

Response of Marguerite Daisy (*Argyranthemum frutescens*) 'Comet Pink' to Plant Growth Regulators¹

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Abstract: The efficacy of pinching, daminozide, flurprimidol, uniconazole, or paclobutrazol + daminozide tank mix for plant height control, diameter control, and days to anthesis were investigated on marguerite daisy (*Argyranthemum frutescens*) 'Comet Pink'. Plants were pinched 14 d after transplanting or treated 23 d after transplanting with foliar sprays of five concentrations from each plant growth regulator. Pinching reduced plant height but delayed anthesis compared to the control. Plant diameter was unaffected by pinching. Daminozide was ineffective at controlling plant height, and plant diameter increased at 2500, 2500-applied twice, and 5000 mg·L⁻¹. Daminozide did not affect days to anthesis. Flurprimidol was effective at 50 to 125 mg·L⁻¹ for height control and at 125 mg·L⁻¹ for diameter control. However, phytotoxicity was observed with the 100 to 125 mg·L⁻¹ applications. Flurprimidol did not affect days to anthesis. Uniconazole was effective at 40 and 80 mg·L⁻¹ with phytotoxicity evident at rates of 80 mg·L⁻¹. Uniconazole did not affect days to anthesis compared to the control. The paclobutrazol + daminozide tank mix did not affect plant height or days to anthesis, but plants treated with 20 or 40 mg·L⁻¹ paclobutrazol plus 1250 mg·L⁻¹ daminozide had larger diameters than control plants. Flurprimidol at 50 to 75 mg·L⁻¹ and uniconazole at 40 mg·L⁻¹ were the most effective plant growth regulators for marguerite daisy (*A. frutescens*) 'Comet Pink'.

Nomenclature, marguerite daisy, *Argyranthemum frutescens* (L.) Schultz-Bib.; chlormequat, (2-chloroethyltrimethyl-ammonium ion); daminozide, [butanedioic acid mono(2,2-dimethylhydrazide)]; flurprimidol, (α-(1-methylethyl)-α-[4-(trifluoromethoxy) phenyl]-5-pyrimidinemethanol); paclobutrazol, (β-[(4-chlorophenyl) methyl]-α-(1,1-dimethylethyl)-1H-1,2,4-triazole-1-ethanol); uniconazole, [(E)-1-(p-chlorophenyl)-4,4-dimethyl 1-2-(1,2,4-triazol-2-yl)-1-penten-3-ol].

Additional index words: vegetative cuttings, growth retardant, B-Nine, Bonzi, Flurprimidol, Sumagic, triazoles, plant growth retardant, PGR

INTRODUCTION

An effective plant growth regulator (PGR) produces compact, marketable plants without decreasing flower number or size, delaying anthesis, or causing phytotoxicity. The gibberellin biosynthesis inhibitors paclobutrazol

(0.4% a.i.) (β-[(4-chlorophenyl) methyl]-α-(1,1-dimethylethyl)-1H-1,2,4-triazole-1-ethanol) (Bonzi, Uniroyal Chemical, Middlebury, CT) and uniconazole (0.055% a.i.) [(E)-1-(p-chlorophenyl)-4,4-dimethyl 1-2-(1,2,4-triazol-2-yl)-1-penten-3-ol] (Sumagic, Valent, Marysville, OH) are effective at much lower concentrations than other PGRs such as chlormequat (11.8% a.i.) (2-chloroethyltrimethyl-ammonium ion) (Cycocel, Olympic Horticultural Products, Mainland, PA) and daminozide (85% a.i.) [butanedioic

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acid mono(2,2-dimethylhydrazide)] (B-Nine, Uniroyal Chemical, Middlebury, CT) (Tayama and Carver, 1990). Consequently, less active ingredient is needed to control growth and fewer applications may be required (Olsen and Andersen, 1995).

Uniconazole has been shown to be more efficient in controlling plant growth than paclobutrazol. Four to ten times less uniconazole than paclobutrazol was needed to achieve the same height control in *Petunia hybrida* Vilm.-Andr., *Coleus blumei* Benth., *Celosia argentea* L., *Impatiens wallerana* Hook., *Antirrhinum majus* L., *Salvia splendens* Ker-Gawl., *Exacum affine* Balf., *Catharanthus roseus* L., *Dendranthema x grandiflorum* Kitam. (Barrett and Nell, 1989), but both PGRs were ineffective in controlling height of zinnia (*Zinnia elegans* Jacq.) (Banko and Stefani, 1988).

Flurprimidol (1.5% a.i.) (α -(1-methylethyl)- α -[4-(trifluoromethoxy) phenyl]-5-pyrimidinemethanol) (SE-5004, SePRO, Carmel, IN) is another gibberellin synthesis inhibitor that has proven effective on chrysanthemums (*Dendranthema x grandiflorum* Kitam.), poinsettias (*Euphorbia pulcherrima* Willd. ex Klotzsch.) and geraniums (*Pelargonium x hortorum* Bailey) when applied as a foliar spray in the range of 30 to 150 ppm ($\text{mg}\cdot\text{L}^{-1}$) (Barrett, 1983). Foliar sprays of 20 ppm ($\text{mg}\cdot\text{L}^{-1}$) flurprimidol produced shorter plants without delaying flowering of potted lilies (*Lilium* 'Prima') (Pobudkiewicz and Nowak, 1992). Flurprimidol at 45 ppm ($\text{mg}\cdot\text{L}^{-1}$) and uniconazole at 8 ppm ($\text{mg}\cdot\text{L}^{-1}$) produced compact cape daisy [*Osteospermum ecklonis* (DC.) Norl.], while paclobutrazol and daminozide were ineffective (Olsen and Andersen, 1995). However, flurprimidol and paclobutrazol were ineffective in reducing plant height of exacum (*Exacum affine* Balf.)

while uniconazole was effective (Newman and Follet, 1986).

The vegetatively propagated annual marguerita daisy [*Argyranthemum frutescens* (L.) Schultz-Bib.] 'Comet Pink' is a recently introduced bedding plant. Due to its vigorous growth, commercial greenhouse producers face the challenge of maintaining a short, yet robust plant that is proportional to pot size. Gao et al. (2000) found that daminozide at 5000 ppm ($\text{mg}\cdot\text{L}^{-1}$) was not effective in retarding height of *Argyranthemum* 'Butterfly', but 80 ppm ($\text{mg}\cdot\text{L}^{-1}$) paclobutrazol and 20 ppm ($\text{mg}\cdot\text{L}^{-1}$) uniconazole did control height without reducing shoot numbers. Starman et al. (2000) also found that 20 ppm ($\text{mg}\cdot\text{L}^{-1}$) uniconazole was optimal for controlling *Argyranthemum* 'Sugar Baby' height.

The purpose of this study was to determine the most effective rates of uniconazole, daminozide, paclobutrazol + daminozide tank mix, and flurprimidol for controlling *Argyranthemum frutescens* 'Comet Pink' stem elongation. Additionally, the effect of these PGRs on days to anthesis and plant diameter was evaluated.

MATERIALS AND METHODS

Approximately 5.5 cm tall *Argyranthemum frutescens* 'Comet Pink' rooted cuttings from 3.5 x 3.8 cm (1.4 x 1.5 inch) cells were transplanted into 13-cm diameter (5-inch) round plastic azalea containers on 29 Mar. 2001. The root substrate was Fafard® 4-P (Fafard, Anderson, SC), which contained (by volume): 4 sphagnum peat : 2 pine bark : 2 vermiculite : 1 perlite. Plants were fertigated alternating weekly with 150 $\text{mg}\cdot\text{L}^{-1}$ N from Peters® 20-10-20 (20N-4.4P-16.6K) and 15-0-15 (15N-0P-12.5K) (Scotts, Marysville, OH). Plants were grown under natural daylength with greenhouse day/night set point temperatures

of 20/18°C (70/65°F). On 7 Apr., six plants were pinched at the fifth node from the substrate surface (approximately 3.0 cm). From 07:00 to 09:00 h, twenty PGR treatments were applied to non-pinched plants as foliar sprays [in ppm ($\text{mg}\cdot\text{L}^{-1}$)] 23 d after potting using a spray volume of $204 \text{ mL}\cdot\text{m}^{-2}$ (0.5 gal/100 ft²): daminozide at 2,500, 2,500 applied twice, 5,000, 7,500, or 10,000; a mix of paclobutrazol at 20, 40, 80, 120, or 160 plus daminozide at 1,250; uniconazole at 5, 10, 20, 40, or 80; and flurprimidol at 25, 50, 75, 100, or 125. A randomized design was used with six single-plant replications for each of the 21 treatments plus a nontreated control. Days to anthesis were recorded when one flower had fully reflexed ray petals. On 13 May, plant height (measured from the pot rim to the highest point) and plant diameter (measured at the widest dimension and turned 90°, and averaged) were recorded. Data were tested by analysis of variance by general linear model (SAS Inst., Cary, NC). Means were separated by Tukey's HSD at $P \leq 0.05$.

RESULTS AND DISCUSSION

Pinching

Pinched plants were 4.8 cm shorter than the control plants (Table 1). However, diameter was not affected. Pinching delayed anthesis by 10 d compared to 5 $\text{mg}\cdot\text{L}^{-1}$ uniconazole and the 20 $\text{mg}\cdot\text{L}^{-1}$ paclobutrazol + 1250 $\text{mg}\cdot\text{L}^{-1}$ daminozide tank mix. Days to anthesis were similar to all other treatments. The additional labor costs may make pinching commercially unfeasible.

Daminozide

Regardless of concentration, daminozide did not affect total height (Table 1). No differences in days to anthesis occurred between the control and daminozide treatments. How-

ever, plants treated with daminozide at 2,500 $\text{mg}\cdot\text{L}^{-1}$ applied twice were wider than the control plants and those treated with 2,500, 5,000, 7,500, or 10,000 $\text{mg}\cdot\text{L}^{-1}$. These results suggest that daminozide used alone at the examined concentrations is not useful for controlling growth of *Argyranthemum frutescens* 'Comet Pink'.

Paclobutrazol + Daminozide

Paclobutrazol + daminozide applications had no effect on plant height compared to the control (Table 1). Pinching, 40 and 80 $\text{mg}\cdot\text{L}^{-1}$ uniconazole, and 75 to 125 $\text{mg}\cdot\text{L}^{-1}$ flurprimidol treated plants were shorter than the paclobutrazol + daminozide tank mix treatments. However, applications of 20 $\text{mg}\cdot\text{L}^{-1}$ paclobutrazol with 1,250 $\text{mg}\cdot\text{L}^{-1}$ daminozide, resulted in 5.1 cm wider plants compared to the control which reached anthesis 4 d earlier than plants receiving 80, 120, or 160 $\text{mg}\cdot\text{L}^{-1}$ paclobutrazol + daminozide.

Daminozide appeared to be ineffective in controlling height and diameter of *Argyranthemum* 'Comet Pink', by itself or in combination with paclobutrazol. These results agree with those of Olsen and Andersen (1995) and Gao et al. (2000) who reported similar results on *Osteospermum* and *Argyranthemum* 'Butterfly', respectively.

Uniconazole

Uniconazole applications of 40 and 80 $\text{mg}\cdot\text{L}^{-1}$ resulted in plants that were 6.3 and 10.4 cm shorter, respectively, than the control plants (Table 1). Plant diameter was similar to the control diameter regardless of application rate. Phytotoxicity, expressed as leaf tip chlorosis advancing to necrosis (brown to gray patches 2-3 mm in diameter) on the young leaves three days after application, was observed on plants treated with 80 $\text{mg}\cdot\text{L}^{-1}$. No

Table 1. Various plant growth regulators (PGRs) affect growth of *Argyranthemum frutescens* ‘Comet Pink’. Data are means of 6 replications per treatment.

PGR	Concentration (mg·L ⁻¹)	Total height (cm)	Diameter (cm)	Days to ^z anthesis
Control	-	25.7	31.0	19.3
Pinch ^y	-	20.9	31.3	25.3
Daminozide	2500	24.8	34.2	19.7
	2500 ^x	24.5	36.7	15.8
	5000	26.5	34.3	19.8
	7500	24.6	33.3	19.2
	10000	25.1	33.9	18.8
Paclobutrazol + daminozide ^w	20	24.9	36.1	14.5
	40	26.1	34.7	17.5
	80	25.9	32.9	23.8
	120	25.0	31.7	24.0
	160	24.0	33.3	20.3
Uniconazole	5	26.1	35.6	14.8
	10	24.7	30.4	23.8
	20	24.3	32.3	22.3
	40	19.4	31.5	18.2
	80	15.3	29.7	23.2
Flurprimidol	25	23.9	31.0	22.5
	50	22.5	31.9	19.0
	75	18.3	32.0	19.2
	100	13.1	28.8	22.7
	125	14.1	28.2	19.5
Tukey's ($\alpha=0.05$)		4.3	4.8	10.3
Significance ^v		***	***	**

^z Measured from date of PGR application, 21 April.

^y Pinched at the fifth node from the substrate surface on 7 April.

^x Applied twice on 21 April and 5 May.

^w Daminozide concentration was 1250 mg·L⁻¹.

^v **, *** Significant at $P \leq 0.01$ or 0.001, respectively for the PGR and concentration.

differences occurred in days to anthesis between the control and uniconazole treatments. However, plants treated with 5 mg·L⁻¹ uniconazole reached anthesis in fewer days than the pinched plants.

Starman et al. (2000) observed that uniconazole at 20 mg·L⁻¹ was optimal for *Argyranthemum* 'Sugar Baby', while our results indicate that 40 mg·L⁻¹ is optimal for production of *Argyranthemum* 'Comet Pink'. This suggests that the response to uniconazole in *Argyranthemum* may vary by cultivar.

Flurprimidol

Plants treated with 50, 75, 100, and 125 mg·L⁻¹ flurprimidol were 3.2, 7.4, 12.6, and 11.6 cm shorter, respectively, than the control plants (Table 1). Plants were generally shorter with increasing flurprimidol concentrations. Diam-

eter was not affected. Phytotoxicity, expressed as leaf tip necrosis (brownish-black patches 2-3 mm in diameter) on the young leaves three days after application, was observed on plants treated with 100 and 125 mg·L⁻¹. No differences in days to anthesis occurred between the control and flurprimidol treatments. A rate of 50 to 75 mg·L⁻¹ was optimal for this study, which falls within the 30 to 150 mg·L⁻¹ range recommended by Barrett (1983) for other floriculture species. The most effective plant growth regulators applied as foliar sprays for *Argyranthemum frutescens* 'Comet Pink' were flurprimidol at 50 to 75 mg·L⁻¹ or uniconazole at 40 mg·L⁻¹ (Fig. 1). Plant heights were retarded and flowering was not delayed. However, these treatments did not retard plant diameter when compared to the control. Plants treated with flurprimidol at rates higher than 75 mg·L⁻¹ or uniconazole at 40 mg·L⁻¹ expressed phytotox-

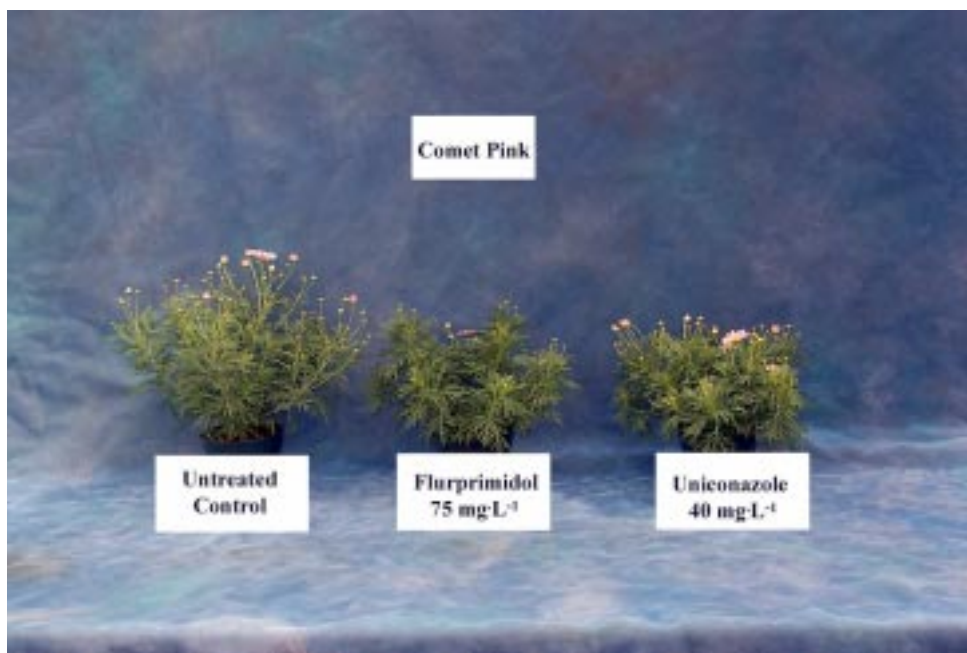


Fig. 1. Plant growth regulator recommendations for *Argyranthemum frutescens* 'Comet Pink'.

icity symptoms. Daminozide and daminozide + paclobutrazol sprays were ineffective in retarding plant height and plants treated with low rates of daminozide had large plant diameters. Pinching was effective for plant height control; however, plant diameter was not controlled and labor cost would likely be prohibitive.

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