Effect of Plant Growth Regulators on Growth and Flowering of Potted Red Firespike

Amir Rezazadeh¹, Richard L. Harkess, and Guihong Bi

ADDITIONAL INDEX WORDS. Odontonema strictum, uniconazole, paclobutrazol, daminozide, flurprimidol, chlormequat

SUMMARY. The effect of plant growth regulators (PGRs) on growth and flowering of potted red firespike (Odontonema strictum) were examined in two experiments. In Expt. 1, foliar spray applications of daminozide, uniconazole, paclobutrazol, or flurprimidol or media drenches of paclobutrazol or flurprimidol were applied. In Expt. 2, foliar spray application of daminozide or media drenches of paclobutrazol or flurprimidol were further tested for efficacy of height control. Both studies included an untreated control. In Expt. 1, drench applications of paclobutrazol and flurprimidol resulted in plants 65% or 46% to 62% shorter than control, respectively. Paclobutrazol and flurprimidol drenches also decreased overall plant growth by 81% to 88% and 74% to 84%, respectively, compared with the control plants. PGRs did not affect number of inflorescences; however, paclobutrazol and flurprimidol delayed flowering 23 to 31 days. In Expt. 2, plants treated with flurprimidol or paclobutrazol drenches were shorter than the control. The greatest reduction in total plant growth occurred using a flurprimidol drench at 0.47 mg/pot, which resulted in plants 78% smaller than the untreated control. Paclobutrazol and flurprimidol increased the time to flowering 11 to 27 days and 10 to 26 days, respectively. The most attractive and well-shaped plants were achieved with flurprimidol applied at 0.24 mg/pot or applications of paclobutrazol at 0.35 mg/pot.

R ed firespike is a vigorous ornamental shrub growing to ≈6 ft in height. It has an upright growth habit and is commonly cultivated as an ornamental plant in the garden due to its attractive tubular red flowers (Daniel, 1995). The plant has potential for introduction as a flowering potted plant because of its attractive red spikes of flowers and shiny green leaves. However, without height control, firespike grows too tall, exceeding the commercial requirements for potted plants. Thus, control of firespike stem elongation is necessary to provide an aesthetically balanced, desirable, and marketable product.

PGRs are commonly used as an effective technique to restrict stem elongation to achieve aesthetically and commercially pleasing plants. Most PGRs act by inhibiting different steps during the biosynthesis of gibberellins (GAs) responsible for stem elongation in plants (Rademacher, 2000). In addition to type of PGR, plant height can be influenced by concentration, time of application, number of applications, method of application, formulation, and growing substrate composition (Barrett and Bartuska, 1982; Gilbertz, 1992; Ruter, 1992). The most important issue when using PGRs is determining the most effective application method and concentration for consistent results.

Several PGRs effectively inhibit stem elongation of ornamental plants and influence the time of flowering. The triazole class of PGRs, including flurprimidol, uniconazole, and paclobutrazol, are one of the largest commercially used groups of PGRs. They have been shown to be effective for height control and producing compact plants (Krug et al., 2005; Warner and Erwin, 2003). The triazoles are often more effective than other PGRs in inhibiting GA synthesis, so high concentrations can result in excessive height control and stunted plants (Latimer and Whipker, 2012). Sanderson et al. (1988) compared five application methods of paclobutrazol and reported a substrate drench was the most effective method for controlling plant height. In a study on purple firespike (Odontonema callistachyum), plant height was 56% and 46% shorter than the control
using drenches of paclobutrazol and flurprimidol at 3.35 and 1.77 mg/pot, respectively (Rezaadeh and Harkess, 2015). Flurprimidol is effective as a foliar spray or substrate drench for height control (Currey and Lopez, 2011; Krug et al., 2005). Diaminozide is not a triazole but rather suppresses plant height by reducing the conversion of GA to active forms of GA and reducing translocation of GA to actively growing tissues (Rademacher, 1991). Whipker and Dasouj (1998) reported that spray application of diaminozide at 4000 to 8000 ppm resulted in marketable size potted sunflower (Helianthus annuus) plants.

Specific PGR recommendations for red firespike have not been previously described. This study was conducted to determine the efficacy of flurprimidol, paclobutrazol, uniconazol, and diaminozide PGRs on the growth and flowering of potted red firespike.

Materials and methods
Vegetative stock plants of red firespike were maintained under long days to prevent floral initiation occurring before starting the experimental treatments. In Jan. 2014, medial, single-node cuttings of red firespike were rooted. Four weeks later, the rooted cuttings were transplanted to 6-inch-diameter pots containing a commercial potting substrate (Sunshine Mix 1; Sun Gro Horticulture, Bellevue, WA) and grown under natural daylength in a double-layered polyethylene covered greenhouse. One plant was grown per container. Greenhouse air temperature set points were 64/74 °F (night/day). Plants were irrigated and fertilized as in the first experiment. Foliar spray applications of diaminozide at 8, 10, 15, 10,000 ppm; paclobutrazol substrate drenches at 0.30 mg/pot applied twice, 0.35, 0.47, or 0.59 mg/pot; or flurprimidol substrate drenches at 0.24 mg/pot, 0.24 mg/pot applied twice, 0.35 mg/pot, or 0.47 mg/pot were applied when the new axillary shoots were 3 to 5 cm long. Both studies included an untreated control. In both experiments, plants of similar size were selected for uniformity before the PGRs were applied.

A complete randomized design with treatments replicated 10 times was used for both experiments. At the end of each experiment (20 weeks after sticking cuttings), final plant height (from the soil level to the top point of the plant), width (the average of the width measured at the widest point of the plant and 90° to the widest point), growth index [GI=\(\pi \times (\text{average width}/2)^2 \times \text{height}\)], total leaf area (LI-3100 area meter; LI-COR, Lincoln, NE), total plant dry weight, number of inflorescences, length of inflorescences from the base of the peduncle to the terminus, and days from date of sticking the cutting to first visible flower bud were recorded. Days to flowering were calculated from sticking the cutting to the date when the first immature inflorescence was observed (i.e., visible bud). Data were analyzed using the GLM procedure of SAS (version 9.8; SAS Institute, Cary, NC) to determine the efficacy of the PGRs on growth and flowering of fire-}

Results and discussion

**EXPT. 1.** All substrate drench applications of paclobutrazol and flurprimidol effectively limited stem elongation and thus final plant height of red firespike (Table 1). Maximum height control was obtained with paclobutrazol or flurprimidol drenches, resulting in plants 65% or 46% to 62%, respectively, shorter than the untreated control. However, high concentrations of paclobutrazol and flurprimidol drench resulted in excessive height control negatively affecting plant aesthetics. Although spray applications of diaminozide, paclobutrazol, and flurprimidol resulted in plants shorter than the control, there were no differences within PGR in final plant height due to spray application concentration (Table 1). Previous studies reported drench applications of paclobutrazol were more effective than foliar sprays (Cox and Keever, 1988; Cramer and Bridgen, 1998) as was also observed in this study. Plant width followed a similar pattern where the greatest reduction in plant width was observed in plants treated with paclobutrazol or flurprimidol drenches. Plant width tended to decrease as paclobutrazol or flurprimidol drench concentration increased (Table 1).

Comparing the GI, all PGRs were effective at limiting plant growth compared with the control. The decrease in GI was related to both restricted plant height and width following PGR application. Drench applications of paclobutrazol or flurprimidol were particularly effective in limiting growth. Paclobutrazol and flurprimidol drenches decreased the GI by 81% to 88% and 74% to 84%, respectively, compared with control plants (Table 1); however, the highest concentrations excessively limited plant growth and resulted in aesthetically unpleasant plants. Only the highest concentrations of uniconazole, paclobutrazol, and flurprimidol sprays and the paclobutrazol and flurprimidol drenches effectively restricted leaf expansion (Table 1). It was also observed that plants drenched with paclobutrazol or flurprimidol had
Table 1. Plant final height, width, growth index \( \text{GI} = \pi \times (\text{average width}/2)^2 \times \text{height} \), leaf area, dry weight, inflorescence number, inflorescence length, and days to flowering (from sticking cuttings to first visible flower bud) in red firespike were measured following spray or drench applications of daminozide, uniconazole, paclobutrazol, or flurprimidol.

| Treatment       | Rate \(^a\) | Method | Plant ht (cm) \(^x\) | Plant width (cm) | GI \(^y\) | Leaf area \((\text{cm}^2)\) \(^x\) | Plant dry wt (g) \(^y\) | Inflorescence (No.) | ht (cm) | Time to flower (d) |
|-----------------|-------------|--------|----------------------|------------------|-----------|-------------------------------|-----------------------|---------------------|---------|-------------------|
| Control         | 2,500 ppm   | Spray  | 45.5 c               | 36.0 a–c         | 46,733 d–f | 3,103 a–d                     | 47 a–c               | 3.0 ab              | 19.2 b–d | 129 g             |
| Daminozide      | 5,000 ppm   | Spray  | 46.5 bc              | 35.0 a–c         | 45,044 fe  | 3,384 a–c                     | 45 a–d               | 3.2 ab              | 23.2 b–d | 131 g             |
| Uniconazole     | 20 ppm      | Spray  | 46.7 bc              | 34.8 c–e         | 44,106 fe  | 3,384 a–c                     | 45 a–d               | 3.2 ab              | 23.2 b–d | 131 g             |
|                 | 30 ppm      | Spray  | 47.7 bc              | 39.2 ab          | 57,036 b–d| 3,384 a–c                     | 44 b–e               | 2.5 b               | 17.3 cd  | 135 e–g           |
|                 | 45 ppm      | Spray  | 57.2 a               | 37.0 a–d         | 60,027 b   | 2,986 b–d                     | 44 b–e               | 2.5 b               | 17.3 cd  | 135 e–g           |
| Paclobutrazol   | 10 ppm      | Spray  | 47.7 bc              | 39.7 a           | 58,192 bc  | 3,253 a–d                     | 47 a–c               | 3.3 ab              | 22.5 b–d | 136 e–g           |
|                 | 20 ppm      | Spray  | 50.0 bc              | 34.0 c–e         | 45,142 fe  | 3,399 a–c                     | 45 a–d               | 3.0 ab              | 26.7 ab  | 139 g             |
|                 | 40 ppm      | Spray  | 50.8 b               | 34.2 c–e         | 57,369 b   | 3,062 a–d                     | 46 a–d               | 3.3 ab              | 23.5 b–d | 137 d–g           |
|                 | 60 ppm      | Spray  | 50.8 b               | 34.2 c–e         | 45,623 fe  | 3,044 a–d                     | 42 de                | 3.0 ab              | 19.8 b–d | 137 d–g           |
|                 | 80 ppm      | Spray  | 50.7 bc              | 33.5 de          | 45,100 fe  | 3,635 ab                       | 47 a–d               | 3.0 ab              | 19.8 b–d | 137 d–g           |
|                 | 100 ppm     | Spray   | 49.7 bc              | 32.0 e           | 39,697 f   | 2,986 b–d                     | 42 de                | 3.0 ab              | 19.8 b–d | 137 d–g           |
|                 | 0.59 mg/pot | Drench  | 24.0 e               | 27.0 fg          | 13,491 g   | 2,627 d–f                      | 42 de                | 3.0 ab              | 19.8 b–d | 137 d–g           |
|                 | 1.2 mg/pot  | Drench  | 21.8 e               | 23.0 gh          | 13,491 g   | 2,627 d–f                      | 42 de                | 3.0 ab              | 19.8 b–d | 137 d–g           |
|                 | 1.77 mg/pot | Drench  | 20.7 e               | 22.7 h           | 13,491 g   | 2,627 d–f                      | 42 de                | 3.0 ab              | 19.8 b–d | 137 d–g           |
| Flurprimidol    | 45 ppm      | Spray   | 49.7 bc              | 34.8 c–e         | 47,745 c–f| 3,190 a–d                     | 46 a–d               | 3.3 ab              | 25.8 a–c | 135 e–g           |
|                 | 60 ppm      | Spray   | 51.5 b               | 35.0 b–e         | 50,398 b–e| 3,174 a–d                     | 45 a–e               | 3.7 a               | 24.0 bc  | 136 e–g           |
|                 | 80 ppm      | Spray   | 49.5 bc              | 33.2 de          | 42,504 ef  | 2,975 b–d                     | 44 b–e               | 3.0 ab              | 26.7 ab  | 139 g             |
|                 | 100 ppm     | Spray   | 49.5 bc              | 33.2 de          | 42,504 ef  | 2,975 b–d                     | 44 b–e               | 3.0 ab              | 26.7 ab  | 139 g             |
|                 | 0.24 mg/pot | Drench  | 31.8 d               | 27.5 f           | 18,361 g   | 2,259 e–g                      | 39 ef                | 1.8 cd              | 19.8 b–d | 150 a–d           |
|                 | 0.47 mg/pot | Drench  | 22.7 e               | 23.2 gh          | 11,253 g   | 1,819 gh                       | 31 g                | 1.2 d               | 15.0 d   | 159 a             |

\(^{a}2\times \text{or } 3\times \text{represents two or three applications applied at 2-week intervals; } 1 \text{ ppm } = 1 \text{ mg/L; } 1 \text{ mg } = 3.5274 \times 10^{-5} \text{ oz.}\)

\(^{b}1 \text{ cm } = 0.3937 \text{ inch; } 1 \text{ cm}^2 = 0.0610 \text{ inch}^2; 1 \text{ cm}^3 = 0.1550 \text{ inch}^3; 1 \text{ g } = 0.0353 \text{ oz.}\)

\(^{c}\text{Means within a column followed by the same letter are not significantly different according to the Fisher’s protected least significant difference means comparison test at } P = 0.05.\)
PGR application has been reported in sunflower (Dasouju et al., 1998) and bleeding heart [Dicentra spectabilis (Kim et al., 1999)].

EXPT. 2

Spray applications of paclobutrazol, flurprimidol, or uniconazole provided minimal height control of red firespike in Expt. 1 and were not included in Expt. 2. Paclobutrazol and flurprimidol drenches and daminozide sprays were examined at lower rates in Expt. 2. Daminozide applied twice at 10,000 ppm resulted in plants 18.8 cm shorter than untreated plants (Table 2). The increased rates of daminozide required to affect height may make use of this PGR impractical.

Plants were shorter than the control after treatment with paclobutrazol and flurprimidol drenches, which provided the most height control (Table 2). However, excessive dwarfing occurred when plants received 0.24 to 0.47 mg/pot flurprimidol or 0.35 or greater mg/pot paclobutrazol (Table 2). All rates of flurprimidol drenches excessively restricted plant width compared with untreated control plants (Table 2). Paclobutrazol or daminozide had less effect on plant width and were similar in width to the control at most rates.

Compared with the control plants, overall plant size, as represented by GI, was considerably reduced by GI, was considerably reduced by paclobutrazol drenches, which had less and also greatly affected by daminozide. Leaf area was also greater restricted in plants treated with daminozide (Table 2). Paclobutrazol had less effect on plant width and was similar in width to the control at most rates.

Leaf area was also greatly affected by paclobutrazol and flurprimidol drenches with less leaf area than paclobutrazol or daminozide (Table 2). Daminozide-sprayed plants had less effect on plant width and were similar in width to the control at most rates.

Table 2. Plant final height, width, growth index [GI = \pi \times \text{(average width/2)}^2 \times \text{height}], leaf area, dry weight, branch number, inflorescence number, inflorescence length, and days to flower (from sticking cuttings to first visible flower bud) in red firespike were measured following spray or drench applications of daminozide, paclobutrazol, or flurprimidol.

| Treatment    | Rate* Method | Plant ht (cm) | Plant width (cm) | GI (cm^3) | Leaf area (cm^2) | Plant dry wt (g) | Inflorescence (No.) ht (cm) | Time to flower (d) |
|--------------|--------------|---------------|------------------|-----------|-----------------|-----------------|--------------------------|-------------------|
| Control      | 8,000 ppm Spray | 57.8 a x 30.8 a | 45.8 bc | 27.8 a-c | 9,320 a | 2.8 a-c | 29.7 a | 108 f |
| Daminozide   | 10,000 ppm Spray | 55.0 ab | 29.0 a-c | 36,401 ab | 3,454 ab | 29 a-c | 2.7 a-c | 23.8 a-c | 113 d-f |
|              | 10,000 ppm Spray | 39.0 cd | 26.3 b-f | 21,253 c-e | 2,822 c | 25 cd | 1.7 c | 17.3 c-e | 115 d-f |
|              | 15,000 ppm Spray | 54.0 ab | 30.8 a | 41,889 a | 2,398 d | 33 a | 3.5 ab | 27.8 ab | 115 d-f |
| Paclobutrazol| 0.3 2× mg/pot Drench | 33.8 de | 30.2 ab | 23,741 cd | 1,979 e | 25 c | 3.7 ab | 27.3 ab | 119 cd |
|              | 0.35 mg/pot Drench | 26.8 cf | 26.0 c-f | 14,592 d-f | 2,146 de | 27 bc | 2.5 a-c | 20.7 b-c | 121 b-d |
|              | 0.47 mg/pot Drench | 36.5 c-e | 28.3 a-d | 24,030 cd | 2,096 de | 26 c | 2.3 bc | 23.3 a-d | 130 ab |
|              | 0.59 mg/pot Drench | 31.6 d-f | 28.7 a-c | 20,479 c-e | 1,353 f | 26 c | 3.5 ab | 24.8 a-c | 135 a |
|              | 0.24 2× mg/pot Drench | 29.8 d-f | 25.0 c-f | 14,491 d-f | 2,029 e | 33 a | 3.0 a | 15.5 de | 118 c-e |
|              | 0.24 2× mg/pot Drench | 21.5 f | 24.5 d-f | 10,774 ef | 2,262 de | 20 d | 3.7 a | 22.3 a-d | 130 ab |
|              | 0.35 mg/pot Drench | 26.7 cf | 23.8 ef | 12,611 ef | 2,196 de | 26 c | 3.0 a | 21.0 b-d | 125 bc |
|              | 0.47 mg/pot Drench | 21.5 f | 23.7 d-f | 9,320 f | 1,519 f | 25 c | 3.3 a | 12.5 e | 134 a |
| Flurprimidol | 0.24 mg/pot Drench | 29.8 d-f | 25.0 c-f | 14,491 d-f | 2,029 e | 33 a | 3.0 a | 15.5 de | 118 c-e |
|              | 0.24 mg/pot Drench | 21.5 f | 24.5 d-f | 10,774 ef | 2,262 de | 20 d | 3.7 a | 22.3 a-d | 130 ab |
|              | 0.35 mg/pot Drench | 26.7 cf | 23.8 ef | 12,611 ef | 2,196 de | 26 c | 3.0 a | 21.0 b-d | 125 bc |
|              | 0.47 mg/pot Drench | 21.5 f | 23.7 d-f | 9,320 f | 1,519 f | 25 c | 3.3 a | 12.5 e | 134 a |

*represents two applications applied at 2-week intervals; 1 ppm = 1 mg L⁻¹; 1 mg = 3.5274 × 10⁻⁵ oz.

Means within a column followed by the same letter are not significantly different according to the Fisher's protected least significant difference means comparison test at \( P = 0.05 \).
There were no differences in the number of inflorescences between PGRs or the control. This result is consistent with previous studies, which reported no effect of PGRs on flower number (Jiao et al., 1990; Sanderson et al., 1989; Simmonds and Cumming, 1977). Inflorescence length was 12 cm shorter than the control when using daminozide at 10,000 ppm applied twice. Single flurprimidol drenches at 0.24, 0.35, or 0.47 mg/pot resulted in shorter inflorescence lengths than the control. A study on ‘Prima’ asiatic hybrid lily (Lilium) also showed a decrease in flower size following flurprimidol applications (Pobudkiewicz and Nowak, 1992). Daminozide only reduced inflorescence height compared with the control when applied in multiple applications of 10,000 ppm (Table 2).

Daminozide sprays did not increase the days to flower (time to visible bud). Paclobutrazol and flurprimidol drenches, however, increased the days to flowering: an effect that increased as paclobutrazol or flurprimidol concentration increased (Table 2). The increased time to flowering when using paclobutrazol was also reported in stock [Matthiola incana (Ecker et al., 1992)], tulip [Tulipa gesneriana (McDaniel, 1990)], and red flag bush [Musaenda crysophylla (Cramer and Bridgen, 1998)]. However, ‘Mustang’ geranium (Pelargonium x hortorum) treated with paclobutrazol spray or drench flowered earlier than control plants (Cox, 1991). Flurprimidol delayed flowering in geranium (Pobudkiewicz, 2000) and chrysanthemum [Dendranthema grandiflora (Pobudkiewicz and Nowak, 1997)] and had no effect on time to anthesis in dwarf carnation [Dianthus Caryophyllus (Pobudkiewicz and Nowak, 1994)]. Delayed flowering may be due to persistence of these compounds in the plant tissues. Delayed flowering following increasing PGR concentrations was reported on ‘Prima’ asiatic hybrid lily (Pobudkiewicz and Nowak, 1992) and in ‘Nellie White’ easter lily [Lilium longiflorum (Bailey and Miller, 1989)].

Flurprimidol and paclobutrazol drenches had the greatest effect on restricting plant height in red firespike. However, high concentrations of both PGRs resulted in excessive height control, which was not within the target range for finished plant height. Both of these PGRs produced long-lasting and uniform results, which could be due to binding of the growth retardants to the organic media components and release over several weeks (Boldt, 2008; Currey and Lopez, 2011). Daminozide provided less growth control of red firespike and required excessively high concentrations to control growth. Spray applications of paclobutrazol, uniconazole, and flurprimidol were not as effective as substrate drenches of paclobutrazol and flurprimidol for growth regulation. Aesthetically balanced potted plants of red firespike were achieved when flurprimidol at 0.24 mg/pot or paclobutrazol at 0.35 mg/pot were used.

**Literature cited**

Bailey, D.A. and W.B. Miller. 1989. Whole plant response of easter lilies to ancyminid and uniconazole. J. Amer. Soc. Hort. Sci. 114:393–396.

Barrett, J.E. and C.A. Bartuska. 1982. PP333 effects on stem elongation dependent on site of application. HortScience 17:737–738.

Boldt, J.L. 2008. Whole plant response of chrysanthemum to paclobutrazol, chloromequat chloride, and (s)-absic acid as a function of exposure time using a split-root system. Univ. Florida, Gainesville, PhD Diss.

Cho, K.C., W.M. Yang, W.S. Kim, and S.J. Chung. 2002. Growth retardation of cucumber (Cucumis sativus L.) seedlings by treatment of paclobutrazol and removal of retardation by foliar spray of gibberellins. J. Korean Soc. Hort. Sci. 43:415–420.

Cox, D.A. 1991. Gibberellic acid reverses effects of excess paclobutrazol on geranium. HortScience 26:39–40.

Cox, D.A. and G.J. Keever. 1988. Paclobutrazol inhibits growth of zinnia and geranium. HortScience 23:1029–1030.

Cramer, C.S. and M.P. Bridgen. 1998. Growth regulator effects on plant height of potted Musaenda ‘Queen Sirikit’. HortScience 33:78–81.

Currey, C.J. and R.G. Lopez. 2011. Early flurprimidol drench applications suppress final height of four poinsettia cultivars. HortTechnology 21:35–40.

Daniel, T.F. 1995. Revision of Odontonema (Acanthaceae) in Mexico. Contrib. Univ. Mich. Herb. 20:147–171.

Dasoji, S., M.R. Evans, and B.E. Whipker. 1998. Paclobutrazol drenches control growth of potted sunflowers. HortTechnology 8:235–237.

Ecker, R., A. Barzilay, L. Algin, and A.A. Watad. 1992. Growth and flowering responses of Matthiola incana L. R. BR. to paclobutrazol. HortScience 7:1330.

Fletcher, R.A., A. Gilley, N. Sankhla, and T.D. Davis. 2010. Triazoles as plant growth regulators and stress protectants. Hort. Rev. 24:55–138.

Gad, M., G. Schmidt, and L. Gerzson. 1997. Comparison of application methods of growth retardants on the growth and flowering of Fuchsia magellanica Lam. J. Hort. Sci. 29:70–73.

Gilbertz, D.A. 1992. Chrysanthemum response to timing of paclobutrazol and uniconazole sprays. HortScience 27:322–323.

Jiao, J., X. Wang, and M.J. Tsujiita. 1990. Comparative effects of uniconazole drench and spray on shoot elongation of hybrid lilies. HortScience 25:1244–1246.

Kim, S.H., A.A. De Hertogh, and P.V. Nelson. 1999. Effects of plant growth regulators applied as sprays or media drenches on forcing of Dutch-grown bleeding heart as a flowering potted plant. HortTechnology 9:630–635.

Krug, B.A., B.E. Whipker, I. McCall, and J.M. Dole. 2005. Comparison of flurprimidol to ancyminid, paclobutrazol, and uniconazole for tulip height control. HortTechnology 15:370–373.

Latimer, J.G. and B. Whipker. 2012. Selecting and using plant growth regulators on floricultural crops. Virginia Coop. Ext. Publ. 430-102.

McDaniel, G.L. 1990. Postharvest height suppression of potted tulips with paclobutrazol. HortScience 25:212–214.

Pobudkiewicz, A. 2000. Response of seed-propagated geranium (Pelargonium hortorum L.H. Bailey) to application of flurprimidol. Acta Agrobotnica 53:31–38.

Pobudkiewicz, A. and J. Nowak. 1992. Effect of flurprimidol and silver thiosulfate (STS) on the growth and flowering of ‘Prima’ lilies grown as pot plants. Acta Hort. 325:193–198.

Pobudkiewicz, A. and J. Nowak. 1994. The influence of flurprimidol and uniconazole on growth of the CMM dwarf Dianthus Caryophyllus L. cv. ‘Snowmass’. J. Fruit Ornamental Plant Res. 2:135–142.

Pobudkiewicz, A. and J. Nowak. 1997. Response of chrysanthemum (Dendranthema...
grandiflora Tzvelev) cvs. Altis and Surf to flurprimidol application. J. Fruit Ornamental Plant Res. 5:43–52.

Rademacher, W. 1991. Inhibitors of gibberellin biosynthesis: Applications in agriculture and horticulture, p. 296–310. In: N. Takahashi, R.O. Phinney, and J. MacMillan (eds.). Gibberellins. Springer, New York, NY.

Rademacher, W. 2000. Growth retardants: Effects on gibberellin biosynthesis and other metabolic pathways. Annu. Rev. Plant Biol. 51:501–531.

Rezazadeh, A. and R.L. Harkess. 2015. Effects of pinching, number of cuttings per pot, and plant growth regulators on height control of purple firespike. HortTechnology 25:71–75.

Ruter, J.M. 1992. Growth and flowering response of butterfly-bush to paclobutrazol formulation and rate of application. HortScience 27:929.

Sanderson, K.C., W.C. Martin, Jr., and J. McGuire. 1988. Comparison of paclobutrazol tablets, drenches, gels, capsules, and sprays on chrysanthemum growth. HortScience 23:1008–1009.

Sanderson, K.C., W.C. Martin, and R.B. Reed. 1989. Slow-release growth retardant tablets for potted plants. HortScience 24:960–962.

Simmonds, J.A. and B.G. Cumming. 1977. Bulb-dip application of growth regulating chemicals for inhibiting stem elongation of ‘Enchantment’ and ‘Harmony’ lilies. Sci. Hort. 6:71–81.

Song, C.Y. and J.S. Lee. 1995. Effect of growth regulators on growth and flowering of potted camellia. J. Korean Soc. Hort. Sci. 36:96–106.

Thakur, R., A. Sood, P.K. Nagar, S. Pandey, R.C. Sobti, and P.S. Ahuja. 2006. Regulation of growth of Lilium plantlets in liquid medium by application of paclobutrazol or ancymidol, for its amenability in a bioreactor system: Growth parameters. Plant Cell Rpt. 25:382–391.

Warner, R.M. and J.E. Erwin. 2003. Effect of plant growth retardants on stem elongation of Hibiscus species. HortTechnology 13:293–296.

Whitaker, B.E. and S. Dasoju. 1998. Potted sunflower growth and flowering responses to foliar applications of daminozide, paclobutrazol, and uniconazole. HortTechnology 8:86–88.