu/floriculture/def/ to view deficiency symptoms and nutrient disorder corrective procedures of 11

Table 4. Production Night Temperatures of Select Vegetative Annuals.

Cool (50 to 58°F)	Moderate (58 to 65°F)	Warm (65 to 70°F)
Argyranthemum	Bacopa	Angelonia
Brachyscome	Calibrachoa	Lantana
Diascia	Coleus	Pentas
Nemesia	Fuchsia	Scaevola
Osteospermum	Petunia	Strobilanthes
Snapdragon	Portulaca	Sweetpotato
Verbena	Scaevola	Torenia

▶ vegetative annuals. Visual diagnosis is a popular monitoring tool, however using a plant diagnostic lab to identify the source of nutritional problems is still the best way to ensure accurate diagnoses, since many nutritional, physiological, insect and disease problems can mimic each other.

Nutritional Monitoring

The root substrate pH and electrical conductivity (EC) should be monitored on a bi-weekly basis because of the potential of salt accumulation and/ or the development of high or low pH values. Todd Cavins, Assistant Professor at Oklahoma State University has suggested use of a pH and EC matrix to manage the nutrition of vegetative annuals (Table 6). An ideal pH range for most vegetative annuals should be between 5.8 and 6.2 and EC levels during active growth should be maintained between 1.8 to 2.7 mS/cm based on the PourThru extraction method. Growers can visit www.pourthruinfo.com for detailed information about the PourThru method. The use of a slow release fertilizer is recommended if plants are grown outdoors; side-dressing the plants before sale is also recommended for post-harvest considerations in the landscape or containers.

Hanging Basket Culture

Producing hanging baskets of vegetative annuals involves similar production protocols to smaller containers, however growers should consider administering the following strategies to extend postproduction quality. (1) To avoid the center foliage of the basket from becoming thin and scraggly, leave room in the center at planting for light to penetrate the interior of the canopy. (2) Growers should also conduct routine soft pinches on trailing- type species such as bacopa, bidens, and scaevola. (3) Invest in a microtube irrigation system as opposed to handwatering to improve crop uniformity and avoid the negative results of overwatering. (4) Consider drenches of Bonzi and Sumagic to vigorous, trailing-type crops to reduce legginess in the later weeks of wholesale production and the retail environment. (5) Improve postharvest life by incorporating slow release fertilizers (Osmocote or Nutricote) into the root substrate.

Marketing

Unfortunately marketing sometimes falls by the wayside after a rigorous production and shipping schedule. The good news is plant suppliers have already performed much of the marketing of vegetative

Table 5. Photoperiod Categories of Select Vegetative Annuals.¹

Short Day ²	Day-Neutral	Long Day
Dahlia*	Bacopa	Begonia*
Plectranthus*	Coleus	Calibracoa
Sweetpotato	Scaevola	Mimulus
Strobilanthes	Verbena	Petunia*

¹Category to flower or produce tubers
²Light for continual vegetative growth
*Some types or cultivars

annuals, including the research, establishment of a target market, and preparation of point-of-purchase (P.O.P.) materials. Plant suppliers are attempting to create a pull-through economy, where consumers ask for their products by name. Plant suppliers also realized that growers are too busy producing quality plants to design integrated marketing programs. By providing stock to retailers and then supplying P.O.P. materials combined with national advertising on HGTV and the Weather Channel, brands like Proven Winners, Flower Fields and Simply Beautiful have been recognized by consumers.

Retailing

Growers should take advantage of the huge color range in vegetative annuals to produce attractive in-store and garden displays. Whether large or small, display gardens are an essential component in an effective marketing strategy (Figure 1). Select a balanced group of tall and upright plants, sprawling moderate growers, and trailing prostrate plants.

Landscapers have influenced homeowners' tastes by adding lots of large, colorful plants to subdivision entryways and corporate landscapes. By demonstrating the proper way to display vegetative annuals, landscapers have shown consumers the value of purchasing large, vivid, and texturally stimulating species. Furthermore, landscapers aren't afraid to change the landscape palette frequently by removing tired plants and replacing them with eye-catching vegetative annuals. Homeowners have begun to adopt this "rip and replace" mentality, and this can only benefit the retailer.

Always have fully-stocked benches, provide lots of carts and baskets for easy shopping, and make sure that prices are always prominently displayed. ▶

► Remember that signage is an excellent salesperson, but there is no substitute for personal customer service. Retailers should also team up with local "horticultural gurus", such as newspaper columnists, arboretum directors, or universities, to provide regional recommendations. Offer "Employee Picks" at your garden center. Promote "rip and replace" landscapes to local landscape firms by offering discounts on bulk orders. Hold monthly workshops that incorporate seasonal vegetative annuals. Personalize your garden center by integrating your own creative ideas into corporate marketing resources.

Resources

Books

- Ball Red Book, Volume 2, 17th ed. Edited by Debbie Hamrick
- The EuroAmerican Container Garden Cookbook by Kerstin Ouellet
- Contain Yourself by Kerstin Ouellet
Available from Ball Publishing Bookshelf. Contact: (888) 888-0013 or www.ballbookshelf.com.
- Tips on Growing Vegetative Annuals by John Gaydos, Steve Jones, Jack Williams, and Mark Wilson.
- Tips on Designing, Growing, and Marketing Mixed Baskets and Containers by Terri Starman, Kathy Pufahl, and Peter Konjoian.
Available from OFA. Contact: (614) 487-1117 or www.ofa.org.

Manuals and Photocards

- Vegetative Annual Manual, North Carolina State University and the North Carolina Commercial Flower Growers' Association have teamed up to publish a 79-page Vegetative Annual Manual. It includes the latest information on production and marketing.
- PICT Guide to Vegetative Annual Disorders, Crompton-Uniroyal, MasterTag, North Carolina State University and NCCFGA have teamed up to publish PICT Guide to Vegetative Annual Disorders. The 54-page guide contains over 70 photographs of insect, disease, nutritional, and physiological disorders. Available from NCCFGA. Contact: (919) 334-0093 or www.nccfga.org.

Internet Resources

Please visit the following plant supplier Web sites to view the latest cultivar,

production and marketing information.

- Ball- www.ballfloraplant.com
- Bodger- www.michells.com/Bodger.htm
- Euro American- www.euroamprop.com
- Fisher- www.fischerusa.com
- Flower Fields- www.theflowerfields.com
- Gro Link- <http://www.grolink.com/>
- HMA- www.hmaplants.com
- Oglevee Ltd.- www.oglevee.com
- Paul Ecke Ranch- www.ecke.com
- Proven Winners- www.provenwinners.com
- Yoder Brothers- www.yoder.com/

Please visit the following Web sites for production and marketing information.

- Retail Reflections, North Carolina State University- www.floricultureinfo.com
- Floriculture Information Center, North Carolina State University, http://www.ces.ncsu.edu/depts/hort/floriculture/crop/crop_prop.htm
- Vegetative Annual Database, Texas A&M University, <http://aggie-horticulture.tamu.edu/floriculture/index.html>
<http://horticulture.tamu.edu:7998/vegetativeannual/search.html>
- Production Guidelines for Four New Crops, University of Massachusetts, http://www.umass.edu/umext/floriculture/fact_sheets/specific_crops.html

Recommendations for the use of products are included in this publication as a convenience to the reader. The use of brand names and any mention or listing of commercial products or services in this publication does not imply endorsement by University of Florida and North Carolina State University nor discrimination against similar products or services not mentioned.

Table 6. pH and Electrical Conductivity (EC) Matrix for Select Vegetative Annuals.

	Low pH	Mod. pH	High pH
Low EC	Coleus	Impatiens	---
Moderate EC	Nemesia	Verbena	Geranium
High EC	Petunia	Scaevola	---