# Growth Regulators

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# Promotion of Camellia Flower Bud Set with Plant Growth Regulators

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**Index Words:** Flower initiation, *Camellia japonica*, B-Nine, Daminozide, Bonzi, Paclobutrazol, Sumagic, Uniconazole

**Nature of Work:** During container production of Camellia (*Camellia japonica* L.), most cultivars set flower buds by three years after propagation from cuttings. There are some cultivars, however, that are slow to develop flower buds and may take three or more years to initiate flowering. This makes sales difficult because most customers prefer to purchase plants that are flowering or ready to flower. Previous research has shown that plant growth regulators (PGRs) applied at the appropriate time can stimulate earlier flower bud initiation of Rhododendron (2, 3) and Kalmia (1, 2). In this study, the application of PGRs was investigated for promotion of flower initiation of Camellia.

The study was conducted at a nursery in Virginia specializing in the production of Camellias (Bennett's Creek Wholesale Nursery, Inc., Suffolk, VA). Three Camellia cultivars with a record of being slow to set flower buds were selected. These included 'Grace Albritton', 'Paulette Goddard', and 'Sea Foam'. The plants were all in 3-gallon containers and were three years from propagation by cuttings. They had not yet started to flower. Treatments were applied on June 4, 2001. The vegetative buds of 'Grace Albritton' were swelling but had not yet begun active growth. Both 'Paulette Goddard' and 'Sea Foam' were actively growing and had new shoots several centimeters in length. The plants were all in shade houses under 50% shade, and were maintained in these houses through the summer. During the winter months, the houses were covered with white polyethylene. Treatments were applied as sprays, and included B-Nine, 5000 ppm; Bonzi, 80, 120, 160, 200, and 240 ppm; Sumagic, 30, 45, 60, 75, and 90 ppm; and a water spray control. The treatments were applied with a CO2-pressurized sprayer at 30 psi, to wet the foliage and stems. The B-Nine was applied a second time on June 22. All other treatments were applied only once. A randomized complete block design was used, with eight single-plant replications per treatment. On Sept. 28, plant heights and widths were measured. Flower buds were counted Feb. 13, 2002. Data were analyzed with analysis of variance, with mean separation by LSD, P=0.05. Each cultivar was analyzed as a separate experiment.

**Results and Discussion:** The results varied considerably depending upon cultivar. With 'Grace Albritton' there was a significant increase in flower buds with 240 ppm Bonzi, and with 45 to 90 ppm Sumagic (Table 1). With 'Paulette Goddard', there was a small but significant increase in flower bud numbers with 30, 60, and 90 ppm Sumagic (Table 2). For these two cultivars, Sumagic treatments also resulted in smaller plants, primarily due to a suppression of plant heights (Tables 1 and 2). With 'Sea Foam', there was no significant increase in flower bud numbers, and no effect on plant size (Table 3). The differences in response to the PGR treatments could be due to cultivar differences or it could be due to growth stage differences at time of application. 'Sea Foam', the least responsive cultivar, had grown the most at time of treatment application, while 'Grace Albritton', the most responsive, had grown the least. 'Paulette Goddard' was intermediate both in PGR response, and in shoot growth at time of treatment application. Application timing will be a subject of future research.

**Significance to Industry:** It is important for consumers that the camellias they purchase are at a stage at which they are flowering, or ready to flower. It may be economically unfeasible to produce certain cultivars if they do not flower for several years. For these cultivars, it may be possible to promote earlier flower bud initiation with the use of PGRs. For 'Grace Albritton', a 45 to 90 ppm Sumagic spray applied at vegetative bud swell provided a significant increase in flower bud set for the following season.

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**Literature Cited:**

1. Banko, T.J. and R.E. Bir. 1999. Use of growth retardants to promote flowering of Mountain Laurel, *Kalmia latifolia* L. J. Environ. Hort. 17:11-17.
2. Gent, M.P.N. 1995. Paclobutrazol or uniconazole applied early in the previous season promotes flowering of field-grown *Rhododendron* and *Kalmia*. J. Plant Growth Reg. 14:205-210.
3. Stuart, N.W. 1961. Initiation of flower buds in *Rhododendron* after application of growth retardants. Science 134:50-52.

**Table 1.** Effect of growth regulators on plant size and flower bud set of *Camellia* 'Grace Albritton'.

| Growth Regulator | Conc. (ppm) | height (cm) | width (cm) | Bud Number |
|---|---|---|---|---|
| **Control** | **0** | 115.6a[z] | 49.8abc | 6d |
| **B-Nine** | **5000[y]** | 109.4ab | 49.1abcd | 5d |
| **Bonzi** | **80** | 104.8abcd | 49.5abcd | 6d |
| | **120** | 105.1abc | 50.4ab | 8d |
| | **160** | 108.9ab | 47.9abcde | 7d |
| | **200** | 101.6bcd | 52.1a | 8d |
| | **240** | 108.9ab | 51.0ab | 12bcd |
| **Sumagic** | **30** | 94.0cd | 39.8f | 11cd |
| | **45** | 97.5bcd | 45.6bcdef | 22ab |
| | **60** | 95.8cd | 41.6ef | 20abc |
| | **75** | 96.1cd | 43.5cdef | 24a |
| | **90** | 92.6d | 43.3def | 28a |

[z]Mean separation by LSD, P = 0.05.

[y]B-Nine applied twice, 2 weeks between applications.

**Table 2.** Effect of growth regulators on plant size and flower bud set of *Camellia* 'Paulette Goddard'.

| Growth Regulator | Conc. (ppm) | height (cm) | width (cm) | Bud Number |
|---|---|---|---|---|
| Control | 0 | 74.5a[z] | 51.4abcd | 3b |
| B-Nine | 5000[y] | 69.5ab | 55.9a | 6ab |
| Bonzi | 80 | 74.3a | 54.0a | 3b |
| | 120 | 69.6ab | 47.1bcd | 4ab |
| | 160 | 66.3bc | 51.4abcd | 3b |
| | 200 | 71.0ab | 53.1ab | 7ab |
| | 240 | 75.9a | 51.5abcd | 3b |
| Sumagic | 30 | 58.8de | 50.0abcd | 9a |
| | 45 | 58.0def | 50.4abcd | 7ab |
| | 60 | 60.5cd | 51.9abc | 8a |
| | 75 | 53.3ef | 46.3cd | 7ab |
| | 90 | 51.1f | 45.1d | 9a |

[z]Mean separation by LSD, P = 0.05. NS = not significant at P, 0.05.

[y]B-Nine applied twice, 2 weeks between applications.

**Table 3.** Effect of growth regulators on plant size and flower bud set of *Camellia* 'Sea Foam'.

| Growth Regulator | Conc. (ppm) | height (cm) | width (cm) | Bud Number |
|---|---|---|---|---|
| Control | 0 | 107.9[z] | 61.9 | 2 |
| B-Nine | 5000[y] | 110.0 | 55.1 | 1 |
| Bonzi | 80 | 111.1 | 59.9 | 2 |
| | 120 | 116.3 | 57.8 | 2 |
| | 160 | 117.5 | 56.3 | 0 |
| | 200 | 116.0 | 60.6 | 1 |
| | 240 | 115.0 | 57.0 | 2 |
| Sumagic | 30 | 109.9 | 57.4 | 4 |
| | 45 | 107.9 | 54.5 | 2 |
| | 60 | 108.0 | 53.4 | 2 |
| | 75 | 104.1 | 59.8 | 0 |
| | 90 | 108.9 | 57.9 | 3 |
| | | NS | NS | NS |

[z]Mean separation by LSD, P = 0.05. NS = not significant at P, 0.05.

[y]B-Nine applied twice, 2 weeks between applications.

# Growth Response of Container-grown Herbaceous Perennials to Ethephon, Daminozide, Paclobutrazol and Uniconazole

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**Index Words:** Plant Growth Regulators, Growth Retardant, Bonzi, B-Nine, Florel, Sumagic, *Echinacea*, *Rudbeckia*, *Monarda*, *Sedum*, *Liatris*

**Nature of Work:** The objective of this study was to determine which plant growth regulators (PGRs) reduced the height and improved the quality and overall appearance of five container-grown herbaceous perennial species. The study focused on the sales and production departments of a wholesale nursery whose needs included a strong desire to decrease blow-over (decrease height) and to produce plants with comparatively denser growth habits.

On April 13, 2001, uniform, 2-gallon containers of *Echinacea purpurea* 'White Swan', *Rudbeckia fulgida* 'Goldsturm', *Monarda didyma* 'Gardenview Scarlet', *Sedum* x 'Autumn Joy' and *Liatris spicata* 'Floristan White' were selected from the nursery's inventories, placed in an experiment area at the end of a container production row and maintained by the grower under normal nursery practices. Plants had been potted using a pine bark medium with a 19-5-19 slow release fertilizer incorporated at 10 lbs/yd$^3$, and lime incorporated at 4 lbs/yd$^3$. On April 20, treatments were applied to all species except Liatris using a handheld $CO_2$-pressurized sprayer at a rate of 2 qt/100ft$^2$. At the time of treatment, temperature was 65F and the relative humidity (RH) was 38%. Treatments included foliar sprays of B-Nine at 5000 ppm (x3) (application repeated on May 4 & 23); Bonzi at 80, 120, 160, 200 and 240 ppm; Sumagic at 15, 30, 45 and 60 ppm; and Florel at 500 ppm (x1) and 500 ppm (x2) (application repeated on May 4: temp 84F, RH 26%). On May 23, soil drenches of Bonzi at 2, 4, 8 and 16 ppm were applied to the *Liatris* at a rate of 500 ml/container. Temperature was 64F and RH was 53%. Each species was arranged in a randomized complete block design, blocked by initial plant size, and evaluated as a separate experiment. The *Monarda* study consisted of 9 treatments with 8 replications; the *Sedum* study consisted of 12 treatments with 8 replications; the *Echinacea* and *Rudbeckia* studies consisted of 13 treatments with 10 replications; and the *Liatris* study consisted of 5 treatments with 8 replications. Plant height (Ht) and two widths (Wd =1/2(widest width plus orthogonal width)) were measured at two-week intervals until plants were in full bloom (6 to 12 weeks). Additionally, for the *Monarda*, *Echinacea* and *Rudbeckia* studies, nursery personnel visually rated each individual plant at the end of the experiment. The data were analyzed using analysis of variance (ANOVA) with mean separation by least significant difference (LSD), P=0.05.

**Results and Discussion:** *Echinacea purpurea* 'White Swan'. Growth reduction was observed for varied periods of time with all rates of B-Nine, Bonzi, Sumagic and Florel (Table 1). Significant reductions in growth over the longest period of time (6 weeks) occurred with B-Nine at 5000 ppm (x3), Florel at 500 ppm (x2) and Sumagic at 60 ppm. Shorter periods of growth retardation occurred with Bonzi at 80 and 240ppm, Sumagic at 45 ppm and Florel at 500 ppm (x1) (4 weeks each). Two treatments, Florel at 500 ppm (x2) and Sumagic 60 ppm, showed an undesirable reduction in width. The nursery's visual ratings for this species indicate a preference for Florel at 500 ppm (x1), and Bonzi at 200 and 60 ppm (Table 4).

*Rudbeckia fulgida* 'Goldsturm'. Significant reduction in growth over the longest period of time (10 weeks) was observed with B-Nine at 5000 ppm (x3) (Table 2). Shorter periods of effectiveness were observed with Sumagic at 45 and 60 ppm (4 weeks each). The Bonzi treatments showed growth retardation only at 2WAT and the Florel treatments had no effect on growth. The nursery's visual ratings for this species indicate no significant preference for any treatment; however, the fact that the control group ranked last may support evidence of treatment effect in this study (Table 4).

*Monarda didyma* 'Gardenview Scarlet'. Significant reduction in growth over the longest period of time (6 weeks) was observed with B-Nine at 5000 ppm (x3) and Florel at 500 ppm (x2) (Table 3). The nursery's visual ratings for this species indicate no significant preference for any treatment; however, the B-Nine and Florel treatments ranked highest, and the controls ranked last (Table 4).

*Sedum* x 'Autumn Joy'. Short-term growth reduction was observed with several rates of Bonzi and Sumagic at 2WAT. However, at 4WAT, only Sumagic at 45 and 60 ppm provided significant height control (data not shown). No response was observed after 4WAT.

*Liatris spicata* 'Floristan White'. There was no evidence of reduced growth due to PGRs in this study (data not shown).

**Significance to the Industry:** Our research contains both measurement and ratings data and their analysis indicates that no one product or treatment produced the desired effects in all species evaluated. Additionally, the ratings and measurement data did not always coincide. This variation suggests that attributes other than height and width determine the overall success of a PGR application. The ratings were conducted at the end of the study (7WAT) when the effects of many of the PGRs had been outgrown by most of the plants. Persistence or the lack of it seems to have an affect on the desirability of a treatment response. Stem density (branching) and flowering time were other attributes considered in the ratings data that were not accounted for in the measurement data. Future studies might investigate the effect on stem density using a combination of pruning and PGRs, the effect of flowering—delayed or accelerated—and the proportional relationship between the pot size and the flowering plant.

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**Table 1.** Growth response of Echinaceae purpurea 'White Swan' at 2, 4 and 6 weeks after treatment (WAT) with foliar sprays of growth regulators.

| | Conc. | 2WAT | | 4WAT | | 6WAT | |
|---|---|---|---|---|---|---|---|
| PGR | (ppm) | Ht (cm) | Wd (cm) | Ht (cm) | Wd (cm) | Ht (cm) | Wd (cm) |
| Control | 0 | 18.8a[z] | 25.1a | 32.4a | 27.1a | 50.1ab | 31.4 |
| B-Nine | 5000 x3[y] | 14.5b | 22.0bc | 24.4bcd | 23.9bcd | 41.8cd | 28.5 |
| Bonzi | 80 | 14.4b | 23.8abc | 24.1bcd | 24.9abc | 47.7abc | 29.4 |
| | 120 | 15.2b | 23.7abc | 28.4ab | 26.6ab | 49.9ab | 30.4 |
| | 160 | 14.7b | 23.0abc | 25.3ab | 24.7abcd | 51.3a | 28.6 |
| | 200 | 12.9bc | 24.2ab | 26.1abc | 25.7abc | 51.5a | 30.8 |
| | 240 | 12.5bc | 23.5abc | 22.9bcde | 25.0abc | 42.3bcd | 28.4 |
| Sumagic | 15 | 15.3b | 23.4abc | 27.2abc | 25.7abc | 50.9a | 29.4 |
| | 30 | 14.2b | 23.9ab | 26.4abc | 25.8abc | 44.2abcd | 29.7 |
| | 45 | 13.5b | 22.0bc | 21.5cde | 23.4cd | 45.2abcd | 29.6 |
| | 60 | 10.2c | 22.25bc | 17.5e | 23.5cd | 37.3d | 26 |
| Florel | 500 | 12.7bc | 23.1abc | 22.7bcde | 26.5ab | 42.5bcd | 30.2 |
| Florel | 500 x2[x] | 13.4bc | 21.5c | 19.0de | 22.0d | 37.4d | 25.9 |
| | | | | | | | NS |

[z]Mean separation within columns by LSD (P = 0.05). NS = not significant at P = 0.05.

[y]B-Nine treatment applied three times at two-week intervals.

[x]Florel treatment applied twice at two-week intervals.

**Table 2.** Growth response of *Rudbeckia fulgida* 'Goldsturm' at 2, 4, 6 and 10 weeks after treatment (WAT) with foliar sprays of growth regulators.

| | Conc | 2WAT | | 4WAT | | 6WAT | | 10WAT | |
|---|---|---|---|---|---|---|---|---|---|
| PGR | (ppm) | Ht (cm) | Wd (cm) | Ht (cm) | Wd (cm) | Ht (cm) | Wd (cm) | Ht (cm) | Wd (cm) |
| Control | 0 | 19.6a[z] | 33.7a | 29.2ab | 37.5ab | 54.1abc | 49.0ab | 70.7ab | 59.1ab |
| B-Nine | 5000 x3[y] | 15.0ef | 30.6cde | 22.9e | 32.9d | 42.1d | 40.0c | 63.6c | 49.7d |
| Bonzi | 80 | 18.1abc | 32.8ab | 30.4a | 36.7abc | 54.3ab | 48.6ab | 69.8ab | 57.5abc |
| | 120 | 17.2bcd | 32.7ab | 30.2a | 37.3ab | 53.6abc | 48.5ab | 71.7ab | 56.3abc |
| | 160 | 17.0cd | 32.9ab | 30.3a | 37.8a | 56.0a | 49.5ab | 73.1a | 55.9abc |
| | 200 | 17.1cd | 32.7ab | 29.9ab | 37.4ab | 55.7bc | 48.1ab | 72.1ab | 53.3cd |
| | 240 | 17.5bcd | 31.6bcd | 27.7abc | 38.0a | 52.0bc | 51.9a | 67.7bc | 57.9abc |
| Sumagic | 15 | 16.4de | 30.7cde | 29.6ab | 36.9abc | 54.7ab | 47.8ab | 68.8ab | 56.3abc |
| | 30 | 15.3ef | 30.2cde | 26.7bcd | 35.8abc | 55.1ab | 47.7ab | 70.3ab | 60.9a |
| | 45 | 15.1ef | 29.7e | 25.4cde | 34.4cd | 52.8abc | 45.8b | 72.8a | 55.7abc |
| | 60 | 14.2f | 30.0de | 23.7de | 35.4abcd | 50.3c | 49.66ab | 69.2ab | 55.3abc |
| Florel | 500 | 18.7ab | 32.0abc | 30.0ab | 34.8bcd | 55.6ab | 49.3ab | 69.3ab | 53.9bcd |
| | 500 x2[x] | 19.4a | 31.3bcde | 29.8ab | 34.1cd | 52.9abc | 45.2b | 69.1ab | 54.7bcd |

[z]Mean separation within columns by LSD (P = 0.05).

[y]B-Nine treatment applied three times at two-week intervals.

[x]Florel treatment applied twice at two-week intervals.

**Table 3.** Growth response of Monarda didyma 'Gardenview Scarlet' at 2, 4 and 6 weeks after treatment (WAT) with foliar sprays of growth regulators.

| PGR | Conc. (ppm) | 2WAT Ht (cm) | 2WAT Wd (cm) | 4WAT Ht (cm) | 4WAT Wd (cm) | 6WAT Ht (cm) | 6WAT Wd (cm) |
|---|---|---|---|---|---|---|---|
| Control | 0 | 32.3a[z] | 30.9a | 43.3a | 34.4bc | 57.8a | 46.1abc |
| B-Nine | 5000 x3[y] | 29.8bc | 30.0ab | 38.4bc | 33.1bc | 50.8bc | 43.1de |
| Bonzi | 80 | 29.4bc | 30.6ab | 36.0cd | 33.1bc | 56.4a | 44.5bcde |
| | 120 | 30.6ab | 29.1b | 41.1ab | 32.6c | 55.8a | 42.6de |
| | 160 | 30.4ab | 30.3ab | 41.0ab | 33.4bc | 55.0abc | 43.6cde |
| Sumagic | 15 | 30.4ab | 29.8ab | 43.0a | 34.8ab | 57.1a | 46.3ab |
| | 30 | 29.8bc | 29.8ab | 41.6ab | 34.6ab | 57.4a | 44.8bcd |
| | 45 | 27.8cd | 30.4ab | 39.0bc | 36.4a | 55.4ab | 47.5a |
| Florel | 500 x2[x] | 26.4d | 26.2c | 33.5d | 30.6d | 50.6c | 41.9e |

[z]Mean separation within columns by LSD (P = 0.05).

[y]B-Nine treatment applied three times at two-week intervals.

[x]Florel treatment applied twice at two-week intervals.

**Table 4.** Treatment ranks based on nursery personnel's visual ratings of individual plants at 7 weeks after treatment (WAT). Rating values: 1=least desirable to 5=most desirable.

| Rank | *Echinacea purpurea* PGR | *Echinacea purpurea* Visual rating | *Rudbeckia fulgida* PGR | *Rudbeckia fulgida* Visual Rating | *Monarda didyma* PGR | *Monarda didyma* Visual Rating |
|---|---|---|---|---|---|---|
| 1 | Florel 500 (x1) | 4.3a[z] | Sumagic 60 | 4.0 | B-Nine 5000 (x3) | 3.6 |
| 2 | Bonzi 200 | 3.9ab | Sumagic 45, Florel 500 (x2) | 3.9 | Florel 500 (x2) | 3.5 |
| 3 | Bonzi 60 | 3.3abc | B-Nine 5000 (x3) | 3.7 | Bonzi 120 | 3.4 |
| 4 | Control, Bonzi 240, Sumagic 45 | 3.2bc | Florel 500 (x1) | 3.6 | Bonzi 160 | 3.3 |
| 5 | B-Nine 5000 (x3), Sumagic 30, Florel 500 (x2) | 3.1bc | Bonzi 160, Sumagic 15 | 3.5 | Bonzi 80 | 3 |
| 6 | Sumagic 15 | 2.8c | Bonzi 0, Bonzi 200, Sumagic 30 | 3.4 | Sumagic 15, Sumagic 45 | 2.9 |
| 7 | Bonzi 80, Bonzi 120 | 2.6c | Control, Bonzi 120, Bonzi 240 | 3.2 | Sumagic 30 | 2.8 |
| 8 | Sumagic 60 | 2.5c | | | Control | 2.6 |
| | | | | NS | | NS |

[z]Mean separation within columns by LSD (P=0.05). NS = not significant at P=0.05.

# Influence of PGRs and Fertilizer Rate on the Growth of *Tradescantia virginiana* L.

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**Index Words:** *Tradescantia*, spiderwort, plant growth regulator, fertilizer, herbaceous perennial

**Nature of Work:** Spiderwort (*Tradescantia virginiana*) is a flowering herbaceous perennial. Little information is available about its production requirements. The purpose of this project was to determine fertilizer and plant growth regulator (PGR) rates yielding high quality growth of *Tradescantia* in a greenhouse production setting. Plant growth regulators (PGRs) are commonly applied to container-grown plants to control stem elongation and produce compact plants (Tayama et al., 1992). Two experiments were conducted with three *Tradescantia* cultivars, the first with four fertilization levels and the second with ascending rates of three PGRs.

The following cultivars were provided by Yoder-Green Leaf Perennials: 'Angel Eyes,' 'Blue Stone,' and 'Red Cloud.' The plugs (54 cell size) were planted in 4.25” (11.43 cm) pots in March 2002 and grown under greenhouse conditions. For the first experiment, fertilizer treatments consisting of 0, 100, 200 and 300 ppm N from 15-16-17 Peter's Peat Lite Special began two weeks after transplant. For the PGR experiment, treatments were applied as a foliar spray two weeks after transplant, and consisted of Bonzi (paclobutrazol) at 0, 40, 80, 120, or 160 ppm; Sumagic (uniconazole) at 0, 15, 30, 45, or 60 ppm; and TopFlor (flurprimidol) at 0, 15, 30, 45, 60, or 75 ppm. Plant height and width and percentage of plants flowering were measured every two weeks for both experiments. Media pH and electrical conductivity (EC) were also measured every two weeks using the pour-through extraction method. For the fertilizer experiment shoots were harvested, dried, and dry weights recorded. Data were subjected to repeated measures analysis of variance (only summary data at time of study termination presented here).

**Results and Discussion:** Fertilizer application rate affected cultivar height (Table 1). 'Blue Stone' and 'Angel Eyes' were tallest after nitrogen (N) application at 100 ppm, while 'Red Cloud' was tallest after N application at 200 ppm (Table 2). 'Blue Stone' was the tallest cultivar; 'Angel Eyes' was the widest, and 'Red Cloud' plants were the smallest 10 weeks after treatments began. Cultivars of herbaceous species can differ in response to fertilizer rates (Whipker et al., 1999). At 100 and 200 ppm N all three cultivars had 100% flowering from six weeks into the experiment until the experiment's end at 10 weeks. As a result of using an acidic fertilizer our media pH dropped on average approximately 1 point over our 10-week experiment. Media EC increased with increasing fertilization rates and was affected by cultivar (data not shown). 'Red Cloud' had higher EC values than either 'Blue Stone' or 'Angel Eyes.' These higher EC values could in part be due to plant size. 'Red Cloud' is the smallest cultivar and this could possibly impact soluble salts uptake, resulting in higher EC values due to the lower nutritional demands in comparison with the other cultivars. 'Blue Stone' had greater dry weight and height reduction in comparison with other cultivars when fertilized at 300 ppm N. Shoot dry weights of 'Angel Eyes' and 'Red Cloud' were similar when they were fertilized with 100 and 200 ppm N, while the dry weight of 'Blue Stone' at these rates was about 15 g heavier. Nitrogen rates between 100 and 200 ppm appeared to produce the most marketable plants.

Bonzi, Sumagic and TopFlor were all effective in reducing *Tradescantia virginiana* height and width (Table 2). The Bonzi rate most effective at reducing plant height was 120 ppm, regardless of *Tradescantia* cultivar (Table 1). At this rate, plant height was 26.5% less than the non-treated control. Width of cultivars differed, but at 120 ppm Bonzi, width of 'Angel Eyes' was suppressed by 14%, 'Blue Stone' by 21%, and 'Red Cloud' by 14% when compared with controls at 6 weeks after treatment. Application of Bonzi did not delay or inhibit flowering and no phytotoxicity was noted for any Bonzi rate. Effective height control of *Tradescantia* cultivars appeared to be achieved with Sumagic application at 45 ppm. Height of all cultivars was controlled; 'Blue Stone' height was suppressed by 45%, 'Red Cloud' by 24% and 'Angel Eyes' by only 3% when compared with non-treated controls at 6 weeks after treatment. At the same application level, width was 13%, 23%, and 49% less than the control for 'Red Cloud,' 'Blue Stone,' and 'Angel Eyes,' respectively. Sumagic did not delay flowering of any cultivars, nor was any phytotoxicity noted. The most effective TopFlor application rate for control of *Tradescantia* height was 45 ppm. With TopFlor application at 45 ppm, average cultivar height was 20% shorter than non-treated controls. At the recommended rate, 'Angel Eyes' width was suppressed 10%, 'Blue Stone' 15%, and 'Red Cloud' 18%. TopFlor rate did not affect time to flower or percentage flowering plants.

Bonzi, Sumagic and TopFlor were all effective in reducing *Tradescantia virginiana* height and width. TopFlor was the most effective PGR at reducing height of all cultivars tested during our experiment. Overall, it appears that 'Angel Eyes' is the cultivar least likely to respond to PGR application. 'Blue Stone' is the largest cultivar in height and also appeared to respond to lower PGR rates. 'Red Cloud' response in height and width usually ranged between the other two cultivars.

**Significance to Industry:** The results indicate that Bonzi, Sumagic and TopFlor are effective at suppressing *Tradescantia* plant growth. Effectiveness of PGR seemed to be dependent upon cultivar vigor, but the rates we recommended appear to provide some growth suppression regardless of cultivar vigor. Cultivars all differed in height, but among the three cultivars we studied fertilization rates of 100 and 200 ppm produced uniform plants in size and quality, so we recommend the lower value, 100 ppm N from a complete fertilizer.

**Literature cited:**

1. Tayama, H.K., R.A. Larson, P.A. Hammer, and T.J. Rolls (eds.). 1992. Tips on the use of chemical growth regulators on floriculture crops. Ohio Florists' Assn., Columbus, Ohio.
2. Whipker, B., S. Dasoju, M. Dosmann, and J. Iles. 1999. Effect of fertilizer concentration on growth of double impatiens. HortTechnology 9 (3): 425-428.

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**Table1.** Plant height, percent plants flowering and shoot dry weight (g) of three *Tradescantia virginiana* cultivars after treatment with ascending rates of a 15-16-17 complete Peter's Peat Lite Special fertilizer. Data presented is for 10 weeks after treatment. (AE = 'Angel Eyes,' BS = 'Blue Stone,' and RC = 'Red Cloud').

| Rate | Plant height (cm) | | | % Plants flowering | | | Shoot dry weight (g) | | |
|---|---|---|---|---|---|---|---|---|---|
| Applied | AE | BS | RC | AE | BS | RC | AE | BS | RC |
| 0 | 16.6 | 25.9 | 15.0 | 25.0 | 100 | 100 | 22.6 | 31.5 | 21.1 |
| 100 | 42.6 | 47.3 | 30.3 | 100 | 100 | 100 | 39.7 | 55.6 | 38.1 |
| 200 | 30.5 | 40.3 | 34.0 | 100 | 100 | 100 | 42.9 | 54.8 | 41.7 |
| 300 | 27.9 | 32.5 | 26.8 | 50.0 | 100 | 100 | 38.8 | 43.0 | 38.1 |
| | Q* | Q* | Q* | Q* | NS | NS | Q* | Q* | Q* |

NSNonsignificant or *significant quadratic (Q) effects at P≤0.05

**Table 2.** Plant height, width and percent plants flowering of three *Tradescantia virginiana* cultivars 6 weeks after foliar application of plant growth regulator at recommended rate. (AE = 'Angel Eyes,' BS = 'Blue Stone,' and RC = 'Red Cloud').

| | Rate | Plant height (cm) | | | Plant width (cm) | | | % Plants flowering | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Applied | AE | BS | RC | AE | BS | RC | AE | BS | RC |
| | 0 | 22.8 | 25.6 | 24.8 | 43.5 | 47.0 | 44.0 | 8.33 | 85.0 | 25.0 |
| Bonzi | 120 | 18.5 | 16.9 | 18.6 | 35.8 | 37.0 | 38.0 | 30.0 | 0.00 | 100 |
| Sumagic | 45 | 22.8 | 15.0 | 18.4 | 44.8 | 36.7 | 37.5 | 50.0 | 100 | 75.0 |
| TopFlor | 45 | 21.0 | 20.3 | 18.1 | 35.8 | 40.0 | 37.0 | 25.0 | 75.0 | 100 |

# Chemical Defoliants on Fall Harvested Bare Root Nursery Crops

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**Key Words:** Ornamental crops, *Cercis canadensis* L., *Pyrus calleryana* Decne. 'Aristrocrat', and *Malus spp.* Mill. 'Yellow Delicious'

**Nature of Work:** Natural defoliation of field-grown nursery stock is frequently later than desired for efficient harvest for bare root plants. Trees and shrubs are harvested bare root in late fall and early winter then shipped to other producers or stored in cold storage facilities until late winter for shipment to northern regions. Delayed fall defoliation and plant harvest can delay fall shipping and expose plants to early fall freezes and thus result in increased cold damage. Controlled early defoliation of field-grown plants would allow the nursery producer to harvest and replant earlier in the fall, ship earlier for fall planting, and avoid exposure to early cold freezes. Leaves retained on plants during storage result in increased disease occurrence, yet leaf removal by hand prior to digging or prior to storage is common and costly. Some growers that produce field grown liner stock attempt to hasten defoliation by root-pruning the plants. Ethephon, a growth regulator, is labeled for defoliation on some ornamental crops, but results have varied from species to species and from year to year. Chemical defoliation can eliminate the laborious task and expense of hand stripping plants and decrease the disease occurrence caused by the decaying leaves in storage (Davison, Peterson, and Mecklenburg, 1994). Defoliants are used successfully in the cotton industry to increase harvest efficiency and reduce harvest cost by removing the foliage as well as open the bolls for easier harvesting (Ball and Glover 2002). Early removal of leaves of nursery stock may influence hormone interactions, storage of carbohydrates and nutrients in shoots and roots, or influence growth the following growing season (Syndor and McCartney, 1996). Treatments are needed that will promote quick defoliation in the fall without significant damage to buds to twigs, or reduced growth next year. A project was initiated to study the effect of chemical defoliants on nursery crops that typically have a late leaf drop or has historically had freeze damage from early fall freezes. Therefore, the objectives were to evaluate the effects of chemical defoliation and their residual effect on bud break, leaf out and regrowth the following spring on selected ornamental plants.

On 11 October 2002, *Malus spp.* Mill. 'Yellow Delicious' apple, *Pyrus calleryana* Decne. 'Aristocrat' pear, and *Cercis canadensis* L. redbud were selected in field plantings at two nurseries in McMinnville, Tenn. 'Aristocrat' and 'Golden Delicious' were one-year budded liners and redbud was one-year old seedlings. Chemical treatments included foliar solutions of 1) 14% CuEDTA at 0.25%, 0.50%, or 0.75% a.i., 2) ethephon (sold commercially as Florel 21.7%) at 1000 and 2000 ppm, and 3) a 6% a.i. of soybean oil mix. Additionally, two control groups were included; plants allowed to defoliate naturally and plants hand defoliated on 16 Oct. Treatments were arranged in a randomized block design with four replications of three trees ('Golden Delicious') or two trees ('Aristocrat') and a linear foot of seedling row (redbud) per experimental unit with each species treated as a separate experiment. 'Aristocrat' and 'Golden Delicious' had at least 2 guard plants between treatments and redbud had one foot of untreated seedlings between treatments. Prior to chemical application, leaves on each treated plant were counted and recounted every 7 days for nine weeks after treatment. In mid-December 2002, all plants were harvested bare root and placed in cold storage until March 2003. Two plants from each experimental unit were replanted in a field location at the TSU Nursery Crop Research Station on 14 March 2003, using standard nursery practices. Bud break, leaf out, regrowth, and bud or stem damage were evaluated biweekly for ten weeks following planting. Damage was rated with the following scale, 1 = healthy, 2 = terminal die back to the 2nd leaf node, 3 = terminal die back to the 3rd leaf node, 4 = terminal die back exceeding 4th leaf node, 5 = dead. Plants were arranged in a completely randomized design by species and analyzed as separate experiments. Data were analyzed with mean separation by LSD using SAS statistical package version 8.0.

**Results and Discussion:** *Malus spp.* Mill. 'Yellow Delicious'. CuEDTA (14%) at 0.50 and 0.75% a.i. induced the greatest amount of leaf abscission, 30 and 38%, respectively, one week (25 October) after foliar application (Fig. 1). Control plants retained 100% of their foliage until 8 November (4 weeks after treatment, WAT) when plants exhibited 18% natural defoliation compared to 81 and 87% leaf abscission with 0.50 and 0.75% a.i. CuEDTA. Sprays of 1000 or 2000 ppm of Florel (ethephon) or 6% soybean oil caused responses similar to the natural defoliation control plants at all observation dates. At harvest on 20 December, plants treated with 0.50 and 0.75% a.i. CuEDTA had almost 100% defoliation whereas the control plants still retained 30% of their leaves.

*Pyrus calleryana* Decne. 'Aristocrat'. Significant leaf drop (50%) occurred on plants treated with 0.75% CuEDTA within 4 WAT compared to 3% leaf drop on plants left to defoliate naturally (Fig. 1). Trees treated with 0.25% and 0.50% CuEDTA had 30% leaf drop by 4 WAT, but less effective than 0.75% CuEDTA. Sprays of 1000 or 2000 ppm Florel (ethephon) or 6% soybean oil had insignificant effects on leaf abscission throughout the test. 'Aristocrat' pears typically defoliate during mid November, but due to the mild fall temperatures, leaf retention was greater than 69% at 7 WAT (29 Nov).

*Cercis canadensis* L. Within 1 WAT, plants treated with 0.75% CuEDTA had dropped 44% of their leaves, and dropped 81% by 2 WAT (Fig. 1). Between 1 and 4 WAT (16 Oct and 8 Nov) naturally defoliated plants had less than 5% natural leaf drop, but a frost on 16 Nov caused a significant leaf drop on all plants in the experiment. Redbuds are susceptible to fall frosts and freezes and can exhibit bark splitting, terminal dieback, and death. Other species in the test were not affected as drastically by the cold temperatures as the seedling redbuds.

Spring bud break and regrowth. Redbud and 'Yellow Delicious' apple trees exhibited no adverse visual affects from defoliation treatments with regards to spring bud break, leaf out and regrowth (data not shown). During the first ten weeks after spring planting, all plants had a spring flush. On 22 Nov (6 WAT) and prior to bare root harvest, the authors observed terminal dieback on 'Aristocrat' pear with the hand defoliated control plants. In spring, terminal damage was evident 4 WAP (weeks after planting) on hand defoliated control plants and leaf out vigor was less than on the naturally defoliated control plants (Table 1, only 3 rating dates shown). CuEDTA at 0.75% suppressed leaf out but plants showed no visual signs of terminal damage. On 15 May (9 WAP), plants hand defoliated and those treated with CuEDTA at 0.75% still exhibited reduced leaf vigor. Hand defoliated plants sprouted along the trunk and overgrew the damaged terminals. The authors believe the hand defoliated pears did not fully achieve winter dormancy and as a result the terminals were damaged by normal cold temperatures.

**Significance to Industry:** There is a potential for using chemical defoliants to allow early harvest of bareroot field grown nursery stock. 'Yellow Delicious' apple, which are typically hand defoliated prior to fall harvest, were ready for harvest 4 WAT when treated with 0.75% a.i. CuEDTA (14%) compared to 10 WAT with naturally defoliated plants. Within 3 WAT, redbuds treated with 0.75% a.i. CuEDTA (14%) had less than 20% leaf retention compared to control plants that retained more than 70% of the foliage. Foliar applications of CuEDTA had less effect on leaf abscission with 'Aristocrat' pear than other species tested, and had a residual effect on spring regrowth. From this data, it is evident that response to the defoliants is species dependent. More ornamental species need to be evaluated to determine the effects of chemical defoliants and the interaction with plant regrowth the following spring.

**Acknowledgement:** The authors are grateful to W. Edgar Davis and Sue Scholl (USDA), Cumberland Valley Nursery and Bottoms Brothers Nursery in McMinnville, TN for their cooperation with this project.

**Literature Cited:**

1. Ball, Shane T. and Charles Glover. 2002. Defoliants, desiccants, and growth regulators used on New Mexico cotton. University of New Mexico Guide A-217.
2. Davison, Harold, Curtis Peterson, and Roy Mecklenburg. 1994. Nursery Management Administration and Culture. 3rd ed.: Prentice Hall Career and Technology, Englewood Cliffs, NJ.
3. Syndor, T. Davis and Robert B. McCartney. 1996. The influence of defoliation on flowering dogwood. Journal of Arboriculture 22(5):218-221.

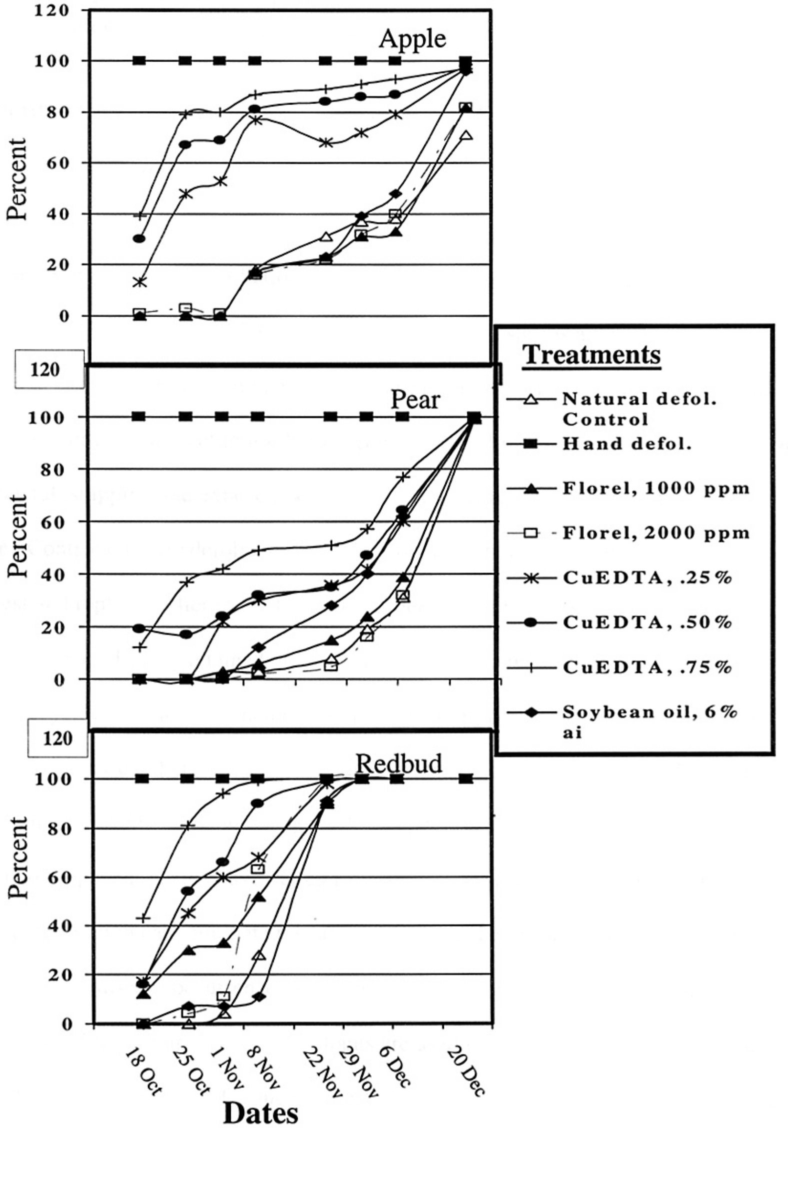
**Table 1.** Influence of chemical defoliants on spring leaf-out and damage on *Pyrus calleryana* 'Aristocrat'.

| | | 16 April 2003 | | 30 April 2003 | | 15 May 2003 | |
|---|---|---|---|---|---|---|---|
| Treatment | Rate | Leaf- out (%) | Damage | Leaf- out (%) | Damage | Leaf- out (%) | Damage |
| Naturally defoliated control | - | 13.0 ab[Z] | 1.0 b[Y] | 46.2 a | 1.0 b | 100.0 a | 1.0b |
| Hand defoliated control | - | 1.5 c | 4.5 a | 3.7 d | 4.2 a | 52.5 b | 2.5a |
| Florel (ethephon, 21.7%) | 1000 ppm | 17.5 ab | 1.0 b | 30.0 ab | 1.0 b | 100.0 a | 1.0b |
| Florel (ethephon, 21.7%) | 2000 ppm | 9.0 ab | 1.0 b | 32.5 ab | 1.0 b | 55.5 b | 1.0b |
| CuEDTA (14%) | 0.25% a.i. | 21.2 a | 1.0 b | 58.8 a | 1.0 b | 77.5 ab | 1.0b |
| CuEDTA (14%) | 0.50% a.i. | 6.5 b | 1.0 b | 21.2 bc | 1.0 b | 100.0 a | 1.0b |
| CuEDTA (14%) | 0.75% a.i. | 2.0 c | 1.0 b | 5.0 cd | 1.0 b | 58.8 b | 1.0b |
| Soybean oil mix | 6.0% a.i. | 11.5 ab | 1.0 b | 46.2 a | 1.0 b | 70.0 ab | 1.0b |
| LSD | | 4.5 | 0.25 | 17.9 | 0.4 | 29.3 | 0.3 |

[Z]Mean separation within columns separated by LSD, ≤ 5%.

[Y]Damage rating scale, 1 = healthy, 2 = terminal die back to the 2nd leaf node, 3 = terminal die back to the 3rd leaf node, 4 = terminal die back exceeding 4th leaf node, 5 = dead.

**Fig. 1.** Effect of chemical defoliants on percent fall leaf abscission on *Cercis canadensis*, redbud, *Malus spp.* 'Yellow Delicious,' apple, and *Pyrus calleryana* 'Aristocrat' pear.



# Ornamental Sweet Potato Response to Bonzi and Sumagic

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**Index Words:** *Ipomoea batatas* 'Margarita', paclobutrazol, uniconazole

**Nature of Work:** Ornamental sweet potatoes are becoming more popular with the plant buying public with at least eight varieties available (1). These plants are aggressive in the landscape and make a very good annual ground cover. This rapid growth is a potential problem for retailers. Frequently at retail locations, plants in 4" cups become so entangled that some consumers may not purchase due to the initial problem of untangling the plants. Pinching of these plants at the retailer may only exacerbate the problem by encouraging more lateral growth. Perhaps the use of plant growth regulating compounds could provide control during the retail phase of the production cycle. Bonzi and Sumagic are very effective compounds used to control the growth of many species of ornamental plants during the production phase. Use of these products enable the grower to effectively handle and transport these plants, but also aid the retailer by limiting growth prior to sale to the homeowner. However, plants treated with triazole growth regulators may inhibit landscape growth due to carryover effects of the growth regulating compound. The objective of this study was to evaluate the response of ornamental sweet potato to Bonzi and Sumagic and subsequent landscape growth.

The study was conducted at the Nursery Research and Service Center at Tennessee Tech University. The ornamental sweet potato 'Margarita' (*Ipomoea batatas* 'Margarita') was chosen due to its aggressive growth habit. Plugs were transplanted into 10 cm square containers using Promix BX container media. Plant growth regulator treatments consisted of either Bonzi (paclobutrazol) or Sumagic (uniconazole) applied as either foliar sprays or container media drenches. Foliar sprays for Bonzi consisted of 0 (control), 20 ppm, 40 ppm, or 80 ppm and for Sumagic 0 (control), 5 ppm, 10 ppm, or 20 ppm. All foliar sprays were applied at a rate of 200ml/m$^2$. Container drenches consisted for Bonzi consisted of 0 (control), 1, 2, or 5 mg/containers and for Sumagic 0 (control), 0.5, 1, or 2 mg/container. Container drench volume was 25 ml/container. Data collected included leaf area (5 mature leaves) measured 49 days after treatment (DAT), growth area are as measured from digital pictures. Observation of landscape performance of treated plants was also performed. One treated plant from each treatment group were installed in the landscape 49 DAT and rated after 35 days. This data was strictly observational and not analyzed statistically.

**Results and Discussion:** While the application of PGRs resulted in reductions in leaf area when compared to control treatments, there were large differences between application methods. Drench applications resulted in larger decreases in leaf area than foliar applications. The Bonzi treatments resulted in reductions in leaf area up to 26% (80 ppm foliar application) and 77% (5 mg ai drench application) when compared to the control treatments (Table 1). The Sumagic treatments resulted in reductions in leaf area up to 27% (20 ppm foliar application) and 55% (2 mg ai drench application) when compared to the control treatments. The resulting control on plant growth from the foliar sprays of both compounds was similar for the rates used, with the exception of Bonzi spray at 20 ppm.

The growth area was measured from digital images. A 1cm grid was overlaid on the image and spaces covered by the plants were counted. A similar growth trend as leaf area was observed with growth area index. Bonzi treatments resulted in leaf area reduction up to 28% (40 ppm and 80 ppm foliar application) and 60% (5 mg ai drench application) when compared to the control treatments (Table 2). Sumagic treatments resulted in leaf area reduction up to 21% (20 ppm foliar application) and 70% (2 mg ai drench application) when compared to the control treatments.

Visual landscape performance was affected by application method and treatment rate. The landscape growth of plants treated with foliar sprays of both compounds was similar in comparison to the control except for the highest rates which resulted in plants of reduced growth. The drench treatments of both compounds resulted in reduced landscape growth. Only the lowest rate of Bonzi (1 mg ai) was similar to the controls plants in overall growth.

**Significance to the Industry:** Bonzi and Sumagic may be an acceptable tool for growers and retailers to control the growth of ornamental sweet potato “Margarita”; however, the use of high treatment rates could prove to be a determent due to the reduction of growth in the landscape and less than ideal performance for the homeowner.

**Literature Cited:**

1. Owings, Allen, Drew Bates, and Stephen Crnko. 2000. Landscape Performance of Ornamental Sweet Potato Cultivars. V45:425-427.

**Table 1.** Leaf area of five mature leaves from Ipomoea batatas 'Margarita' treated with either Bonzi or Sumagic as either foliar spray or container drenches.

| Bonzi Spray | | Bonzi Drench | | Sumagic Spray | | Sumagic Drench | |
|---|---|---|---|---|---|---|---|
| Control | 181.95 a[z] | Control | 168.24 a | Control | 174.59 a | Control | 178.24 a |
| 20 ppm | 167.69 ab | 1 mg ai | 77.61 b | 5 ppm | 149.94 b | .5 mg ai | 92.40 b |
| 40 ppm | 149.57 bc | 2 mg ai | 83.49 b | 10 ppm | 132.23 b | 1 mg ai | 81.79 b |
| 80 ppm | 134.66 c | 5 mg ai | 57.29 c | 20 ppm | 128.79 b | 2 mg ai | 80.13 b |

[z]Mean separation within columns by least significant difference (LSD), $P$=0.05. Different letters indicate significant difference.

**Table 2.** Growth area index *Ipomoea batatas* 'Margarita' treated with either Bonzi or Sumagic as either foliar spray or container drenches.

| Bonzi Spray | | Bonzi Drench | | Sumagic Spray | | Sumagic Drench | |
|---|---|---|---|---|---|---|---|
| Control | 742.79 a[z] | Control | 689.43 a | Control | 670.75 a | Control | 710.56 a |
| 20 ppm | 599.27 b | 1 mg ai | 399.59 b | 5 ppm | 675.45 a | .5 mg ai | 360.78 b |
| 40 ppm | 529.63 b | 2 mg ai | 366.19 b | 10 ppm | 581.29 b | 1 mg ai | 241.35 c |
| 80 ppm | 532.74 b | 5 mg ai | 274.50 c | 20 ppm | 532.61 b | 2 mg ai | 211.15 c |

[z]Mean separation within columns by least significant difference (LSD), $P$=0.05. Different letters indicate significant difference.

# BA-Induced Shoot Formation in Indian Hawthorn

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**Index Words:** Indian hawthorn, *Rhaphiolepis indica* (L.) Lindl. 'Olivia', plant growth regulator (PGR), benzyladenine (BA), N-phenyl-1*H*-purin-6-amine, BAP-10

**Nature of Work:** Indian hawthorn displays little natural branching during commercial production, and without pruning, plants are sparsely branched, mis-shapened, and unmarketable. Plants in 3.8 liter (1 gal.) containers require at least one pruning and 18 to 20 months from liners to a marketable stage, while those in 11.4 liter (3 gal.) containers require two additional prunings and another 9 to 12 months of production. Three or more weeks of active growing time may be lost with each pruning (3). Exogenous applications of cytokinins, including benzyladenine (BA), have been shown to promote axillary bud growth and branching in various woody landscape plants (1). Response to single applications of up to 2500 ppm BA was species dependent. However, multiple applications of 2500 to 5000 ppm BA were much more effective in promoting shoot formation than a single application (2). Therefore our objective was to investigate the effects of multiple applications of BA on shoot formation in Indian hawthorn. An outdoor nursery study was conducted in 2001 with the Indian hawthorn cultivar 'Olivia' in 3.8 liter (1 gal.) and 26.5 liter (7 gal.) containers. BA (BAP-10, Plant-Wise Biostimulant Co., Louisville, KY) was applied weekly at concentrations up to 5000 ppm in 1250 ppm increments. Foliar sprays included 0.2% (v/v) Buffer X (Kalo Agr. Chemicals, Overland, KS), a nonionic surfactant, and were applied with a compressed air sprayer equipped with a flat spray nozzle at 1.4 $kg/cm^2$ (20 psi). BA applications were halted at the first signs of abnormal foliar development in any treatment. Plants in 3.8 liter (1 gal.) containers received three applications and plants in 26.5 liter (7 gal.) containers received two applications. Data were collected 30 days after initial treatment (DAIT), and included quantification of new shoots that measured at least 2.5 cm (1 in) long with unfurling leaves. Plants in 26.5 liter (7 gal.) containers were retreated with two applications in September, during a time of natural dormancy. Data were collected 30 DAIT, and included the same parameters.

**Results and Discussion:** New shoot formation increased linearly ($P = 0.001$) with increasing BA concentrations on plants in 3.8 liter (1 gal.) containers. Plants treated with 1250 ppm and 5000 ppm BA formed 169% and 331%, respectively, more new shoots than controls. Plants in 26.5 liter (7 gal.) containers also increased linearly ($P = 0.001$) with increasing BA concentrations. Controls formed an average of 4.7 new shoots. With BA applications, new shoots increased from an average of 83 with 1250 ppm BA up to 126 with 5000 ppm BA. At this time plants displayed abnormal leaf curling and discoloration when higher BA concentrations were applied. These symptoms were transitory, but severe enough to avoid concentrations above 2500 ppm BA. The second series of applications on the 26.5 liter (7 gal.) 'Olivia' resulted in a linear increase ($P = 0.001$) in new shoots with increasing BA concentrations. Controls formed an average of less than one new shoot, while plants treated with 1250 ppm BA formed an average of 18 new shoots and those treated with 5000 ppm BA formed an average of 105 new shoots at 30 DAIT.

**Significance to industry:** Cultivars of Indian hawthorn typically require multiple prunings during production for the development of well-branched marketable plants. With three weekly applications of 1250 to 5000 ppm BA, chemical stimulation of axillary budbreak is stimulated and there is little or no need for mechanical pruning to produce well-branched marketable plants. However, concentrations above 2500 ppm may result in unacceptable adverse effects on plant appearance.

**Literature Cited:**


1. Keever, G.J., and W. J. Foster. 1990. Chemically induced branching of woody landscape plants. J. Environ. Hort. 8(2):78-82.
2. Keever, G. J. and T. A. Morrison. 2003. Multiple benzyladenine applications increase new shoot formation in nandina. J. Environ. Hort. 21:in press.
3. Vander Woude, S. June 2002. Early Pruning Equals More Dollars. NM Pro. P. 57-58.


**Table 1.** New shoot formation in 'Olivia' Indian hawthorn grown in 3.8 liter (1 gal.) and 26.5 liter (7 gal.) containers following multiple applications of BA applied in 2001.[z]

| BA concn. (ppm) | New shoots[y] | | |
|---|---|---|---|
| | 3.8 liter (1 gal.) | 26.5 liter (7 gal.) | |
| | | 1st Series | 2nd Series |
| 0 | 1.6 | 4.7 | 0.2 |
| 1250 | 4.3 | 82.5 | 17.7 |
| 2500 | 5.5 | 81.5 | 46.8 |
| 3750 | 6.9 | 87.7 | 75.7 |
| 5000 | 6.9 | 125.5 | 105.2 |
| Siginifance[x] | L*** | L*** | L*** |

[z]Benzyladenine (BA) was applied to plants in 3.8 liter containers on June 22, June 29, and July 6, 2001. Plants in 26.5 liter containers were treated on June 27 and July 6. A second series of treatments were applied to plants in 26.5 liter containers on September 19 and September 26. Data were collected 30 DAIT for plants in 3.8 liter containers and both application series for plants in 26.5 liter containers.

[y]New shoots measured at least 2.5 cm (1 in) long and leaves were unfurling.

[x]Regression response linear (L) at P= 0.001 (***).