but not by paclobutrazol, a PGR similar to uniconazole (5). In contrast, daminozide did not delay flowering of 'Hummingbird' rhododendron nor did it confer any freeze tolerance to the flower buds (2).

In conclusion, while neither daminozide nor uniconazole suppressed late fall or early winter growth, both PGR's provided some degree of freeze protection. Freeze protection was manifested through a reduction in foliar freeze injury and/or elimination of stem cracking. The degree of freeze protection was cultivar specific.

Literature Cited

1. Davis, T. D., G. L. Steffens, and N. Sankhla. 1988. Triazole plant growth regulators, p. 63-105. In: J. Janick (ed.). Horticultural reviews, vol. 10. Timber Press, Portland, Ore.
2. Ryan, G. F. 1970. Effects of succinic acid 2,2-dimethyl hydrazide and phosphorus treatments on rhododendron flowering and growth. J. Amer. Soc. Hort. Sci. 95:624-626.
3. Senaratna, T., C. E. Mackay, B. D. McKersie, and R.A. Fletcher. 1988. Uniconazole-induced chilling tolerance in tomato and its relationship to antioxidant content. J. Plant Physiol. 133:56-61.
4. Upadhyaya, A., T. D. Davis, R. H. Walser, A. B. Galbraith, and N. Sankhla. 1989. Uniconazole-induced alleviation of low-temperature damage in relation to antioxidant activity. HortScience 24:955-957.
5. Whealy, C. A., T. A. Nell, and J. E. Barrett. 1988. Plant groth regulator reduction of bypass shoot development in azalea. HortScience 23:166-167.

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COMPARATIVE EFFECTS OF FOLIAR SPRAYS OF GROWTH REGULATORS ON POTTED CHRYSANTHEMUMS

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Abstract. **Single and multiple sprays or single soil drench applications of uniconazole were compared with daminozide, ancymidol, and paclobutrazol sprays for height control of *Dendranthema* x *grandiflorum* (Ramat.) Kitamura (*Chrysanthemum* x *moriflorum* Ramat.). Four cvs. were treated in 1989 and 5 were treated in 1990. All cvs. responded to the growth retardants, but the response was variable and dependent upon concentration and cultivar. In 1989 plants were treated with a directed spray of 0.7 oz (20 ml)/plant or an area spray of 2 or 3 quarts/100 ft². Differences due to volume of area sprays were not significant but 3 qt/100 ft² generally produced shorter plants than 0.7 oz/plant. Short and medium height cvs. exhibited a similar height response when treated with a single uniconazole spray at 20 ppm applied 2 weeks after pinching compared to two daminozide applications of 2500 ppm. A single drench at 1.7 ppm (0.25 mg ai/pot) was as effective as the daminozide sprays. In 1990, single sprays of uniconazole at 10 ppm or 100 ppm of paclobutrazol were as effective as two daminozide applications at 2500 ppm on the short and medium height cvs. Taller cvs. required 20 to 30 ppm of uniconazole or 200 ppm of paclobutrazol to produce marketable plants. Two daminozide sprays at 2500 ppm did not retard plant growth of the tall cultivars to a commercial height.**

Production of multi-plant potted chrysanthemums (*Dendranthema* x *grandiflorum* (Ramat.) Kitamura (*Chrysanthemum* x *moriflorum* Ramat.) was an important component of the floriculture industry in Florida during 1989, with more than 3.6 million 5-inch or larger pots sold (1). Most of these units consisted of 4 or 5 plants grown in 6 or 6.5 inch diameter pots which were sold locally or exported outside of Florida to florist shops, garden centers, and chain stores. The majority of production consisted of center-disbudded plants in order to produce multiple flowers per lateral shoot and required single or multiple applications of chemical growth retardants to prevent excessive internode elongation. These growth-retarding chemicals are applied as soil drenches or foliar sprays when the laterals are 1 to 2 inches long. A second application is often required for the medium and tall growing cultivars (16). Daminozide (SADH, B-Nine, butanedionic acid mono (2,2-dimethylhydrazide)) applied as a foliar spray at 2500 to 5000 ppm as single or multiple applications is used generally because it is inexpensive and effective (7,14,16). Paclobutrazol (Bonzi®,(2RS,3RS)-1-(4-chlorophenyl)-4,4-dimethyl-2-(1,2,4-triazol-1-yl)pentan-3-01), one of the new triazol pyrimidine growth regulators, has growth retarding properties with chrysanthemums (2,3,4,5,6,8,10,12,13). Single paclobutrazol sprays of 100 to 400 ppm were as effective as two applications of daminozide at 2500 or 5000 ppm (5,6,8,10,13), but plant growth within a multi-plant pot was not as uniform as with daminozide (8). Irrigation 2 to 3 hours after application had little influence on the effect of paclobutrazol but did for daminozide (4), indicating a rapid absorption of the chemical into the plant. Because paclobutrazol is poorly translocated from the leaves to the rest of the plant (3) and caused delay in flowering (9), medium drenches are more effective than foliar sprays, with 0.125 to 0.5 mg ai/pot of paclobutrazol as effective as multiple sprays of daminozide (5,6,10). However, medium composition has been shown to affect the efficacy of paclobutrazol drenches (2). An analog of paclobutrazol, uniconazole (Sumagic®, E-(p-chlorophenyl)-4,4-dimethyl-2-(1,2,4-triazol-l-yl)-1-pentan-3-ol) has similar properties but is more effective in retarding plant growth (4,5,6,9,11,14,15). Uniconazole sprays are up to eight times as effective as paclobutrazol and uniconazole drenches are up to ten times as effective. Foliar sprays of 5 to 25 ppm and soil drenches of 0.025 to 0.1 mg ai/pot have been effective depending upon cultivar and location (5,6,9,11,14,15).

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The objective of this research was to evaluate the effect of single or multiple applications of uniconazole compared to paclobutrazol and daminozide on several chrysanthemum cultivars grown in a shade house in central Florida.

Materials and Methods

General. Four rooted chrysanthemum cuttings were planted per 6-inch diameter plastic container (A600) in a medium of Florida sedge peat, coarse white sand, coarse vermiculite, and perlite (5:3:3:1, v/v). Medium amendments in lbs/yd^3 of soil were 12.0 Osmocote® Chrysanthemum Mix 12-8.3-7.4 (NPK), 1.5 dry fertilizer 6-5-2.6, 15.0 dolomite, 10.0 granular calcium carbonate, 4.0 hydrated lime, 6.0 superphosphate, and 1.0 Micro-Max (a minor element mixture). An additional topdress application was made 8 weeks after planting with Osmocote® Chrysanthemum Mix at 1 teaspoon/pot. Plants were grown in a shade house covered with black polypropylene (25% light exclusion) under ambient temperature and humidity. Incandescent lights, which provided a minimum of 10 ft-candles at plant level, were illuminated from 2200 to 0200 hours daily from time of planting until 5 days following pinching. Pots were set on 6-inch high raised beds which were covered with 1.5 mil white on black polyethylene mulch, with the white side up. Pots were spaced on 14-inch centers, with 3 rows of pots down each 2.7 foot wide bed. Plants were watered manually as needed. Each pot was soil drenched at planting with 5 oz solution containing Banrot® (0.5 lb/100 gal) and 20-16.6-8.7 liquid fertilizer (1.0 lb/100 gal). Plants were protected from insects, mites, and diseases by a weekly preventative spray program. The experimental design was a randomized complete block and each cultivar contained 4 replications of 3 pots each. Significant differences among cultivar means for each of the parameters measured were determined by Duncan's multiple range test. Data recorded included date of marketability (1/3 flowers open), plant height above pot rim, plant diameter, inflorescence diameter, number of laterals, and number of floral buds per lateral.

Spring 1989. Chrysanthemum cvs. 'Brightlight', 'Cirbronze', 'Circus', and 'Karma' were planted on 22 Feb. and were soft-pinched (terminal pruned) on 3 March. Lights were discontinued on 8 March. Foliar applications of uniconazole at 0, 10 and 20 ppm, of ancymidol at 15 ppm, or paclobutrazol at 200 ppm, and daminozide at 2500 ppm were applied on 15 Mar. for 'Brightlight' and 'Karma' and on 17 Mar. for 'Cirbronze' and 'Circus'. Uniconazole was either applied as a directed spray of 0.7 oz (20 ml)/plant or as an area spray of 2 or 3 quarts/100 ft^2. The other chemicals were direct sprayed at 0.7 oz/plant. Uniconazole at 10 ppm and daminozide were also applied to 'Brightlight' and 'Karma' on 22 Mar. and to 'Cirbronze' and 'Circus' on 24 Mar. Uniconazole was also applied as a soil drench of 1.7, 3.3 or 6.7 ppm (equivalent to 0.25, 0.5, and 1.0 mg ai/pot) at 5 oz (150 ml)/pot on the first spray dates for each cv. Plants were measured from 15 May to 17 May.

Spring 1990. Five chrysanthemum cultivars were planted on 21 Feb. and soft-pinched on 9 Mar. Lights were turned off on 14 Mar. Foliar spray applications (0.7 oz/plant) of uniconazole at 0,5,10,20, or 30 ppm, paclobutrazol at 100, 150, or 200 ppm, or daminozide at 2500 ppm were applied to 'Dare' and 'Lucido' on 19 Mar. and to 'Cartago', 'Cirbronze', and 'Circus' on 22 Mar. Uniconazole at 5 ppm was reapplied to some plants previously sprayed at 5 ppm and uniconazole at 10 ppm was reapplied to some plants which had been treated with 10 or 20 ppm. Daminozide was also sprayed again at 2500 ppm. The second treatment dates were 7 days after the first. Plants were measured from 18 May through 23 May.

Results and Discussion

Spring 1989. The season began with cool dry days, which were ideal for plant establishment and ended with warm and very dry conditions. Temperature extremes during the crop cycle were 92° and 41°F. All of the chemicals evaluated produced plants shorter than the control plants and had no effect on flower size, number of laterals, or number of floral buds per lateral. Uniconazole sprayed

Table 1. Effect of plant growth regulators on *Dendrathema* cultivars Brightlight and Cirbronze grown in containers (Spring, 1989).

Chemical	Conc. (ppm)	Number Appl.	Application Method[z]	Brightlight Plant Ht. (in.)	Brightlight Plant Diam. (in.)	Cirbronze Plant Ht. (in.)	Cirbronze Plant Diam. (in.)
Water	–	1	Spray-20	18.5 a[y]	19.1 a	15.3 a	17.0 a
Uniconazole	10	1	Spray-20	16.7 bcd	18.9 ab	13.8 bc	16.1 bc
Uniconazole	10	1	Spray-2	17.6 ab	18.9 ab	13.3 cd	15.8 cd
Uniconazole	10	1	Spray-3	16.6 bcd	18.1 abc	12.7 de	15.1 def
Uniconazole	10	2	Spray-20	15.8 cde	17.9 a-d	12.5 ef	15.3 cde
Uniconazole	10	2	Spray-2	15.8 cde	17.5 b-e	12.1 e-h	15.0 def
Uniconazole	10	2	Spray-3	14.6 f	17.2 cde	11.6 ghi	14.8 ef
Uniconazole	20	1	Spray-20	16.3 cde	17.2 cde	12.4 ef	15.5 cde
Uniconazole	20	1	Spray-2	16.3 cde	18.4 abc	11.4 hi	14.5 ef
Uniconazole	20	1	Spray-3	15.3 ef	17.6 b-e	11.8 f-i	14.7 ef
Uniconazole	1.7	1	Drench	15.9 cde	17.4 cde	12.8 de	15.2 cde
Uniconazole	3.3	1	Drench	15.7 def	17.2 cde	12.2 efg	15.2 cde
Uniconazole	6.7	1	Drench	15.2 ef	16.5 de	11.3 i	14.7 ef
Ancymidol	15	1	Spray-20	17.0 bc	17.5 cde	14.4 b	16.8 ab
Paclobutrazol	200	1	Spray-20	12.6 g	14.7 f	11.7 f-i	14.1 f
Daminozide	2500	2	Spray-20	13.2 g	16.2 e	12.5 ef	15.9 cd

[z]Spray-20 = 0.7 oz/plant; Spray-2 = 2 qts/100 ft^2; Spray-3 = 3 qts/100 ft^2; Drench = 5 oz/6" pot.
[y]Mean separation, within columns, by Duncan's multiple range test, 5% level.

at 20 ppm with 3 quarts/100 ft² appeared to delay marketability of the plants. In general, uniconazole spray applications of 0.7 oz/plant or 2 quarts/100 ft² produced similar results, but plants sprayed at 3 quarts/100 ft² were shorter than those given a directed spray (Tables 1 and 2). A single application of uniconazole at 20 ppm was as effective as two sprays at 10 ppm. Effects of the growth retardants on each cultivar are described below.

'Brightlight'. This cultivar, with its bright yellow daisy flowers, was the tallest of the cultivars evaluated (Table 1). Since the acceptable height range was between 11.5 and 13.5 inches, none of the plants treated with uniconazole, either as a foliar spray or medium drench, was within this set of parameters. The shortest uniconazole treated plants were with two foliar sprays of 10 ppm and a medium drench of 6.7 ppm (0.1 mg ai/pot). Two applications of uniconazole at 10 ppm produced plants of equivalent height to a single spray of 20 ppm. Only paclobutrazol at 200 ppm and two sprays of daminozide at 2500 ppm produced plants of an acceptable height. Plant diameters exhibited similar results, with the smallest plants resulting from the paclobutrazol spray of 200 ppm.

'Cirbronze'. This medium height cultivar, with its orange ray flowers and yellow disc, responded to all the chemicals, producing plants within the ideal height range for all treatments except the water spray, the uniconazole directed spray at 10 ppm (slightly tall), the ancymidol at 15 ppm (tall), and the uniconazole drench at 6.7 ppm (slightly short) (Table 1). Volume used per unit area had no effect on plant height, although the 3 quart/100 ft² sprays produced shorter plants than the direct spray treatments. The uniconazole spray at 10 ppm yielded plants of a similar height as ancymidol treated plants at 15 ppm. Paclobutrazol at 200 ppm and two sprays of daminozide at 2500 ppm produced plants similar to uniconazole applied as a single 20 ppm or two 10 ppm sprays. An occasional "escaped" lateral was observed with uniconazole at 10 ppm when applied on an area basis. Close observation of these laterals, which were 1 to 3 inches taller than the rest of the canopy, determined that they generally originated below the medium surface and probably developed after the chemical application date.

'Circus'. A rose-pink daisy, this cultivar responded to growth retardants in a similar manner as its color mutant 'Cirbronze' and produced marketable plants with most of the chemical treatments (Table 2). 'Circus' plants treated with directed sprays of uniconazole at 10 ppm and ancymidol at 15 ppm were too tall, while those sprayed with 200 ppm of paclobutrazol were too short. Uniconazole at 20 ppm applied at 3 quarts/100 ft² and paclobutrazol at 200 ppm delayed flowering but had no effect on flower size.

'Karma'. This snow-white daisy with its bright yellow disc center required a very small quantity of growth retardant to produce plants within the 11.5 to 13.5 in. height range (Table 2). In fact, the paclobutrazol and several of the uniconazole treatments, either applied as a spray or drench, produced plants too short to be marketable. One uniconazole spray at 10 ppm was equal to two daminozide sprays at 2500 ppm, all of which produced well proportioned plants. Using either 2 or 3 quarts/100 ft² was similar except for uniconazole at 10 ppm. Uniconazole at 20 ppm produced plants similar to those sprayed with paclobutrazol at 200 ppm.

Data from this season indicate that the concentration of uniconazole needed to produce marketable plants ranges from 10 to 20 ppm for medium height cultivars and either single or multiple applications 20 ppm or greater for tall cultivars. Applications can be made either as a directed spray of 0.7 oz/plant or an area spray of 2 quarts/100 ft² to achieve similar plant heights.

Spring 1990. This season was one of the hottest and driest recorded in central Florida, with high and low temperatures ranging from 95 to 40°F, with many days in May at 90° or above. Irrigation had to be applied twice a day during the last 3 weeks of the crop to maintain plant turgidity and not reduce plant quality. Effect of the growth retardants was directly related to the height of the untreated plants, with the taller growing cultivars requiring a higher concentration and/or multiple spray applications to maintain a height within the ideal range.

Table 2. Effect of plant growth regulators on *Dendrathema* cultivars Circus and Karma grown in containers (Spring, 1989).

Chemical	Conc. (ppm)	Number Appl.	Application Method[z]	Brightlight		Cirbronze	
				Plant Ht. (in.)	Plant Diam. (in.)	Plant Ht. (in.)	Plant Diam. (in.)
Water	–	1	Spray-20	15.9 a[y]	16.9 a	16.1 a	20.1 a
Uniconazole	10	1	Spray-20	14.0 bc	15.9 bc	12.7 bcd	17.2 bc
Uniconazole	10	1	Spray-2	13.3 cd	15.4 cd	13.3 bc	17.4 bc
Uniconazole	10	1	Spray-3	13.0 de	14.9 de	11.6 def	16.5 b-e
Uniconazole	10	2	Spray-20	12.8 de	15.4 cd	11.5 def	15.1 c-f
Uniconazole	10	2	Spray-2	12.3 efg	14.9 de	11.8 def	15.8 def
Uniconazole	10	2	Spray-3	11.4 gh	13.5 f	10.7 fg	15.0 fg
Uniconazole	20	1	Spray-20	12.4 def	14.4 e	11.6 def	16.2 c-f
Uniconazole	20	1	Spray-2	12.3 d-g	14.9 de	10.7 fg	15.7 ef
Uniconazole	20	1	Spray-3	11.8 fgh	14.4 e	10.0 g	14.2 g
Uniconazole	1.7	1	Drench	12.2 efg	15.1 de	11.9 de	15.8 def
Uniconazole	3.3	1	Drench	12.6 def	14.7 de	10.9 efg	15.0 fg
Uniconazole	6.7	1	Drench	11.3 gh	14.3 e	10.9 efg	14.3 g
Ancymidol	15	1	Spray-20	14.4 b	16.6 ab	13.5 b	17.4 b
Paclobutrazol	200	1	Spray-20	11.1 h	13.4 f	10.7 fg	15.0 fg
Daminozide	2500	2	Spray-20	12.7 def	15.1 de	12.3 cd	17.0 bcd

[z]Spray-20 = 0.7 oz/plant; Spray-2 = 2 qts/100 ft²; Spray-3 = 3 qts/100 ft²; Drench = 5 oz/6" pot.
[y]Mean separation, within columns, by Duncan's multiple range test, 5% level.

Table 3. Effect of plant growth regulators on *Dendrathema* cultivars Cartago, Cirbronze, and Circus grown in containers (Spring, 1989).

Chemical[z]	Conc. (ppm)	Number Appl.	Cartago Plant Ht. (in.)	Cartago Plant Diam. (in.)	Cirbronze Plant Ht. (in.)	Cirbronze Plant Diam. (in.)	Circus Plant Ht. (in.)	Circus Plant Diam. (in.)
Water	–	1	14.4 a[y]	15.5 abc	14.6 a	15.3 ab	15.9 a	16.2 a
Uniconazole	5	1	13.9 a	15.9 a	14.2 a	15.5 a	15.4 a	15.6 ab
Uniconazole	5	2	13.1 b	15.6 ab	13.2 b	14.9 abc	14.8 b	15.3 bc
Uniconazole	10	1	12.8 bc	15.2 a-d	13.1 b	14.6 a-d	14.6 b	5.3 bc
Uniconazole	10	2	12.0 de	15.0 b-e	12.5 bc	14.6 b-f	13.2 de	14.6 de
Uniconazole	20	1	12.4 cd	14.8 b-e	12.1 c	14.4 c-f	13.9 c	14.9 cde
Uniconazole	20+10	2	10.7 f	14.2 efg	11.3 d	13.8 ef	12.5 f	14.4 de
Uniconazole	30	1	11.8 de	14.5 def	12.0 c	13.7 f	12.9 ef	14.4 de
Paclobutrazol	100	1	11.7 de	14.6 def	12.6 bc	14.6 b-f	14.2 bc	15.0 cd
Paclobutrazol	150	1	11.6 e	13.9 fg	12.0 c	14.0 def	13.8 cd	14.4 de
Paclobutrazol	200	1	10.3 f	13.7 g	11.3 d	13.0 g	12.8 ef	14.3 e
Daminozide	2500	2	12.3 cde	14.7 c-f	13.0 b	14.8 a-d	14.1 bd	15.4 bc

[z]Spray applied at 2 qts/100 ft².
[y]Mean separation, within columns, by Duncan's multiple range test, 5% level.

'Cartago'. This newly available cultivar, with its lemon yellow ray and butter yellow disc flowers, did not pink in the hot weather and responded very well to the chemical sprays (Table 3). 'Cartago' was very early to flower and the water sprayed plants were only 14.4 inches tall, only one inch taller than ideal. All growth regulator treatments produced plants within the ideal range except the single uniconazole spray at 5 ppm (slightly tall), the multiple uniconazole spray of 20 plus 10 ppm and the paclobutrazol spray at 200 ppm. Two 5 ppm or one 10 ppm uniconazole sprays were equivalent to two daminozide sprays at 2500 ppm; paclobutrazol at 100 ppm yielded similar results. No flowering delay was evident with any treatment.

'Cirbronze'. This cultivar was slightly shorter than in 1989, but the response to the growth retardants was similar (Table 3). The 5 ppm uniconazole spray was the only treatment that yielded plants slightly taller than desired and the 20+10 ppm treatment of uniconazole and the 200 ppm spray with paclobutrazol were shorter than preferred. The latter plants were slightly delayed in flowering and were very compact.

'Circus. This cultivar was taller than its color mutant 'Cirbronze', as in 1989 but required at least two sprays of uniconazole at 10 ppm to attain a height of 13.5 inches or less (Table 3). But, even two applications of daminozide at 2500 ppm failed to retard plant growth at an acceptable level. Although uniconazole at 30 ppm produced plants within the ideal height range, a safer application method would be to spray at 10 or 20 ppm, observe the growth of the plants, and spray a second time with 10 ppm if warranted.

'Dare'.This white-flowered daisy is normally very tall and is difficult to attain adequate height control with the chemicals available (Table 4). None of the chemicals used retarded plant growth less than 15.9 inches, which was achieved with paclobutrazol at 200 ppm. Rather than increase concentrations of the chemicals, which would be risky if temperatures were cool and plant growth slowed, either earlier chemical applications or shorter supplemental light durations following pinching should be evaluated.

'Lucido.' This tall bright red daisy, earlier and more freely branching than 'Spotlight' responded to the growth retardants only at high concentrations (Table 4). Uniconazole as a single spray of 30 ppm or multiple sprays of 20+10 ppm and paclobutrazol at 200 ppm were the only treatments that provided plants less than 13.5 inches tall. Earlier application of these chemicals at lower concentrations should be evaluated in future studies. This cultivar has small leaves and when the stems are too elongated, the plant looks very open and bare.

Table 4. Effect of plant growth regulators on *Dendrathema* cultivars Dare and Lucido grown in containers (Spring, 1990).

Chemical[z]	Conc. (ppm)	Number Appl.	Dare Plant Ht. (in.)	Dare Plant Diam. (in.)	Lucido Plant Ht. (in.)	Lucido Plant Diam. (in.)
Water	–	1	22.2 a[y]	19.6 a	17.7 a	19.1 a
Uniconazole	5	1	21.6 ab	19.2 ab	17.2 ab	18.8 a
Uniconazole	5	2	20.1 cd	18.5 bc	16.6 bc	18.5 ab
Uniconazole	10	1	20.5 cd	19.2 ab	16.8 b	18.9 a
Uniconazole	10	2	18.3 e	18.4 bcd	15.3 de	18.3 ab
Uniconazole	20	1	18.1 ef	18.7 ab	14.8 ef	17.7 bc
Uniconazole	20+10	2	16.9 g	17.0 e	13.1 g	17.2 cd
Uniconazole	30	1	16.8 g	17.4 de	12.9 g	16.5 de
Paclobutrazol	100	1	19.7 d	18.5 abc	15.8 cd	18.3 ab
Paclobutrazol	150	1	17.4 fg	17.5 cde	15.1 def	17.6 bc
Paclobutrazol	200	1	15.9 h	16.6 e	13.0 g	16.2 e
Daminozide	2500	2	20.9 bc	18.7 ab	14.4 f	17.6 bc

[z]Spray applied at 2 qts/100 ft².
[y]Mean separation, within columns, by Duncan's multiple range test, 5% level.

Uniconazole, paclobutrazol, and ancymidol are viable alternatives to use of daminozide and can be applied as single spray applications to give similar plant heights as achieved with multiple daminozide treatments. Spray volume of 2 quarts/100 ft^2 produced plants of similar height as those provided a directed spray of 0.7 oz/plant. Short and medium height chrysanthemum cultivars needed between 10 and 20 ppm of uniconazole or 100 to 150 ppm of paclobutrazol sprays or a uniconazole solution of 1.7 to 3.3 ppm applied as a medium drench for optimum plant height. Taller cultivars would require multiple uniconazole sprays of 20 ppm or single paclobutrazol sprays of 200 ppm to retard plant height. In future studies time of application and chemical concentration need to be evaluated for the tall cultivars and to determine the optimum concentration for the major potted chrysanthemum cultivars grown in Florida.

Literature Cited

1. Anonymous. 1990. Floriculture crops: 1989 summary. USDA Agr. Stat. Board Circ. SpCr 6-1 (90).
2. Barrett, J. E. 1982. Chrysanthemum height control by ancymidol, PP-333, and EL-500 dependent on medium composition. HortScience 17(6):896-897.
3. Barrett, J. E. and C. A. Bartuska. 1982. PP-333 effects on stem elongation dependent on site of application. HortScience 17(5):737-738.
4. Barrett, J. E, C. A. Bartuska, and T. A. Nell. 1987. Efficacy of ancymidol, daminozide, fluprimidol, paclobutrazol, and XE-1019 when followed by overhead irrigation. HortScience 22(6):1287-1289.
5. Barrett, J. E. and T. A. Nell. 1990. Bonzi and Sumagic effective for controlling height of chrysanthemum. Prof. Plt. Grw. Assoc. News 21(6):2-3.
6. Barrett, J. E., M. E. Peacock, and T. A. Nell. 1986. Height control of exacum and chrysanthemum with paclobutrazol, XE-1019, fluprimidol, and RSW-0411. Proc. Fla. State Hort. Soc. 99:254-255.
7. Cathey, H. M. 1975. Comparative plant growth retarding activities of ancymidol with ACPC, Phosphon, Chlormequat, and SADH on ornamental plant species. HortScience 10:204-216.
8. Larson, R. A. 1986. Bonzi: A new growth regulator for floricultural crops. N.C. Flower Grw. Bull. 30(2):1-21.
9. Larson, R. A. and C. B. Thorne. 1987. A new growth regulator works on pot mums. N.C. Flower Grw. Bull. 31(1):1-6.
10. McDaniel, G. L. 1983. Growth retardation activity of paclobutrazol on chrysanthemum. HortScience 18(2):199-200.
11. McDowell, J. M. and E. J. Holcomb. 1987. The influence of XE-1019 on height of pointsettia (*Euphorbia pulcherima* Willd. ex Klofzsch) and Chrysanthemum (*C.* x *morifolium* Ramat.). HortScience 22(5):61. (Abstr.).
12. Menhenett, R. 1984. Comparison of a new triazole retardant paclobutrazol (PP-333) with ancymidol, chlorphonium chloride, daminozide, and piproctanyl bromide on stem extension and inflorescence development in *Chrysanthemum morifolium* Ramat. Scientia Hort. 24:349-358.
13. Shanks, J. B. 1980. Chemical dwarfing of several ornamental greenhouse crops with PP-333. Proc. Plant Growth Regulator Working Group 7:46-51.
14. Starman, T. W. 1990. Whole-plant response of chrysanthemum to uniconazole foliar sprays or medium drenches. HortScience 25(8):935-937.
15. Wilfret, G. J. 1988. Effect of XE-1019 on height of containerized chrysanthemums. HortScience 23(3):163. (Abstr.).
16. Wilfret, G. J. 1989. Chrysanthemum cultivars evluated as center-disbudded pot plants. Proc. Fla. State Hort. Soc. 102:277-280.

Proc. Fla. State Hort. Soc. 103:201-203. 1990.

BRANCHING OF VERBENA LINERS IS INFLUENCED BY CYTOKININ APPLICATION DURING CUTTING PROPAGATION

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Abstract. **Rooting, growth and subsequent branching of *Verbena* cuttings (*Verbena X hybrida*) were measured to determine response to foliar applied cytokinin (benzylaminopurine—BAP). Rooting was not enhanced or inhibited by BAP application when visible nodal roots were present at the base of the cuttings, or when 30, 100, or 300 mg BAP liter^{-1} was applied to the foliage 48 or 96 hours after cuttings were stuck. Fewer roots were formed when a nodal root was present at the base of the cuttings before being stuck. Rooting-zone dry mass, total cutting dry mass, and root number were increased by 30 mg BAP liter^{-1} applied immediately after excision when there were no visible nodal roots at the base of the cuttings. Foliar application of 10 or 30 mg BAP liter^{-1} during propagation reduced plant height 13% and 22%, respectively, and increased lateral bud elongation 20% and 50%, respectively. Application of BAP during cutting propagation of *Verbena* to enhance branching and compactness of rooted liners did not inhibit rooting.**

Root initiation and root growth are affected differently by the application of cytokinins. Exogenous applications of cytokinins immediately after cutting preparation has generally inhibited rooting, while application after formation of root primordia has little effect on rooting (3). The influence of cytokinins on adventitious root development may depend on the specific stage of initiation (timing of application), concentration and type of cytokinin applied, species, type of cutting, morphological location of application, and stock plant growing environment (6).

Application of cytokinins can enhance lateral bud elongation of shoots of a variety of species (1, 2, 4, 5). If foliar application to cuttings having preformed root initials or visible nodal roots does not inhibit rooting, branching of the subsequently rooted shoot may be enhanced.

The objective of these studies was to determine if foliar applied BAP would inhibit rooting of *Verbena* with or without visible nodal roots at the base of stem cuttings, and to determine if BAP applied before rooting would enhance subsequent lateral bud elongation after rooting.

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