Improving Branching and Postharvest Quality

When used properly, BA sprays can yield tremendous commercial potential. Benefits include increasing the number of tertiary shoots in poinsettias and delaying lower leaf chlorosis.

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Figure 1. Poinsettia 'Freedom Red' plants three weeks after transplant (first pinch) when BA applications were made.

Cytokinins are plant hormones that plants produce naturally and regulate plant growth, including cell division and leaf senescence. There are several commercial plant growth regulators (PGRs) that contain benzyladenine (BA), a synthetic cytokinin. Configure (Fine Americas) contains BA alone, whereas Fascination (Valent Professional Products) and Fresco (Fine Americas) contain BA with another plant hormone, gibberellic acid (GA_{4+7}). All three products are labeled for greenhouse use on floriculture crops.

BA has been shown to increase branching of some echinacea cultivars (see Joyce Latimer's article in the April 2008 issue of *GPN*), holiday cactus and hosta. BA application can also increase the number of flower spikes in some orchids. Additionally, BA inhibits lower-leaf chlorosis and necrosis in Easter and Asiatic lilies when used in combination with GA_{4+7}. Our goal was to evaluate whether BA applications would improve branching and postharvest quality of other commercially important potted floriculture crops, including poinsettia and seed geranium. Here, we summarize research-based information from two experiments performed at Michigan State University.

BA's Influence on Branching

There are many factors that influence branching of poinsettia after pinch. In some years, some cultivars do not branch as well or as uniformly as desired. Based on results with other crops, we wanted to determine whether an application of BA or BA+GA_{4+7} improved branching of poinsettia 'Freedom Red'. Rooted 72-cell liners of 'Freedom Red' were transplanted into 6-inch containers in a peat-based media and grown in a glass greenhouse set at 73° F under a 16-hour photoperiod. BA applications were made either at pinch (three weeks from transplant; Figure 1) or four weeks after transplant, when axillary buds were just emerging. BA or BA+GA_{4+7} were applied as a single foliar spray of 50 or 100 ppm at a volume of 2 quarts per 100 square feet, with Capsil added as a surfactant. Another treatment was a media drench of 25 ppm at a volume of 2 ounces per 6-inch container. A non-treated control was maintained, and 10 plants per treatment were used.

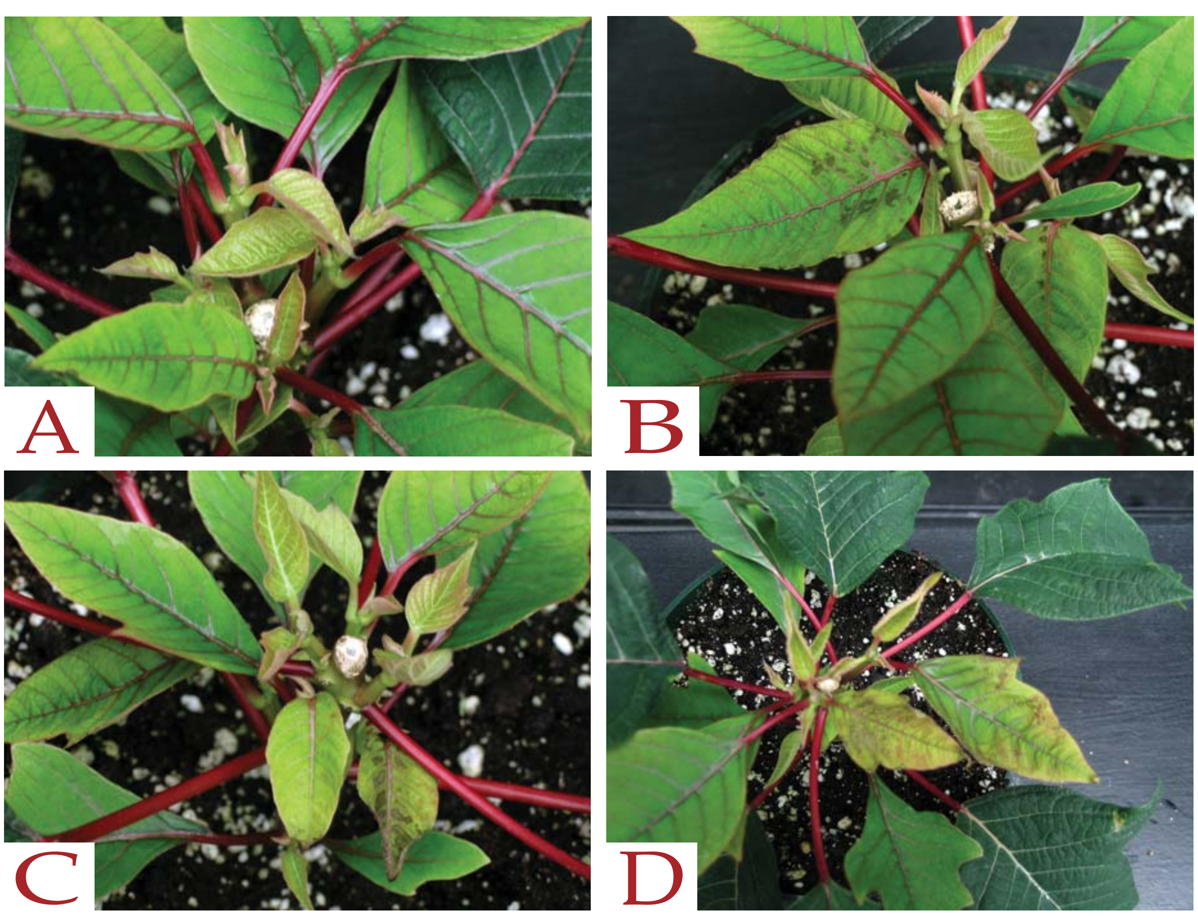

Figure 2. When PGRs spray applications were made four weeks after transplanting poinsettia, almost no phytotoxicity was observed after a 50-ppm BA spray (A). However, a 50-ppm BA+GA_{4+7} spray elicited minor phytotoxicity symptoms (B), and moderate and high phytotoxicity was observed after 100-ppm spray of BA (C) and BA+GA_{4+7} (D), respectively.

Figure 3. Poinsettia drenched or sprayed with BA or BA+GA_{4+7} occasionally developed leaves with an irregular morphology.

Figure 4. *Each poinsettia had one primary shoot that was pinched three weeks after transplant. Secondary shoots developed from the leaf axils of the primary pinched shoot. Tertiary shoots developed in the leaf axils of the secondary shoots.*

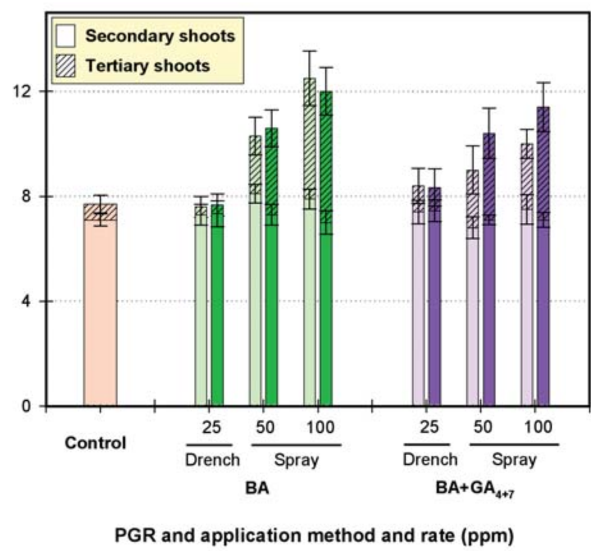

Figure 5. *The number of secondary and tertiary shoots on poinsettia treated with BA or BA+GA$_{4+7}$ either three weeks (light bars) or four weeks (dark bars) after transplant. Means ± standard errors of means of 10 plants per treatment are reported.*

Figure 6. *Poinsettias that developed more tertiary lateral shoots from the BA applications looked similar to the non-treated control plants at flowering.*

Phytotoxicity

No phytotoxicity was observed following the PGR applications at pinch. However, when PGR spray applications were made one week later (four weeks after transplant), we observed some phytotoxicity in the form of leaf scorching. The extent of this phytotoxicity depended on the PGR used and the spray application rate. Typically, BA alone produced a lesser degree of phytotoxicity compared with BA+GA$_{4+7}$.

At the rate of 50 ppm, BA alone did not elicit phytotoxicity (Figure 2A) and phytotoxicity from BA+GA$_{4+7}$ was minimal (Figure 2B). However, a 100-ppm BA spray resulted in moderate leaf burn (Figure 2C) and BA+BA$_{4+7}$ elicited more severe leaf burn (Figure 2D). There was no phytotoxicity observed following a 25-ppm drench of BA or BA+GA$_{4+7}$. When grown in the greenhouse until flowering, all the scorched leaves were covered by newly developed leaves; hence, the visual appearance of the finished crop was unimpaired. Occasionally, these newly developed leaves on plants drenched or sprayed with BA or BA+GA$_{4+7}$ were irregular in morphology (Figure 3). However, these irregular leaves formed on a few plants and did not influence the plant quality.

Branching Response of Poinsettia

After growing the poinsettias under the 16-hour long days at 73° F for seven weeks, plants were moved to 68° F under a nine-hour photoperiod and grown until flowering. At flowering, data collection included the number of shoots, time to flower and plant height. Each pot contained one primary shoot, which was the rooted cutting that was pinched three weeks after transplant. Secondary shoots were those that developed in the leaf axils of the primary shoot after pinch. We observed that the poinsettias treated with BA and BA+GA$_{4+7}$ developed additional tertiary shoots in the leaf axils of secondary shoots (Figure 4). When the number of shoots was recorded at flowering, the number of secondary and tertiary shoots was reported separately.

At flowering, the number of secondary shoots on the poinsettias treated with BA and BA+GA$_{4+7}$ were similar to that of non-treated controls (Figure 5). However, poinsettias treated with a spray of 50- or 100-ppm BA or BA+GA$_{4+7}$ had more tertiary shoots at flowering compared with the non-treated controls. The number of tertiary shoots on the plants drenched with BA or BA+GA$_{4+7}$ was similar to that of non-treated controls. The timing of PGR application did not influence the number of shoots.

Joyce Latimer reported that BA sprays delayed flowering of some echinacea cultivars. In this study, BA treatment did not influence the flowering time of poinsettia 'Freedom Red'. Application of GA$_{4+7}$ promotes stem extension of many plants, including poinsettias. When a poinsettia crop is too short, such as from an overapplication of a plant growth retardant, a spray application of GA$_{4+7}$ at much lower rates (3-5 ppm) is recommended to promote stem extension and increase plant height. In our study, the application of GA$_{4+7}$ earlier in the developmental stage and at much higher rates did not influence poinsettia flowering height.

Although the poinsettias sprayed with BA or BA+GA$_{4+7}$ had more tertiary shoots, the bracts covered these additional shoots at flowering. Hence, the increased branching did not improve the visual quality of the plants compared with the non-treated controls (Figure 6). Therefore, in the production scheme used in this study, an application of BA or BA+GA$_{4+7}$ was not cost effective. We are currently evaluating whether BA or BA+GA$_{4+7}$ applications can increase branching and improve the visual appearance of non-pinched poinsettia.

Influence of BA on Postharvest Quality

Geraniums are often grown at a pot-to-pot spacing to maximize use of greenhouse space. Consequently, the lower leaves often turn chlorotic or die, requiring manual removal of leaves before shipping (Figure 7). Since sprays of BA+GA$_{4+7}$ inhibit lower leaf loss of lilies, our goal was to determine if BA or BA+GA$_{4+7}$ applications would inhibit lower leaf loss and thus improve the postharvest quality of geranium. Geranium 'Pinto Red' seedlings grown in 128-cell plugs were transplanted into 4-inch round containers in a peat-based medium and grown at a pot-to-pot spacing in a glass greenhouse set at 68° F under a 16-hour photoperiod provided by high-pressure sodium lamps. When at least 80 percent of the plants had visible flower buds (38 days from transplant), they were sprayed with 2½-, 5- or 10-ppm BA or BA+GA$_{4+7}$. These rates were based on preliminary experiments in which higher rates were phytotoxic to plants. A second group of plants was sprayed with the same concentrations of PGRs when more than 80 percent of the plants were flowering (45 days after transplant).

When the foliage of treated plants was dry (approximately three hours after the PGR application), plants were moved to a growth chamber set at 59° F and stored in the dark for four days to simulate long-distance shipping. The plants were then moved and stored in another growth chamber set at 68° F under a 12-hour photoperiod provided by fluorescent lamps (about 40 foot-candles of light) to simulate a retail store environment. Plants were stored such that leaves of adjacent plants touched

$BA+GA_{4+7}$ application time	$BA+GA_{4+7}$ spray rate (ppm)	Storage duration (weeks)	Percentage decrease in the number of chlorotic and necrotic leaves
At visible bud	2.5	2	23
	5		45
	10		48
	2.5	4	8
	5		31
	10		22
At flowering	2.5	2	60
	5		48
	10		54
	2.5	4	51
	5		31
	10		41

Table 1. *Percentage decrease in the number of chlorotic and necrotic leaves of geranium sprayed with $BA+GA_{4+7}$ at visible bud (38 days after transplant) or flowering (45 days after transplant) compared with the non-treated controls.*

Figure 7. *Geraniums are often grown pot-to-pot, which causes lower leaves to turn chlorotic and necrotic. Therefore, growers manually remove these lower leaves before shipping, which requires a substantial amount of labor and results in a less appealing plant.*

and were watered when necessary. The number of chlorotic and necrotic leaves was recorded two and four weeks after the initiation of storage.

Phytotoxicity Symptoms

Geraniums were extremely sensitive to BA and produced phytotoxicity symptoms at moderately low rates. In a preliminary trial, a foliar spray of 50-ppm BA and higher produced severe necrosis of young leaves of geranium and, subsequently, the necrotic leaves abscised. Following a foliar spray of BA at only 20 ppm, prominent leaf burn was observed (Figure 8). Therefore, it is essential that growers conduct their own small-scale trials to prevent phytotoxicity on geranium as well as other crops.

Postharvest Quality of Geranium

BA alone did not inhibit leaf chlorosis or necrosis of geranium 'Pinto Red' stored for two or four weeks. However, plants sprayed with $BA+GA_{4+7}$ had fewer chlorotic and necrotic leaves after two and four weeks of storage compared with the non-treated controls (Table 1). $BA+GA_{4+7}$ sprays at flowering were more effective in delaying leaf chlorosis and necrosis compared with sprays at the visible bud stage. After two weeks of storage, plants sprayed with $BA+GA_{4+7}$ at flowering had up to 60 percent fewer chlorotic and necrotic leaves compared with the non-treated controls. However, after two-week storage, all treated and nontreated plants were visually unappealing because of the low-light conditions and tight spacing and, hence, were unmarketable (Figure 9). Additional research investigating the influence of $BA+GA_{4+7}$ sprays on the inhibition of leaf chlorosis and necrosis after shorter storage durations is currently under way.

Summary

In conclusion, BA sprays can increase the number of tertiary shoots in poinsettia, and $BA+GA_{4+7}$ sprays can delay lower leaf chlorosis and necrosis in geranium. The reduction in the number of lower geraniums that were dead or chlorotic has tremendous commercial potential. In contrast, the increased branching observed with poinsettia did not improve plant quality in our treatments. Growers should conduct their own small-scale trials to determine appropriate rates and more importantly, evaluate whether applications of BA or $BA+GA_{4+7}$ produce phytotoxicity symptoms. When used appropriately, BA and $BA+GA_{4+7}$ can improve the quality of some potted crops, although the effects appear to be rather species-specific.

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Figure 8. *A foliar spray of 20-ppm BA caused phytotoxicity in geranium.*

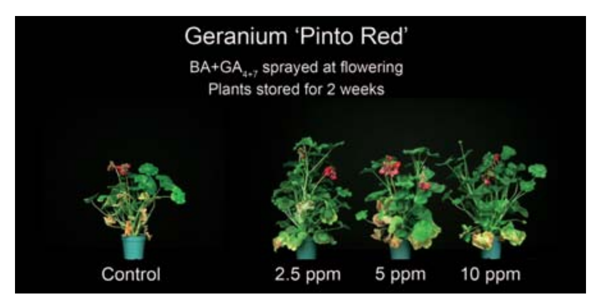

Figure 9. *A single foliar spray application of $BA+GA_{4+7}$ at flowering produced fewer chlorotic and necrotic leaves on geranium after two weeks of storage compared with non-treated controls. Treated and non-treated plants were both unmarketable after the two-week storage because of the low light levels and tight plant spacing in the postharvest environment.*