Research Reports

Effects of Paclobutrazol Drench Application Date on Poinsettia Height and Flowering

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SUMMARY. **Experiments were conducted to evaluate the effects of paclobutrazol drenches on poinsettia (*Euphorbia pulcherrima*) 'Freedom Red' height and flowering. In 1997 and 1998, paclobutrazol drenches [(a.i.) 0.118 mg/container; (28,350 mg = 1.0 oz)] were applied to poinsettias grown under natural photoperiods on four dates from 1 Oct. to 2 Nov. On plants receiving the paclobutrazol drench application during the second week in October, bract area was reduced by 15% and 12% compared with that of the control in 1997 and 1998, respectively; however, the bract area reduction was commercially acceptable. Anthesis date was not significantly affected during either year. Plant height and internode length measurements indicate that paclobutrazol drench applications had both a rapid and a long-term impact on poinsettia stem elongation. Paclobutrazol drenches applied in late October or early November are an effective tool for controlling late-season stem elongation of 'Freedom Red' poinsettias grown under natural photoperiods. These late-season applications have the least risk for negatively affecting bract size while still reducing stem elongation in the last few weeks of the crop. Chemical names used: (±)-(R*,R*)-b-[(chlorophenyl)methyl]- a-(1,1-dimethyl)-1H-1,2,4-triazole-1-ethanol (paclobutrazol).**

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Controlling stem elongation of poinsettias is essential to producing crops at the desired market height specifications. Plant growth regulators are frequently used by commercial growers to reduce poinsettia stem elongation, and several plant growth regulator options exist. Spray applications of chlormequat, paclobutrazol, uniconazole and a tank mix of chlormequat and daminozide can be used before flower initiation (Bailey and Whipker, 1998). Chlormequat sprays can continue to be applied until first bract color (Fisher and Heins, 1997a). Plant growth regulator spray applications made after the recommended dates can reduce bract area and delay flowering (Barrett, 1996). Spray applications are not typically recommended after the appearance of first bract color; however, commercial growers will occasionally apply growth regulators during bract expansion recognizing a tradeoff between bract size and height control (Fisher and Heins, 1997b). Several plant growth regulator options exist for applications made prior to first color; however, reliably safe options are limited during the latter part of the poinsettia growing season.

'Freedom Red' is a poinsettia cultivar that achieves a considerable amount of height after the appearance of first color (Faust and Klein, 1998). The stem elongation that occurs after first color is frequently referred to as late stretch. A late-season graphical tracking curve has even been specifically developed to assist growers in anticipating late stretch of 'Freedom Red' poinsettias (Fisher et al., 1997).

Commercial formulations of paclobutrazol and ancymidol are labeled for late-season drench application to poinsettias (Bailey and Whipker, 1998). The first trials testing the use of paclobutrazol drenches on poinsettias were reported in 1991 (Barrett, 1991). As a growing medium drench, paclobutrazol has increased activity compared to foliar spray applications (Barrett and Bartuska, 1982) and has fewer problems with excessive height and bract area reduction (Dole and Wilkins, 1999).

Managing the height of 'Freedom Red' poinsettias after first color has been a challenge, especially among warm-climate growers, since 'Freedom Red' can achieve a relatively large height increase after first color, when plant growth regulator options are limited. Late-season paclobutrazol drenches appear to be a viable option for poinsettia growers; however, concerns exist about the timing of paclobutrazol drench applications and the potential for excessive height reduction, reduced bract size and delayed flowering resulting from this technique. Therefore, the objective of this research was to identify the effects of the timing of paclobutrazol drenches on poinsettia stem elongation and bract development.

Materials and methods

In 2 consecutive years, similar experiments were conducted in which paclobutrazol drench applications were

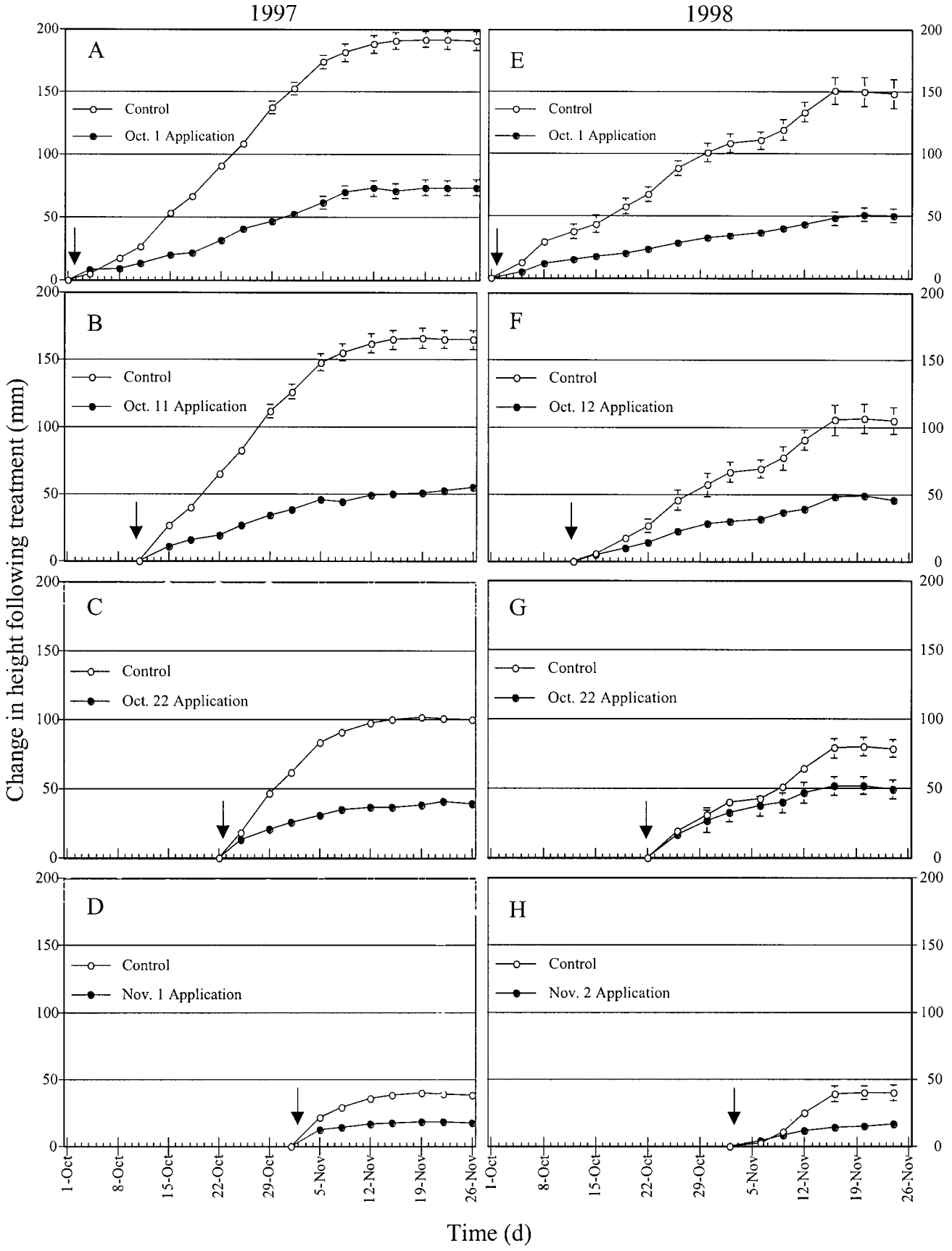

Fig. 1. Two studies on the effect of paclobutrazol drench application date on the change in plant height of 'Freedom Red' poinsettia after the application. Paclobutrazol drenches were applied at 1 mg·L^{-1} (ppm) in 118-mL (4.0 fl oz) volumes per container [(a.i.) 0.118 mg/container (28,350 mg = 1.0 oz)] on the indicated date. Arrows identify treatment dates. Error bars represent ±SE. SE values less than ±5 are not visible behind the symbols. n = 7 in 1997, n = 8 in 1998; 25.4 mm = 1.0 inch.

made on poinsettias on four application dates. In 1997, rooted cuttings of 'Freedom Red' poinsettias were received from a commercial propagator (Paul Ecke Ranch, Encinitas, Calif.) on 15 Aug., transplanted to 16.5-cm (6.5-inch) diameter containers on 18 Aug., and pinched on 25 Aug. A commercially-blended peat-based medium (Pro-Mix BX; Premier Horticulture, Rivière du Loup, Québec) was used. This growing medium does not contain pine bark which can reduce the efficacy of paclobutrazol drenches (Million et al., 1998). During both years, plants were fertilized two to three times per week. Each week the fertilizer was alternated between Peter's 20–10–20 (20N–4.4P–16.6K) and 15–0–15–11 (15N–0P–12.5K–11Ca) (The Scott's Company; Marysville, Ohio). The fertilizer solution ranged from 200 to 400 $mg \cdot L^{-1}$ (ppm) of nitrogen, depending on weekly measurements of the medium's electrical conductivity (EC). The medium's EC was maintained between 0.7 and 1.5 $mS \cdot cm^{-1}$. Measurements were made by using a 2:1 (water [vol.]: media [vol.]) media extract test (Lang, 1996). Monthly applications of magnesium sulfate at 100 $mg \cdot L^{-1}$ of magnesium also were made.

During the 1997 experiment, containers were placed at 16.5 × 16.5-cm (6.5 inches) spacing until 9 Sept., when they were placed at 30.5 × 30.5 cm (12 inches) spacing for the remainder of the experiment. Fifty percent photosynthetic photon flux density (PPF) reduction shade cloth was on the outside of the greenhouse from the beginning of the experiment until 29 Sept. In addition, 50% PPF-reduction shade cloth was placed 1 m (3.28 ft) above the plants from 15 to 20 Aug. The plants were grown in a double-layer polyethylene quonset greenhouse under natural photoperiods. The average daily temperatures in the greenhouse during October and November were 20 ± 3.5 °C (68 ± 6 °F) and the average daily PPF was 11.4 $mol \cdot m^{-2} \cdot d^{-1}$.

Paclobutrazol drenches were applied on 1, 11, 22 Oct. or 1 Nov. at 1 $mg \cdot L^{-1}$ in 118 mL (4.0 fl oz) volumes per container [(a.i.) 0.118 mg/container]. The medium was irrigated 24 h before the drench applications. Eight plants per treatment were individually randomized among all the experimental treatments in a completely randomized design. The most recently unfolded leaf on each lateral shoot was marked just before the paclobutrazol application to compare the length of internodes developing after the treatment. An unfolded leaf was defined as a 1 to 2 cm (0.39 to 0.79 inches) long leaf blade that had a horizontal arrangement.

Plant heights were recorded twice weekly from 1 Oct. to 26 Nov. Heights were recorded at the tallest shoot tip per plant. A rod with millimeter markings was placed in each container for the duration of each experiment so that plants received minimal physical contact while being measured. On 27 and 28 Nov., the three tallest shoots per plant were removed, and internode lengths and bract areas were recorded for these shoots. The first internode length was measured from the base of the lateral shoot. Bract area was measured on six individual bracts per stem. The three primary bracts that immediately subtend the whorl of cyathia located at the shoot tip and the three transitional bracts located on the stem immediately below the true bracts were used for the bract area measurements. The anthesis date was recorded when the first cyathium displayed anthesis on each plant.

In 1998, a second experiment was conducted; however, the following are differences in the protocol for the second experiment. Cuttings were harvested from stock plants and placed on a propagation bench on 17 July, transplanted on 14 Aug. and pinched on 28 Aug. The final plant spacing was 40.6 × 40.6 cm (16 inches). Paclobutrazol drenches were applied on 1, 12, 22 Oct. or 2 Nov. Plant heights were recorded twice weekly from 1 Oct. to 24 Nov. On 16 and 17 Dec., bract areas and internode lengths were recorded on the tallest two shoots per plant. The average daily temperatures in the greenhouse during October and November were 22.1 ± 3.8 °C (71.8 ± 7.8 °F), and the average daily PPF was 11.5 $mol \cdot m^{-2} \cdot d^{-1}$.

Results and discussion

Plant height and internode length: In 1997, the change in plant height from the drench application date to 26 Nov. was reduced by 61%, 66%, 62%, and 55% compared with that of the control plants for the 1, 11, 22 Oct. and 1 Nov. application dates, respectively (Fig. 1A–D). In 1998, the treated plants were 66%, 56%, 37%, and 58% shorter on 24 Nov. than the control group for the 1, 12, 22 Oct. and 2 Nov. application dates, respectively (Fig. 1E–H). The treated plants were typically shorter than the control plants by 7 d after treatment and continued to grow at a reduced rate for the remainder of the experiment. Therefore, the paclobutrazol drenches were extremely effective for rapidly reducing stem elongation and continuing to impact stem elongation for the duration of the crop, regardless of the application date.

The average length of the internodes located above the most recently unfolded leaf at the time of the drench application over the two experiments was 50%, 48%, 27%, and 23% shorter compared to the control plants for the treatments applied on 1, 12, 22 Oct. or 2 Nov., respectively (Table 1). The mean length on internodes that devel-

Table 1. The effect of paclobutrazol drench application date on the length of 'Freedom Red' poinsettia internodes that developed above the most recently unfolded leaf at the time of the drench application. Paclobutrazol drench applications delivered on the indicated date at 1 $mg \cdot L^{-1}$ (ppm) were applied in 118-mL (4.0 fl oz) volumes per container [(a.i.) 0.118 mg/container (28,350 mg = 1.0 oz)].

Year	Application date	Internode length after drench (mm)[z]	
		Control	Treated
1997	1 Oct.	15.8 a[y]	7.2 b
	11 Oct.	12.9 a	6.5 b
	22 Oct.	7.4 a	6.2 b
	1 Nov.	5.6 a	5.7 a
1998	1 Oct.	11.0 a	6.1 b
	12 Oct.	10.4 a	5.6 b
	22 Oct.	9.6 a	6.0 b
	2 Nov.	9.7 a	5.0 b

[z]25.4 mm = 1.0 inch.
[y]Letters indicate mean separation within rows and years by Tukey's, $P = 0.05$.

Table 2. The effect of paclobutrazol drench application date on 'Freedom Red' poinsettia bract area and anthesis date. Bract area means represent six bracts per stem. Paclobutrazol drench applications were applied at 1 mg·L^{-1} (ppm) in 118-mL (4 fl oz) volumes per container [(a.i.) 0.118 mg/container (28,350 mg = 1.0 oz)] on the indicated date. Bract area, n = 126 in 1997, n = 144 in 1998; anthesis date, n = 7 in 1997, n = 8 in 1998.

Year	Application date	Individual bract area (cm^2/bract)[z]	Anthesis date
1997	1 Oct.	50.2 ab[y]	25 Nov. a
	11 Oct.	45.3 a	23 Nov. a
	22 Oct.	52.2 ab	23 Nov. a
	1 Nov.	53.2 b	23 Nov. a
	Control	53.5 b	22 Nov. a
1998	1 Oct.	87.7 b	19 Nov. a
	12 Oct.	81.5 a	18 Nov. a
	22 Oct.	86.8 ab	19 Nov. a
	2 Nov.	89.5 b	16 Nov. a
	Control	92.5 b	14 Nov. a

[z]6.45 cm^2 = 1.0 inch^2.
[y]Letters indicate mean separation by column within years by Tukey's, $P = 0.05$.

oped after the drench applications ranged from 5.0 to 7.2 mm (0.20 to 0.28 inches), while the internodes on the control plants ranged from 5.6 to 15.8 mm (0.22 to 0.62 inches), regardless of the treatment date. Internode measurements indicated that the three internodes located below the most recently unfolded leaf at the time of the treatment were also significantly shorter than the control internodes (data not shown). The number of internodes that developed above the most recently unfolded leaf was 9, 7, 4, and 2 for the 1, 12, 22 Oct. or 2 Nov. application dates, respectively. Therefore, paclobutrazol drenches affected all of the internodes that developed following the application, regardless of the application date.

Bract area and anthesis: In 1997, bract area of the plants receiving the 11 Oct. application was 15.3% smaller than that of the untreated control group, while in 1998, the plants receiving the 12 Oct. paclobutrazol application developed bracts that were 11.9% smaller than that of the control group (Table 2). No other treatments significantly reduced bract area during either year.

During the second week of October, 'Freedom Red' poinsettia crops grown under natural daylengths will typically begin to show first bract color. The first leaves to display color are the lowest leaves on the stem to eventually develop into bracts. The three to four leaves that unfold after first bract color become the large transitional bracts on 'Freedom Red' and the primary bracts that contribute to the plant's appearance for early season market dates, e.g., mid-November. We hypothesize that the second week of October drenches caused the largest reduction in bract area because the transitional bracts are just beginning to unfold and expand in the shoot-tip at this time.

Bract area was considerably smaller in the 1997 experiment compared to the 1998 experiment. This was probably because of a combination of a cooler greenhouse environment, closer spacing, more lateral shoots located at the top of the canopy, and an earlier data collection date in 1997. There were no statistical differences of the anthesis date during either year (Table 2).

For warm-climate growers, moderate bract size reduction can be beneficial on a cultivar such as 'Freedom Red' that has relatively large bracts; however, this reduction could be problematic cultivars with smaller bracts or on poinsettias grown under cooler temperatures and lower irradiance levels. We hypothesize that the paclobutrazol drenches made during the first and third weeks of October can have a bigger impact on 'Freedom Red' crops than was demonstrated in these experiments when crops are grown under cooler temperatures and lower light levels. We also hypothesize that paclobutrazol applications made near the time of first color could potentially have a greater impact on bract area on cultivars that develop first color later than 'Freedom Red'; however, further work is required to test these hypotheses.

Paclobutrazol drenches are an effective tool for controlling late-season stem elongation when spray applications are no longer considered safe. Ideally, paclobutrazol drenches should be applied to natural daylength 'Freedom Red' crops at the end of October or early November. These applications have the least risk for negatively affecting bract size while still reducing stem elongation in the last 2 to 3 weeks of the crop. Note that the chemical concentration used in this project is typical for warm-climate growers. Growers located in cooler environments should use lower rates to achieve the desired results.

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