Pampas Grass Responses to Ancymidol, Paclobutrazol, and Uniconazole Substrate Drenches

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SUMMARY: Plant growth retardant (PGR) substrate drenches (in mg a.i. per pot.) of ancymidol at 0.25, 0.5, 1, 2, or 4; paclobutrazol at 1, 2, 4, 8, or 16; and uniconazole at 0.25, 0.5, 1, 2, or 4 (28,350 mg = 1.0 oz) were applied to pampas grass (*Cortaderia selloana*). Control of height growth during greenhouse forcing and the residual effects on plant growth in the landscape were evaluated. During greenhouse forcing, plant height exhibited a quadratic dose response to

paclobutrazol and uniconazole, while ancymidol treated plants exhibited a linear response to increasing dose. All rates of uniconazole resulted in plant heights which were 56% to 75% shorter than the nontreated control, whereas paclobutrazol and ancymidol treatments resulted in 6% to 64% and 5% to 29% shorter plants, respectively. Severe height retardation was evident with $(X_{\text{treatment}}) 2$ mg uniconazole. When the plants were transplanted and grown in the landscape (24 weeks after the PGR application), all plants treated with ancymidol, paclobutrazol, and $(X_{\text{treatment}}) 0.5$ mg uniconazole exhibited heights similar to the nontreated control, suggesting no residual effects of the PGR for these treatments. Only plants treated with uniconazole at $(X_{\text{treatment}}) 1$ mg remained shorter than the nontreated control in the landscape. These results demonstrate that plant growth regulators can be effectively and economically applied in the greenhouse production of pampas grass.

Ornamental grasses are available in a variety of forms and sizes from bunch grasses like blue fescue (*Festuca ovina*) to large tussock-forming grasses like pampas grass which reach a mature size of 7 ft (2.1 m) tall by 4 ft (1.2 m) in diameter at maturity in the landscape (Armitage, 1997). During greenhouse or nursery production, grasses like pampas grass can become disproportionately large relative to container size resulting in overturned plants on the growing pad and at the garden center. Plant growth retardants are commonly applied to containerized crops when plants are likely to become too large relative to the container size (Tayama et al., 1992). Extensive research has been conducted on the use of PGRs in controlling plant growth of herbaceous perennials (Hamaker et al., 1996; Kim et al., 1999), however, the use of PGRs on ornamental grasses has not been reported. This study compared the efficacy of PGR substrate drenches of ancymidol (a-cyclopropyl-a-(4-methoxyphenyl)-5-pyrimidinemethanol, A-Rest, SePRO, Carmel, Ind.), paclobutrazol ((+)-(R*,R*)-β([4-chlorophenyl]methyl)-a-(1,1-dimethylethyl)-1H-1,2,4-triazole-1-ethanol, Bonzi, Uniroyal Chemical, Middlebury, Conn.), and uniconazole ((E)-1-(p-chlorophenyl)-4,4-dimethyl-2-(1,2,4-triazol-1-yl-1-

penten-3-ol), Sumagic, Valent USA, Marysville, Ohio) applied to pampas grass for height control during greenhouse forcing. Residual effects of the PGRs on plant growth in the landscape were also evaluated.

Materials and methods

GREENHOUSE CONDITIONS: Pampas grass plugs were transplanted into 0.32-gal (1.2-L) [6-inch-diameter (15-cm)] round plastic pots containing Fafard 4P (Fafard, Anderson, SC) potting substrate on 3 Mar. 1998. Plants were fertilized each watering with 150 ppm (mg·L⁻¹) N from Excel 15-5-15 Cal-Mag (15N-2.1P-12.5K, Scotts, Marysville, Ohio), and grown under natural daylength. Greenhouse day/night set points were 75/65 °F (24/18 °C). Plants were treated 17 d after potting using 4.5 fl oz (133 mL) of solution of ancymidol at 0.25, 0.5, 1, 2 or 4 mg (a.i. per pot); paclobutrazol at 1, 2, 4, 8, or 16 mg; uniconazole at 0.25, 0.5, 1, 2, or 4 mg; and a nontreated control. The experiment was a completely randomized design with eight single-plant replications. On 27 Apr. 1998, total plant height (measured from the pot rim to the top of the foliage), basal diameter at the soil line (measured at the widest dimension and turned 90°, averaging the two measurements), and plant diameter (measured at the widest dimension and turned 90°, then averaged) were recorded.

LANDSCAPE CONDITIONS: Four replications of each treatment were transplanted outdoors in a randomized complete block design on 8 May 1998 in a sandy-loam soil 4 ft (122 cm) apart and to a depth corresponding to the pot rim. Data on plant height, plant diameter, and basal diameter were collected on 8 July 1998 (15 weeks after PGR application) and 8 Sept. 1998 (24 weeks after PGR application).

DATA ANALYSIS: Plant height, plant diameter, and basal diameter were analyzed using analysis of variance by general linear model procedures (SAS Institute, Cary, N.C.). Means were separated by least significant differences (LSD) at $P_{(X_{\text{treatment}})} 0.05$. Total plant height, plant diameter, and basal diameter values during greenhouse forcing were also regressed using the PROC REG procedure (SAS Inst.) to determine the best fit linear or quadratic model based on a comparison of adjusted R^2 and F values.

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Results and discussion

PLANT HEIGHT IN THE GREENHOUSE: Pampas grass plant height exhibited a quadratic dose response to paclobutrazol and uniconazole, while ancymidol treated plants responded with a linear response to increasing dose during greenhouse forcing (Fig. 1A, B, and C). Paclobutrazol treated plants were 6% to 64% shorter than nontreated plants, while plants receiving ancymidol

drenches of 0.25 to 4 mg were 5% to 29% shorter. The uniconazole rates of 0.25 to 4 mg resulted in plants that were 56% to 75% shorter than the nontreated control. Severe height retardation was evident at 2 mg of ancymidol, although phytotoxicity symptoms were not visible.

PLANT DIAMETER IN THE GREENHOUSE: A significant quadratic response was found between pampas grass plant diameter and each of the PGRs during green-

house forcing (Fig. 1D, E, and F). Plant diameter was 26% less with ancymidol rates 1 mg a.i., paclobutrazol rates 2 mg, or with all the uniconazole rates, when compared to the control. This offers an economic advantage for commercial greenhouse operations; smaller diameter plants can be spaced closer together. This spreads out the overhead, cost-per-square-foot-per-week, over a larger number of plants resulting in lower per-pot

Fig. 1. Effect of ancymidol, paclobutrazol, or uniconazole substrate drenches (a.i. mg/pot; 28,350 mg = 1.0 oz) on plant height (A, B and C), plant diameter (D, E and F), and basal diameter (G, H and I) of pampas grass grown in 0.32-gal (1.2-L) containers in the greenhouse. Plant height at the end of the greenhouse phase was significant at $P \leq 0.001$ for ancymidol (adjusted $R^2 = 0.49$), paclobutrazol (adjusted $R^2 = 0.72$), and uniconazole (adjusted $R^2 = 0.57$). Plant diameter was significant at $P \leq 0.001$ for ancymidol (adjusted $R^2 = 0.75$), paclobutrazol (adjusted $R^2 = 0.62$), and uniconazole (adjusted $R^2 = 0.48$). Basal diameter was significant at $P \leq 0.001$, 0.001 , or 0.01 , respectively, for ancymidol (adjusted $R^2 = 0.53$), paclobutrazol (adjusted $R^2 = 0.53$), and uniconazole (adjusted $R^2 = 0.31$). Each $\square$ represents the means of eight observations; 2.54 cm = 1.0 inch.

Table 1. Responses of pampas grass grown in 0.32-gal (1.2-L) containers to ancymidol, paclobutrazol, or uniconazole substrate drenches over 19 weeks in the landscape, n= 4.

Plant growth regulator treatment	Rate a.i. (mg/pot) ^x	Plant ht (cm) ^y			Plant diam (cm)			Basal diam (cm)		
					Week					
		5	15	24	5	15	24	5	15	24
Untreated	0	60.2	111.9	131.3	62.2	96.9	142.1	4.7	11.1	19.0
Ancymidol	0.25	56.6	112.7	148.3	61.9	97.4	140.5	4.1	10.9	19.8
	0.5	61.0	113.8	142.8	66.5	97.4	141.6	4.4	10.4	20.0
	1.0	56.2	104.8	132.3	46.0	96.2	127.4	4.8	11.2	18.4
	2.0	49.9	107.8	148.3	44.7	99.9	138.8	4.8	10.3	22.0
	4.0	42.2	99.0	130.5	35.0	97.8	137.5	5.6	12.2	20.1
	16.0	21.5	77.4	118.3	32.0	79.9	113.5	7.0	12.1	16.1
Paclobutrazol	1.0	56.0	103.9	145.8	58.1	99.8	147.6	5.0	10.9	20.6
	2.0	49.4	104.7	134.0	41.5	98.6	140.6	6.0	11.2	16.8
	4.0	31.8	100.7	122.0	35.0	80.9	125.5	5.5	12.0	16.1
	8.0	25.0	92.3	130.5	35.3	80.9	130.0	7.3	11.4	17.4
	16.0	21.5	77.4	118.3	32.0	79.9	113.5	7.0	12.1	16.1
	28.0	15.3	27.3	63.0	32.0	34.9	54.3	7.2	9.6	9.8
Uniconazole	0.25	26.4	96.7	132.3	37.0	96.6	124.9	6.9	13.2	19.0
	0.5	22.4	84.1	118.8	36.8	76.2	116.1	7.2	12.7	15.4
	1.0	19.7	59.9	98.3	33.7	57.0	105.5	7.5	12.4	15.5
	2.0	17.1	38.4	93.8	36.0	40.6	94.8	7.6	12.5	14.6
	4.0	15.3	27.3	63.0	32.0	34.9	54.3	7.2	9.6	9.8
Significance ^z		***			***			***		

^zSignificant at P (XtreqalX) 0.001 for plant height, plant diameter, and basal diameter for the plant growth regulator (XtimesX) week interaction. LSD ((Xsalphax) (XtreqalX) 0.05) was 16.1, 14.6, and 2.6 cm (6.34, 5.75, and 1.02 inches), respectively, for height, plant diameter, and basal diameter for the plant growth regulator (XtimesX) week interaction. Values are means of four replicates of each treatment.

^y2.54 cm = 1.0 inch.

^x28,350 mg = 1.0 oz.

production costs.

BASAL DIAMETER IN THE GREENHOUSE: In contrast to the retardation of height and plant diameter growth, pampas grass basal diameters exhibited an incremental increase in size across increasing concentrations of each PGR by week 5 after treatment (Fig. 1G, H, and I). Ancymidol treated pampas grass exhibited a linear dose response whereas, significant quadratic dose responses were observed with both paclobutrazol and uniconazole treatments (Fig. 1G, H, and I). Plants treated with ≥ 8 mg paclobutrazol or with 1 or 2 mg uniconazole exhibited a significantly greater basal diameter than the nontreated control within 5 weeks after the PGRs were applied. The larger basal diameter was due to the high PGR rates which induced a proliferation of smaller sized shoots. The reduced height and increased basal diameter gave the plants a robust appearance.

PLANT HEIGHT IN THE LANDSCAPE: In the landscape, pampas grass plants treated with (XtreqalX) 8 mg paclobutrazol or (XtreqalX) 0.5 mg uniconazole, remained significantly shorter than the nontreated plants 15 weeks after the PGR application (Table 1). When the study ended 24 weeks after the PGR application, all plants in the landscape

treated with ancymidol or paclobutrazol had heights similar to the nontreated control. In general, as the plants age they grow out of the PGR affects if the rate is not too excessive (Norremark and Andersen, 1990). Results for ancymidol and paclobutrazol treated plants confirm similar reports of limited PGR persistence in bedding plants (Keever and Foster, 1991). Significant retardation of plant growth (25% to 52% shorter plants) was still evident with uniconazole rates (XtreqalX) 1.0 mg.

PLANT DIAMETER IN THE LANDSCAPE: At the end of the field trial, plants treated with (XtreqalX) 0.5 mg uniconazole were significantly smaller in plant diameter (18% to 62%) compared to the nontreated control. Pampas grass treated with 4 or 16 mg paclobutrazol were also smaller in diameter than the nontreated plants (Table 1).

BASAL DIAMETER IN THE LANDSCAPE: By week 15 after treatment, all basal diameters were similar among the PGR treatments. By the end of the field trial, the basal diameters of plants treated with 4 or 16 mg paclobutrazol remained slightly smaller whereas plants treated with (XtreqalX) 0.5 mg uniconazole were substantially smaller. The basal diameters at week 24 after treatment mirror results reported for

plant diameters.

This research compared the efficacy of PGR substrate drenches applied to pampas grass during greenhouse forcing and production. Use of ancymidol drenches offered limited control of plant growth at the highest rate used during forcing. By the end of the experiment in the landscape, plant growth was equal to the nontreated plants. Overall, ancymidol may not be economical for the commercial grower to use on pampas grass because the 1 and 2 mg drench rates cost \$0.26 and \$0.52 per pot, respectively, based on the cost of \$65/qt (\$69/L).

Uniconazole rates used in this study resulted in shorter plants than the nontreated control, with rates (XtreqalX) 0.5 mg considered excessive. The efficacy of uniconazole continued after the plants were placed in the landscape. Uniconazole rates lower than the 0.25 mg rate used in this study may provide economical control of pampas grass for the grower, as the 0.125 and 0.25 mg rates would cost \$0.03 and \$0.06 per pot, respectively, based on the cost of \$110/qt (\$116/L).

Optimal rates of paclobutrazol were between 1 and 2 mg for growth control of pampas grass. These rates resulted in plants that were smaller in diameter and would allow an increased

plant density on the growing bench. The 1 and 2 mg drench rates were also cost effective at \$0.03 and \$0.06 per pot, respectively, based on the cost of \$110/qt.

These results demonstrate that applications of 1 to 2 mg paclobutrazol or uniconazole at rates $\times 0.25$ mg a.i. per 0.32-gal pot can be effectively and economically employed to prevent pampas grass from becoming disproportionately large relative to the container size during greenhouse forcing while assuring growth recovery within a few weeks of planting into the landscape.

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