

Using Gibberellic Acid and Ethephon to Induce Flowers on Tropical Foliage Plants¹

R. J. Henny and J. Chen²

Ornamental foliage plants are evergreen, herbaceous plants prized for colorful and attractive leaves rather than for flowers or fruits. Tropical foliage plants can be used for interior decoration in homes and offices, in large atriums, or as landscape plants in warmer climates (Figure 1). Currently, more than 500 species with various forms, colors, textures, and styles are grown as foliage plants.

Florida leads the nation in foliage plant production, accounting for more than 55% of the national wholesale market (Chen, Henny, and McConnell 2002). The foliage plant market is kept fresh and profitable by finding new plants from the wild, selecting mutants, and introducing hybrids (Chen and Henny 2008). As a result of such innovations, the Florida foliage plant industry has prospered for more than 100 years.

Even though they are prized for their beautiful leaves, flowers are induced in tropical foliage plants 1) to obtain flowers for breeding and 2) to obtain additional flowers for marketing purposes. There are several factors to consider when developing protocols for inducing blooms in tropical foliage crops. Photoperiod, temperature, and moisture (wet/dry cycles) influence flower production in all plants, including tropical foliage plants. This EDIS publication is for Florida nurserymen, interiorscapers, landscapers and horticulture industry professionals seeking information about improving flowering cycles on tropical foliage plants.



Figure 1. Foliage plants enhance indoor environments.

Plant Characteristics

Photoperiod

Because of their tropical origins, flowering cannot be induced for crop production purposes on most foliage plants by altering day and night lengths. In tropical and subtropical regions, day and night length are roughly equal and do not vary significantly through seasonal changes as they do in temperate climates. Some genera may sporadically flower with change in day length, but it is not economically feasible to manipulate day length when producing commercial foliage crops.

1. This document is ENH1186, one of a series of the Environmental Horticulture Department, UF/IFAS Extension. Original publication date October 2011. Revised March 2021. Visit the EDIS website at <https://edis.ifas.ufl.edu> for the currently supported version of this publication.

2. R. J. Henny, professor; and Jianjun Chen, professor, Department of Environmental Horticulture; UF/IFAS Mid-Florida Research and Education Center, Apopka, FL 32703.

Temperature

Similar to photoperiod, temperatures in the tropics and subtropics vary only within a narrow range; therefore, foliage plants generally lack a temperature-driven dormancy response. In some cases, foliage plants may flower in the spring following intentional exposure to dryer and cooler temperatures during the winter months.

Wet/Dry Cycles

While homeowners may be pleased with an occasional bloom on their houseplants, a commercial grower must ensure uniform flowering across an entire greenhouse crop on a schedule to meet production demands. Likewise, a breeder must be able to ensure that flowers open predictably on breeding stock to enable cross pollination.

Chemical Induction

For commercial and breeding purposes, two plant growth regulators are routinely applied to predictably induce flowering of foliage plants. These are gibberellic acid (GA_3 ; Pro-Gibb T&O®) and ethephon (Florel®).

Gibberellic Acid

Gibberellins are naturally occurring plant hormones. Gibberellins were first identified and extracted from fungi in 1935 (Yabuta and Sumiki 1938). Gibberellic acid was subsequently refined and commercially produced by researchers in 1954 (Curtis and Cross 1954). Gibberellins cause cell enlargement and elongation.

In order to have flowers available for breeding at the University of Florida Mid-Florida Research and Education Center in Apopka, Henny (1980) treated and successfully flowered *Dieffenbachia* using gibberellic acid (GA_3). Subsequently, many genera of foliage plants in the Araceae plant family (plus *Cordyline*; family Asparagaceae) were shown to bloom predictably in response to GA_3 application (Table 1).

Aglaonema—The use of GA_3 treatment is imperative for *Aglaonema* breeding to ensure simultaneous flowering of different species and cultivars. Natural flowering cycles of *Aglaonema* are highly variable and sporadic, which limits their ability to make cross pollinations. A single foliar spray with 250 ppm GA_3 consistently induces flowering and increases flower number in many *Aglaonema* species. Time from treatment to blooming is about 4–5 months (Henny 1983). *Aglaonema* flowers have no ornamental market value and are removed if not used for hybridization.

Anthurium—*Anthurium* is prized as cut flowers and as flowering potted plants. *Anthurium* flowers often bloom under natural conditions without hormone inputs. Application of GA_3 is reported to cause branching; therefore, more flowers can be produced, and the plant looks thicker and fuller in the pot. If *Anthurium* flowers are to be induced for breeding purposes, *A. scherzerianum* has shown a positive flowering response to GA_3 treatments in research trials, but only at high light levels (Henny and Hamilton 1992).

Caladium—While *Caladium* cultivars are valued for their brilliant leaf colors and patterns, gardeners would not find their small, beige, semi-inconspicuous flowers desirable. Flowers are induced for breeding purposes only. Tubers removed from storage and soaked for 8 or 16 hours in 250 ppm GA_3 produced flowers after approximately 65 days (Harbaugh and Wilfret 1979).

Cordyline—Also known as Ti plant or Hawaiian good-luck plant, *Cordyline terminalis* produces terminal inflorescences 4–6 weeks after apical buds are treated with GA_3 or GA_{4+7} (Fisher 1980). Optimum flowering requires application of 0.12–0.15 ml of 500 ppm GA_3 or GA_{4+7} applied to the apical bud. Some selections of Ti plant are used extensively as cut florist greens. Flowers should be induced for breeding purposes only.

Dieffenbachia—The ability to flower *Dieffenbachia* species and cultivars simultaneously on demand has made breeding this popular plant much easier (Henny 1980). Flowering is accomplished by a single foliar spray with 250 ppm GA_3 . Flowers normally mature within 3–4 months following treatment. Tetraploid *Dieffenbachia* breeding lines have proven more difficult to flower using GA_3 sprays and require higher treatment rates than diploid plants. Even at rates of 500 ppm, only 30%–80% of tetraploid *Dieffenbachia* flowered compared to 100% of diploids (Henny 1989).

Homalomena—*Homalomena lindenii* plants can be stimulated to flower with a single foliar spray to runoff with 100 ppm GA_3 . Treated plants flowered within approximately 120–140 days. All treated plants averaged 10–11 flowers, while untreated plants did not bloom (Henny 1988).

Philodendron ‘Black Cardinal’—a self-heading type of *Philodendron*, flowered approximately 168 days or 6 months after a single foliar spray application of GA_3 at 500 ppm. One hundred percent of treated plants subsequently flowered (Chen et al. 2003). Flowers should be induced for breeding purposes only. To date, no vining types of *Philodendron* have shown a positive bloom response to GA_3 applications.

Spathiphyllum—When the ability to induce flowering of *Spathiphyllum* with GA₃ was first reported (Henny 1981), it moved this crop from the category of foliage plant into the flowering potted plant category. Initially, *Spathiphyllum* ‘Mauna Loa’ seedlings flowered after receiving a single foliar spray of GA₃ at 250, 500, or 1000 ppm. Most treated plants had visible buds or open blooms within 12–14 weeks of treatment. In that study, approximately 15% of the inflorescences exhibited bloom distortion consisting of either curved peduncles or spathes with extra appendages.

Subsequent testing on other cultivars was conducted since flower distortion was not desirable for marketing purposes. Four additional *Spathiphyllum* cultivars were given a single foliar spray with 250 ppm GA₃ in August 1984. The cultivars tested included ‘Tasson’, ‘Wallisii’, ‘Queen Amazonica’, and ‘Bennett’ (Henny and Fooshee 1985). All four cultivars flowered readily in response to GA₃ treatment. Treated ‘Bennett’ and ‘Wallisii’ plants had open blooms within 9 weeks of treatment. ‘Tasson’ and ‘Queen Amazonica’ required approximately 2 weeks longer to flower. Overall flower quality was good for ‘Bennett’ and moderate for ‘Tasson’ and ‘Queen Amazonica’. ‘Wallisii’ produced poor-quality flowers.

Spathiphyllum ‘Starlight’ was treated with a single foliar spray of GA₃ at 0, 125, 250, or 375 ppm in March 1988. All treated plants had good-quality flowers at 15 weeks after treatment while no untreated plants bloomed (Figure 2). GA₃-treated plants were slightly taller and had new leaves that were narrower than untreated plants (Henny and Fooshee 1988). It was concluded that different cultivars of *Spathiphyllum* respond differently to GA₃ treatments. Each cultivar must be tested on a small-scale basis before GA₃ is applied to an entire crop.



Figure 2. Each *Spathiphyllum* cultivar must be tested on a small-scale basis before GA₃ is applied to an entire crop.

Zantedeschia—GA₃ can be applied to calla lily at 500 ppm as a 10-minute preplant rhizome soak. Soaking rhizomes in 500 ppm GA₃ prior to planting increased the number of flowering shoots and flowers per shoot (Corr and Widmer 1987). Leaf width was narrower on treated plants, but length was not affected. GA₃ may also be applied as a foliar spray. Foliar sprays were applied when the first leaf was unfolded on half of the plants. However, foliar sprays were generally not effective. Treatment of the tubers is essential for uniform sprouting and blooming of this crop, either for cut flower or flowering potted plant production.

Zamioculcus—ZZ plant is prized for its durability as a foliage plant in low light interior conditions. ZZ can be induced to bloom for breeding purposes (Figure 3). Application of 500 ppm GA₃ as a foliar spray induced 90% of plants treated to bloom approximately 135 days after treatment (R. J. Henny, unpublished data).



Figure 3. Plant breeders must ensure predictable flowering of different cultivars and species for selected pollinations to be made. Flowers (denoted by arrows) shown in this photo are of *Zamioculcus zamiifolia* (ZZ plant).

Ethylene

Ethylene is a gas naturally produced by all plants. Ethylene is generally not desirable around florist crops because it causes flower abscission; however, in other crops, ethylene is used to ripen fruits and to induce blooms (Table 2). Ethephon, invented in 1965, is a liquid that converts into ethylene and acts as a plant hormone after it is sprayed on plants. Ethephon is used for a wide variety of agronomic crops, such as wheat, coffee, cotton, and rice, and is sold under a variety of product names.

Bromeliads—Studies with *Aechmea*, *Guzmania*, and *Vriesea* showed that 25 mg/L of ethephon applied to the vase of these bromeliads, 1.5–2 years old at the time of

treatment, induced flowering (Figure 4) within 2 months without damaging leaves (Poole and Conover 1975). In the above study, the vases contained water from overhead watering the day before treatment, so it is not necessary to drain existing water from the vases before applying the ethephon.



Figure 4. Bromeliad growers routinely apply Florel® treatments to induce shiny, colorful inflorescences.

Ficus—Application of 500 ppm ethephon to *Ficus ben-jamina* liners in 2-gallon pots stimulated flowering and seed set (Johnson and Joiner 1978). These results may be of value to breeders of ornamental *Ficus*; however, growers should note that root growth was severely reduced and top growth became prostrate.

Gynura—Ethylene does not induce flowering in purple passion plant, but it serves an important function in this foliage crop. The flowers of *Gynura* have a foul odor that is not appealing to consumers and detracts from market value. Flowers drop following a foliar spray of ethephon at 500 ppm (Chen, Henny, and Caldwell 2002).

Gibberellic Acid and Ethephon Sources

Gibberellic acid can be purchased as Pro-GibbT&O®. Read and follow all label directions. Other products may be registered with this active ingredient.

Ethephon for greenhouse and horticultural use can be purchased as Florel® (Henny 2001). Other products may be registered with this active ingredient. Read and follow all label directions.

Literature Cited

- Chen, J., and R. J. Henny. 2008. *Tropical Foliage Cultivar Development: New Ornamental Introductions Drive Plant Markets*. ENH1093. Gainesville: University of Florida Institute of Food and Agricultural Sciences. <https://edis.ifas.ufl.edu/ep357>.
- Chen, J., R. J. Henny, and R. D. Caldwell. 2002. "Ethephon Suppresses Flowering of Purple Passion (*Gynura aurantiaca*).” *Journal of Environmental Horticulture* 20 (4): 228–231.
- Chen, J., R. J. Henny, and D. B. McConnell. 2002. "Development of New Foliage Plant Cultivars." In *Trends in New Crops and New Uses*, edited by J. Janick and A. Whipkey, 466–472. Alexandria, VA: ASHS Press.
- Chen, J., R. J. Henny, D. B. McConnell, and R. D. Caldwell. 2003. "Gibberellic Acid Affects Growth and Flowering of Philodendron 'Black Cardinal'." *Plant Growth Regulation* 41: 1–6.
- Corr, B. E., and R. E. Widmer. 1987. "Gibberellic Acid Increases Flower Number in *Zantedeschia elliottiana* and *Z. rehmannii*." *HortScience* 22 (4): 605–607.
- Curtis, P. J., and B. E. Cross. 1954. "Gibberellic Acid: A New Metabolite from the Culture Filtrates of *Gibberella fujikuroi*." *Chem. Ind.* (London) 1066.
- Fisher, J. B. 1980. "Gibberellin-Induced Flowering in Cordyline (Agavaceae)." *Journal of Experimental Botany* 31 (3): 731–735.
- Harbaugh, B. K., and G. J. Wilfret. 1979. "Gibberellic Acid (GA_3) Stimulates Flowering in *Caladium hortulanum* Birdsey." *HortScience* 14 (1): 72–73.
- Henny, R. J. 1980. "Gibberellic Acid (GA_3) Induces Flowering in *Dieffenbachia maculata* 'Perfection'." *HortScience* 15 (5): 613.
- Henny, R. J. 1981. "Promotion of Flowering in *Spathiphyllum* 'Mauna Loa' with Gibberellic Acid." *HortScience* 16 (4): 554–555.
- Henny, R. J. 1983. "Flowering of *Aglaonema commutatum* 'Treubii' Following Treatment with Gibberellic Acid." *HortScience* 18 (3): 374.
- Henny, R. J. 1988. "Inducing Flowering of *Homalomena lindenii* (Rodigas) Ridley with Gibberellic Acid." *HortScience* 23 (4): 711–712.

Henny, R. J. 1989. "Floral Induction in 2n and 4n *Dieffenbachia maculata* 'Perfection' After Treatment with Gibberellic Acid." *HortScience* 24 (2): 307–308.

Henny, R. J. 2001. "Tips on Regulating Growth of Floricultural Crops." In *Foliage Plants*, edited by M. Gastson, 83–87. Columbus: Ohio Florists Association.

Henny, R. J., and W. C. Fooshee. 1985. "Inducing Flowering of Four *Spathiphyllum* cultivars with Gibberellic Acid (GA₃)." *CFREC-Apopka Research Report* RH-85-3. Gainesville: University of Florida Institute of Food and Agricultural Sciences.

Henny, R. J., and W. C. Fooshee. 1988. "Floral Induction in *Spathiphyllum* 'Starlight' with Gibberellic Acid Treatment." *CFREC-Apopka Research Report* RH-88-17. Gainesville: University of Florida Institute of Food and Agricultural Sciences.

Henny, R. J., and R. L. Hamilton. 1992. "Flowering of *Anthurium* Following Treatment with Gibberellic Acid." *HortScience* 27 (12): 1328.

Johnson, C. R., and J. N. Joiner. 1978. "Influence of Ancymidol and Ethephon Growth of *Ficus benjamina* L." *Proceedings of the Florida State Horticultural Society* 91: 204–205.

Poole, R. T., and C. A. Conover. 1975. "Flowering of Bromeliads." *Florida Foliage Grower* 12 (6): 1–2.

Yabuta, T., and Y. Sumiki. 1938. "On the Crystal of Gibberellin, a Substance to Promote Plant Growth." *Journal of the Agricultural Chemical Society Japan* 14: 1526.

Table 1. Foliage plant genera that have been induced to flower by gibberellic acid (GA3).

Genus	GA ₃ treatment rate	Method of application
<i>Aglaonema</i>	250 ppm	A singular foliar spray to runoff
<i>Anthurium</i>	500 ppm	A singular foliar spray to runoff
<i>Caladium</i>	250 ppm	Tuber soak for 8–16 hours
<i>Cordyline</i>	500 ppm	3 drops on 3 consecutive days to the newest unrolled leaf
<i>Dieffenbachia</i>	250 ppm	A singular foliar spray to runoff
<i>Homalomena</i>	100 ppm	A singular foliar spray to runoff
<i>Philodendron</i> 'Black Cardinal'	500 ppm	A singular foliar spray to runoff
<i>Spathiphyllum</i>	250 ppm	A singular foliar spray to runoff
<i>Zantedeschia</i>	500 ppm	10-minute rhizome soak
<i>Zamioculcus</i>	500 ppm	A singular foliar spray to runoff

Table 2. Foliage plant genera that can be induced to flower by treatment with ethephon.

Crop	Ethephon treatment rate	Method of application
Bromeliads		
<i>Aechmea, Vriesea, Guzmania</i>	25 ppm	A single drench into the vase
<i>Ficus</i>	500 ppm	A singular foliar spray to runoff
<i>Gynura</i> *	25 ppm	Single foliar spray

*Gynura is included in this table even though treatment is to induce abscission of flowers, which are foul smelling.