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Production and Postproduction Performance of Uniconazole-Treated Bedding Plants[1]

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Abstract

Growth and flowering responses of *Pelargonium* × *hortorum* L. H. Bailey 'Ringo Deep Scarlet', *Tagetes erecta* L. 'Inca Orange', *Viola* × *wittrockiana* Gams. 'Blue Shades', *Impatiens* × 'Zenith' and *Salvia farinacea* Benth. 'Victoria Blue' to uniconazole applied at the seedling stage were evaluated at the end of production and 5 to 7 weeks after transplanting into the landscape (geranium, impatiens and salvia only). A drought stress evaluation was also conducted. Response to uniconazole varied with species, sampling date and uniconazole concentration. Growth of all species was suppressed when measured 4½ to 8½ weeks after treatment (WAT), and stress tolerance of all species except marigold increased with increasing concentrations of uniconazole. Flowering generally was delayed with uniconazole. Impatiens and geranium treated with 10 ppm or less of uniconazole were similar in height to nontreated plants 5 to 7 weeks after being transplanted; at this time, uniconazole had no effect on plant height or shoot dry weight of salvia. Daminozide applied once as a 5000 ppm foliar spray was not effective in suppressing vegetative growth of any of the tested species.

Index words: growth retardant, uniconazole, Sumagic, daminozide, B-nine

Growth regulators used in this study: Sumagic (uniconazole), (E)-1-(p-chlorophenyl)-4,4-dimethyl-2-(1,2,4-triazol-1-yl)-penten-3-ol; B-nine (daminozide), butanedioic acid mono (2,2-dimethylhydrazide).

Species used in this study: 'Ringo Deep Scarlet' geranium (*Pelargonium* × *hortorum* L. H. Bailey 'Ringo Deep Scarlet'); 'Inca Orange' marigold (*Tagetes erecta* L. 'Inca Orange'); 'Blue Shades' pansy (*Viola* × *wittrockiana* Gams. 'Blue Shades'); 'Zenith' New Guinea impatiens (*Impatiens* × 'Zenith'); 'Victoria Blue' salvia (*Salvia farinacea* Benth. 'Victoria Blue').

Significance to the Nursery Industry

Chemical growth retardants commonly are applied to bedding plants to promote compactness and to extend the marketing period. Sumagic (uniconazole) is an effective retardant in suppressing internode elongation and increasing a plant's tolerance to water stress, both of which should enhance and extend marketability; however, optimum rates are specific to a given species. Growth suppression may continue after plants are transplanted into the landscape, but plants may exhibit an accelerated growth rate after the growth-retarding effect dissipates. Sumagic (uniconazole) applied at too high a concentration will suppress growth excessively and delay flowering. The effects may persist for 5 or more weeks after plants are transplanted into the landscape, depending upon the bedding plant species and the concentration of uniconazole applied.

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Introduction

Chemical growth retardants, such as B-nine (daminozide), Cycocel (chlormequat chloride), and A-rest (ancymidol), are applied to bedding plants to promote compactness and uniformity and to extend marketability (9). Such growth retardants also may improve transplant survival by maintaining favorable root to shoot ratios and reduce water use, hence increasing a plant's tolerance to drought stress (10). Triazole inhibitors, a group of plant bioregulants represented by Sumagic (uniconazole) and Bonzi (paclobutrazol), suppress stem elongation by interfering with gibberellin biosynthesis (7). Studies indicate that both compounds are active on a variety of bedding plants (2, 4, 5, 8, 10), including species which are unaffected by other commercially available growth retardants (1).

Compared to other retardants, triazole inhibitors are active in low dosages and are persistent (6), characteristics that could result in undesirable growth inhibition after plants are transplanted into the landscape. Limited information is available on postproduction growth and performance of triazole-treated bedding plants (5, 8). Our study was conducted to determine the influence of various dosages of Sumagic

(uniconazole) on production and post-production performance of several bedding plant species.

Materials and Methods

Uniform 1.5 cm (0.6 in) plugs (288 cells per tray) of 'Ringo Deep Scarlet' geranium, 'Inca Orange' marigold, 'Blue Shades' pansy, 'Zenith' New Guinea impatiens and 'Victoria Blue' salvia were transplanted on January 31, 1989, into 0.4 l (0.42 qt) containers (C-350, Lerio Corp., Mobile, AL) of a peat moss and perlite growth medium (Pro-Mix BX, Premier Brands, Inc., New Rochelle, NY). Plants were maintained in a glasshouse with heat and ventilation set points of 15.6°C (60°F) and 29.4°C (85°F), respectively, and fertilized weekly with 500 ppm N from 20N-4.3P-16.6K (20-10-20) Peter's Peatlite Special (Grace-Sierra Co., Fogelsville, PA).

The following treatments were applied on February 16, 1989, when geranium, marigold, pansy, impatiens and salvia were an average of 3.7, 9.3, 4.5, 9.5, and 2.9 cm (1.5, 3.7, 1.8, 3.7 and 1.1 in) tall, respectively: a single uniconazole spray of 0, 1, 3, 5, 10, 15, 20 or 30 ppm or a single daminozide spray of 5000 ppm. Sprays were applied in a volume of 204 ml/m^2 (2 qt/100 ft^2) using a hand-held sprayer to uniformly wet foliage and stems. Ambient temperature was 28.8°C (84°F) with 63% relative humidity at time of application. Treatments were arranged in a randomized complete block design with 5 replicates of 3 plants per treatment.

Plant heights, growth indices [(height + width at the widest point + width 90° to the widest point)/3], and a foliar color rating (1, 3, 5 = light, medium, dark green, respectively) were determined 4½ to 8½ weeks after treatment (WAT). Specific dates of data collection were based upon growth and developmental rates of the individual species and are given in the tables. When these data were collected, flowers (pansy, impatiens) or inflorescenses (marigold, salvia, geranium) were counted and peduncle lengths of pansy were measured.

To determine treatment effects on water stress tolerance, 5 single-plant replicates of each species, except geranium, were blocked by treatment on a greenhouse bench in April 12 and thoroughly watered; thereafter, water was withheld from the plants, and time to first signs of wilting was noted by monitoring plants every 30 minutes from 8 am until 6 pm. Hours between 6 pm and 8 am were not counted in determining time to wilting because loss of moisture during this period was considered insignificant. Water was withheld from geraniums beginning on April 24. Following wilting of all plants of a species, shoots were cut at the growth medium surface, dried at 48.9°C (120°F) for 72 hours and weighed.

On April 12 (impatiens, salvia), and April 26 (geranium), 5 single-plant replicates were planted into the landscape to evaluate post-production growth. Pansies were not transplanted because of their typically poor performance in the south Alabama landscape after early April. Marigolds were not planted into the landscape because of their relatively minor responses to growth retardant treatments. The ground bed consisted of a sandy-loam soil with 5.0 cm (2 in) of amendment grade pine bark tilled into the upper 15 cm (6 in). On May 31, vegetative (to uppermost leaf) and inflorescence heights of salvia and geranium were measured, and shoots of the 3 species were cut for dry weight determination. Rate response to uniconazole was determined by regression analysis. Specific treatments were compared to daminozide using Dunnett's test for least significant difference.

Results and Discussion

Production. Growth of impatiens, geranium, salvia, marigold and pansy measured 4½ to 8½ WAT was significantly suppressed by a single foliar spray of uniconazole (Tables 1–5). Plant height (data not shown), growth indices and shoot dry weight of all species were lower as concentration of uniconazole increased. Magnitude of suppression varied with species and concentration. Growth indices of impatiens, geranium, salvia, marigold and pansy treated

Table 1. Effects of uniconazole foliar sprays on growth and drought stress tolerance of New Guinea impatiens.

Treatment		Growth index[z] 7½ WAT[y]	Foliar color rating[x] 7½ WAT	Flower no. 4½ WAT	Time to wilt (hr.)	Height (cm) 15 WAT	Shoot dry wt. (g)	
Growth retardant	Concentration (ppm)						8 WAT	15 WAT
Uniconazole	0	23.7	4.0	4.9	20.5	20.6	4.2	28.2
	1	21.6	4.3	3.0	19.4	19.2	3.1	20.9
	3	15.6*[w]	4.8*	2.0	28.5*	16.0*	1.8*	14.5*
	5	16.7*	5.0*	3.4	30.5*	16.2*	2.0	15.9
	10	14.8*	5.0*	2.3	32.2*	14.0*	1.9*	8.0*
	15	14.9*	5.0*	2.6	32.8*	15.6*	1.2*	10.2*
	20	14.2*	5.0*	0.4*	33.5*	13.3*	0.9*	7.4*
	30	13.8*	5.0*	0.0*	33.5*	11.4*	0.7*	11.5*
Significance of rate[v]		c	c	l	c	c	c	c
Daminozide	5000	21.2	4.1	3.8	17.2	20.2	3.1	23.4

[z]Growth index = (vegetative height + width at widest point + width 90° to widest point)/3, in cm.

[y]WAT = weeks after treatment on February 16, 1989; plants were transplanted into the landscape 8 WAT.

[x]Foliar color rating: 1, 3, 5, = light, medium, and dark green, respectively.

[w]Dunnett's test for least significant differences; means followed by an asterisk differ significantly from the mean of the daminozide treatment at the 5% level.

[v]Control included in regression analyses; l = linear, c = cubic, 5% level of significance.

Table 2. Effects of uniconazole foliar sprays on growth and drought stress tolerance of geranium.

Treatment		8½ WAT[z]		Time to wilt (hr.)	Height (cm) 15 WAT		Shoot dry wt. (g)	
Growth retardant	Concentration (ppm)	Growth index[y]	Inflorescence no.		Vegetative	Flowering	10 WAT	15 WAT
Uniconazole	0	26.6	1.6	9.7	18.0	28.8	14.3	39.2
	1	25.5	1.1	10.8	17.4	28.6	14.0	42.0
	3	25.5	1.3	10.5	17.8	28.0	15.0	43.8
	5	23.9	1.4	11.4	18.8	29.2	12.7	49.0
	10	22.9	1.5	10.9	17.4	27.0	12.6	45.1
	15	19.0*[x]	1.6	12.5	11.0*	19.4*	7.8	30.8
	20	17.1*	1.9*	14.8*	11.4*	18.8*	5.2*	19.8*
	30	14.7*	2.1*	19.4*	7.6*	12.8*	3.6*	8.9*
Significance of rate[w]		l	l	q	c	c	l	c
Daminozide	5000	24.8	1.1	11.4	17.6	28.4	11.2	41.5

[z]WAT = weeks after treatment on February 16, 1989; plants were transplanted into the landscape 10 WAT.

[y]Growth index = (vegetative height + width at widest point + width 90° to widest point)/3, in cm.

[x]Dunnett's test for least significant differences; means followed by an asterisk differ significantly from the mean of the daminozide treatment at the 5% level.

[w]Control included in regression analyses; l = linear, q = quadratic, c = cubic, 5% level of significance.

with 5 ppm of uniconazole decreased 29.5, 10.2, 5.9, 2.5 and 1.4%, respectively, relative to the control; shoot dry weights of the same species decreased 52.3, 11.2, 22.2, 12.5 and 10.5%, respectively. Suppression of top dry weight was most pronounced with application of the highest concentration of uniconazole, 30 ppm, and equalled 81.0, 74.8, 44.4, 27.3 and 66.7% with impatiens, geranium, salvia, marigold and pansy, respectively. Differences among species in response to rate of uniconazole application concur with previous research (2). Foliar color ratings of impatiens increased with higher concentrations of uniconazole (Table 1); foliar color of the other species was not visibly affected by application of uniconazole (data not shown).

Table 3. Effects on uniconazole foliar sprays on growth and drought stress tolerance of salvia.

Treatment		7½ WAT[z]		Shoot dry wt. (g)	Time to wilt
Growth retardant	Concentration (ppm)	Growth index[y]	Inflorescence no.	8 WAT	(hr.)
Uniconazole	0	30.7	1.9	6.3	14.2
	1	28.8	2.1	4.9	13.7
	3	29.0	1.3	4.1	16.3
	5	28.9	1.1	4.9	15.8
	10	29.0	0.5	4.7	16.6
	15	26.1	0.2	4.6	18.0
	20	26.2	0.3	3.7	18.1
	30	23.2*[x]	0.1	3.5	19.0*
Significance of rate[w]		l	q	l	q
Daminozide	5000	28.6	1.1	4.4	16.1

[z]WAT = weeks after treatment on February 16, 1989; plants were transplanted into the landscape 8 WAT.

[y]Growth index = (vegetative height + width at widest point + width 90° to widest point)/3, in cm.

[x]Dunnett's test for least significant differences; means followed by an asterisk differ significantly from the mean of the daminozide treatment at the 5% level.

[w]Control included in regression analyses; l = linear, q = quadratic; 5% level of significance.

Flowering varied with species used, while the amount of influence varied with the concentration of uniconazole used. Flower number of impatiens, inflorescence number of salvia and peduncle number of pansy showed a decrease with an increase in the concentration of uniconazole; these reductions in flowering appeared to be due to a delay in floral development rather than an actual suppression of flowering because subsequent observations on flowering in the landscape did not show treatment differences. Flower buds of geranium were first observed on March 29 on plants treated with the 3 highest concentrations of uniconazole. This trend towards earlier floral development with the highest concentrations of uniconazole continued through April and is re-

Table 4. Effects of uniconazole foliar sprays on growth and drought stress tolerance of marigold.

Treatment		Growth index[z] 4½ WAT[y]	Shoot dry wt. (g) 8 WAT
Growth retardant	Concentration (ppm)		
Uniconazole	0	20.1	8.8
	1	19.9	8.9
	3	19.7	8.7
	5	19.6	7.7
	10	17.7	8.0
	15	17.6	7.5
	20	17.4*[x]	7.7
	30	16.7*	6.4
Significance of rate[w]		l	l
Daminozide	5000	19.4	7.0

[z]WAT = weeks after treatment on February 16, 1989.

[y]Growth index = (height to top of inflorescence + width at widest point + width 90° to widest point)/3, in cm.

[x]Dunnett's test for least significant differences; means followed by an asterisk differ significantly from the mean of the daminozide treatment at the 5% level.

[w]Control included in regression analyses; l = linear; 5% level of significance.

Table 5. Effects of uniconazole foliar sprays on growth and drought stress tolerance of pansy.

Treatment		6 WAT[z]		Time to	Shoot
Growth retardant	Concentration (ppm)	Growth index[y]	Peduncle no.	wilt (hr.)	dry wt. (g) 8 WAT
Uniconazole	0	20.9	3.7	17.4	5.7
	1	22.3	3.6	16.5	5.5
	3	21.7	4.0	16.0	5.4
	5	20.6	4.2	17.5	5.1
	10	18.8	3.7	17.9	4.5
	15	16.9	2.7	17.3	3.4
	20	14.1*[x]	2.7	19.8	2.7
	30	11.0*	2.2*	23.5*	1.9*
Significance of rate[w]		l	l	l	l
Daminozide	5000	20.9	3.9	16.6	4.8

[z]WAT = weeks after treatment on February 16, 1989.

[y]Growth index = (vegetative height + width at widest point + width 90° to widest point)/3, in cm.

[x]Dunnett's test for least significant differences; means followed by an asterisk differ significantly from the mean of the daminozide treatment at the 5% level.

[w]Control included in regression analyses; l = linear; 5% level of significance.

flected in the inflorescence count taken on April 18. Earlier flowering of geranium but a delay in flowering of other bedding plant species treated with a foliar spray of uniconazole was previously reported (6, 11). Flower bud number of marigold averaged 10 to 12 per plant and was not affected by treatment (data not shown).

Uniconazole had a significant effect on time to wilt of all species except marigold. Time to wilt of impatiens increased from 39% with 3 ppm of uniconazole to 63% with 30 ppm compared to the control (Table 1); with geranium the increase was from 11% with 1 ppm of uniconazole to 100% with application of 30 ppm of uniconazole (Table 2). Wilting of salvia was delayed 15% with 3 ppm of uniconazole and 34% with 30 ppm of uniconazole (Table 3). The delay in wilting of pansy was negligible at concentrations of uniconazole less than 20 ppm, but the time to wilt was increased by 35% with the application of 30 ppm of uniconazole.

Landscape evaluation. As with the production and stress evaluation, plant response to uniconazole 5 to 7 weeks after transplanting into the landscape varied with species and concentration. Plant height of impatiens was suppressed less than 25% with application of 1, 3, or 5 ppm of uniconazole compared to the control; plants treated with uniconazole at these concentrations had excellent quality. Shoot dry weight was inhibited by 26% with an application of 1 ppm of uniconazole but increased to 74% with a 20 ppm concentration.

Vegetative and inflorescence heights of geranium 5 weeks after transplanting were not affected by application of 10 ppm or less of uniconazole; concentrations greater than 10 ppm inhibited plant height as much as 58%. Shoot dry weight of geranium treated with 1, 3, 5 or 10 ppm of uniconazole was 7, 12, 25, and 15%, respectively, greater than that of nontreated plants; however, shoot dry weight was suppressed 77% with 30 ppm uniconazole. Vegetative and inflorescence heights and shoot dry weights of salvia 7 weeks after transplanting into the landscape were not affected by uniconazole concentration (data not shown); similarity of heights indicates a more rapid rate of growth of uniconazole-treated plants compared to nontreated plants. Accelerated growth of triazole-treated plants has been observed after growth suppression effects have dissipated (8) and may relate to the accumulation of large reserves of carbohydrates during the period of growth inhibition which stimulate rapid growth as growth retardation lessens (3). The high activity and persistence of triazole retardants are well documented (6) and emphasize the importance of applying appropriate concentrations.

Growth and flowering data taken on daminozide-treated plants following production, during the stress evaluation or after 5 to 7 weeks in the landscape did not differ from values for nontreated plants of the 5 bedding plant species. Therefore, higher concentration and/or repeated application for effective growth suppression are indicated.

(**Ed. note:** This paper reports the results of research only, and does not imply registration of a pesticide under amended FIFRA. Before using any of the products mentioned in this research paper, be certain of their registration by appropriate state and/or federal authorities.)

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