

Paclobutrazol Inhibits Growth of Zinnia and Geranium

Douglas A. Cox¹ and Gary J. Keever²

Department of Horticulture and Alabama Agricultural Experiment Station, Auburn University, AL 36849

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Abstract. 'Scarlet Ruffles' zinnia (*Zinnia elegans* Jacq.) and 'Smash Hit' geranium (*Pelargonium × hortorum* L.H. Bailey) were treated with soil drenches and foliar sprays of paclobutrazol for height control. Single drench applications of 0.5 or 1.0 mg a.i./pot and single spray applications of 250, 500, or 1000 ppm were effective in reducing the height of zinnia. Geranium height was reduced by single drenches of 0.0075 or 0.015 mg a.i./pot and single sprays of 20 or 40 ppm. Higher drench or spray rates resulted in excessive reductions in height and leaf size. Chemical name used: (±)-(R*, R*)-β([4-chlorophenyl)methyl]-α-(1,1-dimethylethyl)-1H-1,2,4-triazole-1-ethanol (paclobutrazol).

Paclobutrazol is an effective growth-retarding chemical for a large number of floriculture crops including: poinsettia (6), chrysanthemum (5), many species of tropical foliage plants (2,4), and annual bedding plants (1,7). Because of its wide range of applicability, paclobutrazol has the potential of becoming the principal growth retardant for many commercial growers. Zinnia and geranium are among the most important commercial bedding plant species and are frequently treated with growth retardants to improve their appearance and postharvest handling and shipping. Few data have been published on the response of geranium to paclobutrazol and none for zinnia. In preliminary trials (unpublished data), geranium was more responsive to paclobutrazol than zinnia, suggesting that the amount of paclobutrazol required to control the growth of the two species is different. Therefore, the objective of this study was to determine the paclobutrazol drench and spray rates necessary for significant, but not excessive, suppression in the growth of each species.

Seeds of 'Smash Hit' geranium and 'Scarlet Ruffles' zinnia were direct-sown in 127-mm pots containing Pro-Mix BX (Premier Brands Inc., New Rochelle, N.Y.) on 21 Apr. 1986 (Expt. 1). Seedlings were thinned to one per pot and fertilized at every watering with 200 ppm N and K from NH₄NO₃ and KNO₃ beginning 14 days later. Plants were grown in a polyethylene-covered greenhouse maintained at about 24°/18°C (day/night). Paclobutrazol soil drench and foliar sprays were applied to zinnia on 13 May, 22 days after sowing, when the plants were about 65 mm tall and to geranium on

26 May, 35 days after sowing, when the plants were about 45 mm tall. Spray rates of 250, 500, 1000, or 2000 ppm and 10, 20, 40, or 80 ppm were applied to zinnia and geranium, respectively. Sprays (1.5 to 2 ml/plant) were applied with the growing medium covered to protect it from drip. Tween 20 (1% v/v) was used as a surfactant. Drench rates of 0.5, 1.0, 2.0, or 4.0 mg a.i./pot and 0.03, 0.06, 0.12, or 0.24 mg a.i./pot were applied to zinnia and geranium, respectively. Drench volume was 50 ml/pot. Spray and drench rates were chosen based on our unpublished results. There were eight single plant replicates per treatment and an untreated control. Species were grown separately with replicates completely randomized. Zinnia growth for each treatment was measured 17 June, 35 days after treatment. Measurements made were: total plant height, measured from the surface of the growth medium to the top of the first inflorescence; mean length of the distal pair of side branches; and shoot dry weight. Geranium growth for each treatment

was measured 5 July, 40 days after treatment. Measurements made were: total plant height, measured from the surface of the growth medium to the uppermost floret in the first inflorescence; vegetative plant height, measured from the surface of the growth medium to the uppermost leaf held parallel to the growth medium surface; and shoot dry weight. The effect of paclobutrazol on the size of leaves developing after treatment was determined by measuring the area of the leaf at the first flowering node. Data were subjected to analysis of variance and regression analyses were used to determine significant linear and quadratic responses to paclobutrazol spray and drench rates (control not included in regression analyses).

Paclobutrazol applied as a drench or spray was effective in reducing zinnia height, branch length, and shoot dry weight (Table 1). At the tested rates, there was no difference between drench and spray applications in the amount of height retardation, but branch length and dry weight were reduced to a greater extent by drench application. With both drenches and sprays, plant height, branch length, and shoot dry weight decreased with increasing paclobutrazol rate. Height retardation was severe and unacceptable at 2.0 and 4.0 mg a.i./pot drench rates and 2000 ppm spray rate. Days to flower were not affected by paclobutrazol (data not shown).

Paclobutrazol drenches and sprays were effective in retarding height and shoot dry weight of geranium (Table 2). Drench application resulted in significantly greater growth suppression than spray application at the tested rates. Vegetative and total height decreased with increasing drench or spray rate. All drench rates caused excessive retardation of vegetative and total plant height. Shoot dry weight decreased with increasing spray rate, but not drench rate. Paclobutrazol significantly reduced leaf area and, at the tested rates, these retardations were greater with drench than with spray treatment. Reductions in leaf size with drench treatment

Table 1. Effect of drench and spray applications of paclobutrazol on growth of 'Scarlet Ruffles' zinnia (Expt. 1.).

Treatment	Growth characteristic		
	Total ht (mm)	Branch length (mm)	Shoot dry wt (g)
Method			
Control	503 a ^z	192 a	8.9 a
Drench	234 b	68 c	5.0 c
Spray	243 b	114 b	5.7 b
Drench rate (mg a.i./pot)			
0.5	330	129	6.0
1.0	273	74	5.5
2.0	176	41	4.3
4.0	157	27	4.1
Significance ^y	L**	L**Q*	L**
Spray rate (ppm)			
250	294	177	6.6
500	260	113	5.9
1000	218	87	5.4
2000	202	78	4.7
Significance ^y	L**Q**	L**Q**	L**

^zMean separation in columns by Duncan's multiple range test, 5% level.

^yTreatment effects were significant at the 1% (**) level and were linear (L) or quadratic (Q).

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¹Assistant Professor. Present address: Suburban Experiment Station, Univ. of Massachusetts, 240 Beaver St., Waltham, MA 02154.

²Associate Professor.

Table 2. Effect of drench and spray applications of paclobutrazol on growth of 'Smash Hit' geranium (Expt. 1.)

Treatment	Growth characteristic			
	Vegetative ht (mm)	Total ht (mm)	Shoot dry wt (g)	Leaf area (cm ²)
Method				
Control	171 a ^z	262 a	7.7 a	44.8 a
Drench	73 c	123 c	3.4 b	13.2 c
Spray	146 b	222 b	7.0 a	30.8 b
Drench rate (mg a.i./pot)				
0.03	91	155	4.3	17.0
0.06	81	128	3.8	15.7
0.12	64	114	3.0	10.6
0.24	54	93	2.4	9.5
Significance ^y	L**Q*	L**	NS	L**Q**
Spray rate (ppm)				
10	169	246	7.8	43.6
20	141	231	6.9	28.4
40	140	209	7.3	26.4
80	132	203	6.0	24.6
Significance ^y	L**	L**	L*	L**

^zMean separation in columns by Duncan's multiple range test, 5% level.

^yTreatment effects were not significant (NS) or significant at the 5% (*) or 1% (**) level and were linear (L) or quadratic (Q).

Table 3. Effect of paclobutrazol drenches on growth of 'Smash Hit' geranium (Expt. 2).

Treatment (mg a.i./pot)	Growth characteristic			
	Vegetative ht (mm)	Total ht (mm)	Shoot dry wt (g)	Leaf area (cm ²)
Control	228	272	14.7	45.3
0.00375	213	269	13.4	40.6
0.0075	195	261	13.1	37.3
0.015	173	241	10.4	27.9
0.03	133	189	8.8	25.7
Significance ^z	L**	L**	L**	L**

^zTreatment effects were significant at the 1% (**) level and were linear (L).

were excessive and became noticeable, even with casual examination, within 3 weeks of treatment. Because of the excessive suppression in height and leaf size, none of the plants treated with the tested drench rates were commercially desirable. With spray applications, height reduction was excessive only at 80 ppm. Days to flower were not affected by paclobutrazol (data not shown).

Since all paclobutrazol drench rates tested on geranium in Expt. 1 resulted in unacceptable retardation in height and leaf size, Expt. 2 was conducted to determine acceptable drench rates. 'Smash Hit' was grown using the same methods as in Expt. 1 except that seeds were sown 11 Feb. 1987 and treatments were made on 22 Mar., 40 days after sowing, when the plants were about 75 mm

tall. Drench rates of 0, 0.00375, 0.0075, and 0.015 and 0.03 mg a.i./pot were applied at 50 ml/pot. There were eight single-plant replicates per treatment completely randomized. Growth measurements were made on 6 May, 45 days after treatment. The same data were taken as in Expt. 1; (control was included in regression analyses).

Vegetative and total height, shoot dry weight, and leaf area were significantly suppressed by the drench rates applied (Table 3); these retardations became larger with increasing rate. However, only with 0.03 mg a.i./pot were reductions in height and leaf size considered severe and unacceptable.

Acceptable height control was obtained with paclobutrazol when zinnia was treated with a single soil drench application at 0.5 or 1.0 mg a.i./pot or a foliar spray of 250, 500, or 1000 ppm. Desirable height was obtained for geranium with a single soil drench of 0.0075 or 0.015 mg a.i./pot or a foliar spray of 20 or 40 ppm.

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