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Effects of Preemergence-applied Herbicides on Pampas Grass Grown in Containers[1]

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Abstract

Two experiments evaluated the effects of preemergence herbicides on growth of pampas grass [*Cortaderia selloana* (Schult. and Schult f.) Asch. and Graebn.] applied after transplanting from 72-cell packs into 3.8 liter (#1) containers. Ronstar (oxadiazon) and Regal O-O (oxadiazon + oxyfluorfen) applied at the manufacturers' recommended rates caused little or no injury. Ornamental Weedgrass Control (pendimethalin), Pendulum 2G (pendimethalin), Pendulum 60 WDG (pendimethalin), Surflan 4AS (oryzalin), Rout (oryzalin + oxyfluorfen), and Factor 65 WG (prodiamine) suppressed root development in the upper 5.1 cm (2 in) of the container medium in both experiments. Application of Surflan 4AS resulted in 100% and 70% mortality of plants in the two experiments, respectively. Lodging was greatest with Factor 65 WG (100% and 90% in the two experiments) and Pendulum 60 WDG (50% in both studies). Some lodging occurred with the application of all dinitroaniline herbicides in the two studies.

Index words: ornamental grass, weed control, container-grown landscape plants.

Herbicides used in this study: Rout, [oxyfluorfen, 2-chloro-1-(3-ethoxy-4-nitrophenoxy)-4 (trifluoromethyl)benzene + (oryzalin), 4-(dipropylamin0)-3,5-dinitrobenzenesulfonamide]; Surflan 4AS (oryzalin), 3,5-dinitro-N_4, N_4-dipropylsulfanilamide; Ornamental Weedgrass Control, Pendulum 2G, and Pendulum 60 WDG (pendimethalin), N-(1-ethylpropyl)-3,4 dimethyl-2,6-dinitrobenzenamine; Ronstar (oxadiazon), 3-[2,4dichloro-5-(1-methylethoxy) phenyl]-5-(1,1-dimethyl ethyl)-1,3,4- oxadiazol-2-(3H)-one; Factor (prodiamine) [N_3,N_3-Di-n-propyl-2, 4-dinitro-6-(trifluoromethyl)-m-phenylenediamine; Ornamental Herbicide-II (oxyfluorfen + pendimethalin); Regal O-O (oxyfluorfen + oxadiazon).

Species used in this study: Pampas grass [*Cortaderia selloana* (Schult. and Schult f.) Asch. and Graebn.].

Significance to the Industry

A recent trend in the southeastern United States is to transplant small liners of pampas grass (72-cell pack) into 3.8-liter (#1) containers. In the past, larger-sized liners were used for transplanting. Applying certain dinitroaniline preemergent herbicides to these smaller liners at potting results in severe shoot or root inhibition, lodging, or plant death. Based on our results, injury is less severe with granular formulations of dinitroaniline herbicides than with spray-applied formulations. Non-dinitroaniline herbicides (Ronstar and Regal O-O) appear safe for use on small pampas grass liners at potting.

Introduction

Pampas grass is widely grown in containers in the Southeastern United States. Previous work has reported pampas grass to be tolerant of several preemergence-applied herbicides (3, 5). Several herbicides, Ornamental Weedgrass Control (pendimethalin) (Scotts Co., Marysville, OH), Ornamental Herbicide II (pendimethalin + oxyfluorfen) (Scotts Co.), Factor 65 WG (prodiamine) (Sandoz Agro Inc., Des Plaines, IL), Pendulum 60 WDG (pendimethalin) (Cynamid, Wayne, NJ), and Regal O-O (oxadiazon + oxyfluorfen) (Regal Chemical Co., Marietta, GA), are currently registered for use on container-grown pampas grass.

Growers in the Southeast have observed midseason lodging (inelastic displacement of plants from the vertical position) of pampas grass. Most of the herbicides labeled for pampas grass contain a dinitroaniline herbicide. Dinitroaniline herbicides inhibit new root development as their mode of action. Dinitroaniline herbicides registered for landscape and nursery use include oryzalin, pendimethalin, prodiamine, and trifluralin. Neal and Senesac (5) reported that 6 ornamental grass species were tolerant of several preemergent herbicides, including prodiamine, pendimethalin, and trifluralin. In their work, seedlings were transplanted from plug trays into 250 ml (8.5 oz) containers and grown for three months prior to herbicide application. In the Southeast, a typical production practice is to seed pampas grass in late winter into 72-cell pack trays and in April or May transplant directly into larger containers for field production. Therefore, preemergent herbicides are applied to much smaller transplanted liners than in Neal and Senesac's work (5). Other research (8, 9) with radiolabeled isotopes showed oxadiazon and oryzalin movement in container media was limited to the upper 5.1 cm (2 in). Thus, preemergence-applied herbicides may have a greater impact on pampas grass when applied to a smaller liner following transplanting because all roots would be in the upper 5.1 cm (2 in) of the medium. The objective of our work was to evaluate the effects of preemergence-applied herbicides on growth of pampas grass in containers after transplanting from 72-cell pack trays.

Materials and Methods

Experiment 1. Uniform liners (72-cell packs), 12.7 cm (5 in) in height, of white pampas grass, propagated from seed, were potted April 8, 1996, in 3.8-liter (#1) containers at the Ornamental Horticulture Substation, Mobile, AL. The potting medium consisted of pinebark:peat (3:1 by vol) amended per m^3 (yd^3) with 5.9 kg (10 lb) Osmocote 17N–3.1P–10K (17–7–12), 3.6 kg (6 lb) dolomitic lime, 1.2 kg (2 lb) gyp-

[1]Received for publication November 5, 1996; in revised form April 5, 1997.

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sum, and 0.9 kg (1.5 lb) Micromax. Two days after potting, 9 herbicides were applied over-the-top at the following rates in kg ai/ha (lb ai/A): Ornamental Weedgrass Control (pendimethalin) at 3.4 (3.0), Rout 3G (oxyfluorfen + oryzalin) (Scotts Co.) at 3.4 (3.0), OH-2 3G (oxyfluorfen + pendimethalin) at 3.4 (3.0), Regal O-O (oxyfluorfen + oxadiazon) at 3.4 (3.0), Factor 65 WG (prodiamine) at 1.7 (1.5), Surflan 4AS (oryzalin) (DowElanco, Indianapolis, IN) at 3.4 (3.0), Pendulum 60 WDG (pendimethalin) at 3.4 (3.0), Pendulum 2G (pendimethalin) at 3.4 (3.0), and Ronstar 2G (oxadiazon) (Rhone Poulenc, Research Triangle Park, NC) at 4.5 (4.0). Granular herbicides were applied with a hand-held shaker, while the three liquid formulation herbicides, Factor 65 WG, Surflan 4AS, and Pendulum 60 WDG, were applied using a CO_2 backpack sprayer with an 8004 nozzle (R & D Sprayers, Opelousas, LA) at 235 k-pascals (34 psi) in 187 l/ha (20 gpa). Treatments also included a nonweeded control. Following treatment, containers were spaced 35.5 cm (12 in) apart on a container bed and irrigated daily with overhead irrigation. All containers were hand weeded to eliminate any weed competition affects. The statistical design was a randomized complete block (RCB) with 8 single plant replications.

Data were collected at 45 and 75 days after treatment (DAT). Plant height was determined by extending the longest leaf prior to measuring (including lodged plants). Roots in the upper 5.1 cm (2 in) and lower 10.2 cm (4 in) of the container were rated separately on a scale of 1–5 where 1–5 = 0, 25, 50, 75, or 100% root coverage at the medium-container interface (sides and bottom of container). Mortality, lodging (+ or –), and foliar dry weight were also recorded at 75 DAT. Treatment means were separated using Duncan's multiple range test (P = 0.05).

Experiment 2. Experiment 1 was repeated at Auburn University, Auburn, AL with minor changes. Plants were potted May 20, 1996, in pinebark:sand (6:1 by vol) amended per m^3 (yd^3) with 7.4 kg (12.5 lb) Polyon 24N–1.7P–11.6K (24–4–14), 3.0 kg (5 lb) dolomitic lime, and 0.9 kg (1.5 lb) Micromax). Treatments were applied May 23, 1996, to 10 single-plant replications in a RCB design, and data collected at 30 and 60 DAT.

Results and Discussion

Experiment 1. Surflan 4 AS, Rout 3G, and Factor 65 WG all retarded height development at 45 and 75 DAT (Table 1) compared to nontreated plants, while Regal O-O and Ronstar had little affect on plant growth. These same three herbicides, plus OH-2 3G, Pendulum 60 WDG, and Pendulum 2G suppressed upper root development at 45 and 75 DAT. Both Ornamental Weedgrass Control and Regal O-O had decreased upper root development only at 75 DAT compared to controls. Less root development in the lower portion of the container was evident at both 45 and 75 DAT with Surflan 4AS, Rout 3G, Factor 65 WG, and Pendulum 60 WDG when compared to control plants. Previous work had demonstrated oryzalin injury to pampas grass (4). Stamps and Neal (6) reported Surflan, a dinitroaniline herbicide, suppressed root development of four landscape species during container production. Gilreath (2) showed Surflan caused stunting and reduced panicle yield of statice (*Limonium sinuata* L.). Other work (7) evaluating herbicide use in propagation showed that Surflan-treated Korean boxwood (*Buxus microphylla* var. *koreana* Nakai) exhibited root and shoot suppression and Surflan treated Compacta holly (*Ilex crenata* Thunb. 'Compacta') exhibited root suppression 13 months after propagation. Davies and Duray (1) evaluated preemergent herbicides on rooting and subsequent liner growth of selected nursery crops and showed that root numbers of hibiscus (*Hibiscus rosa-sinensis* L. 'White Leprechaun') and Burford holly (*Ilex cornuta* Lindl. & Paxt. 'Burfordii') were reduced by several dinitroaniline herbicides.

In experiment 1, foliar dry weights of plants treated with Surflan 4AS, Rout 3G and Factor 65 WG were less than plants in all other treatments (Table 1). Plant mortality was 100% and 12.5%, in Surflan 4AS and Rout 3G treatments, respectively (Table 2). Lodging occurred in 100, 50, and 12.5% of plants treated with Factor 65 WG, Pendulum 60 WDG, and Ornamental Weedgrass Control, respectively, at 75 DAT (Table 2). The authors observed that aerial support roots of

Table 1. Height, root rating and foliar dry weight of pampas grass treated with 9 preemergence herbicides, experiment 1.

Herbicide	Rate kg ai/ha	Height (cm)		Root rating[z]				Foliar dry weight (g)
				Upper 5.1 cm (2 in)		Lower 10.2 cm (4 in)		
		45 DAT	75 DAT	45 DAT	75 DAT	45 DAT	75 DAT	75 DAT
OWC[y]	3.4	75.2a[x]	118.4a	2.1ab	3.1c	4.0ab	4.6a	38.93a
Pendulum 2G	3.4	71.5a	118.5a	1.4cd	3.0c	3.9ab	5.0a	39.73a
Pendulum 60 WDG	3.4	67.7a	112.0a	1.0d	1.1d	2.6c	3.0b	29.59a
OH-2 3G	3.4	74.5a	121.9a	1.9bc	3.1c	3.8b	4.6a	35.99a
Surflan 4AS	3.4	13.6d	—[w]	1.0d	1.0d	1.0e	1.0d	—
Rout 3G	3.4	33.2c	71.9b	1.1d	1.1d	2.0d	1.9c	17.63b
Factor 65 WG	1.7	46.7b	72.7b	1.0d	1.0d	1.0e	1.3d	10.10b
Ronstar	4.5	70.1a	118.1a	2.5a	3.9a	4.5a	5.0a	39.81a
Regal O-O	3.4	72.9a	119.6a	2.5a	3.4bc	4.0ab	4.5a	40.30a
Control	—	77.8a	121.5a	2.6a	3.9a	4.5a	5.0a	37.91a

[z]1–5 rating scale = 0, 25, 50, 75, or 100% root coverage at the container-medium interface.

[y]OWC = Ornamental Weedgrass Control.

[x]Mean separation using Duncan's multiple range test (P = 0.05).

[w]Plants died before 75 DAT (days after treatment).

Table 2. Height, root rating and leaf dry weight of pampas grass treated with 9 preemergence herbicides, experiment 2.

Herbicide	Rate kg ai/ha	Height (cm)		Root rating[z]				Foliar dry weight (g)
				Upper rootball		Lower rootball		
		30 DAT[y]	60 DAT	30 DAT	60 DAT	30 DAT	60 DAT	60 DAT
OWC[x]	3.4	49.9a[w]	111.9bc	1.2bc	2.1de	2.0abc	3.4b	23.16bc
Pendulum 2G	3.4	54.3a	134.2a	1.5b	3.4c	2.4abc	4.4a	30.86ab
Pendulum 60 WDG	3.4	53.4a	102.9c	1.3bc	2.3d	2.5ab	3.1b	32.88ab
OH-2 3G	3.4	58.2a	134.0a	1.3bc	3.7bc	2.2abc	4.4a	31.74ab
Surflan 4AS	3.4	29.1c	36.2d	1.1c	1.0f	1.6bc	1.4c	3.50d
Rout 3G	3.4	39.2b	97.3c	1.1c	1.2ef	1.5c	2.0c	15.44c
Factor 65 WG	1.7	55.5a	112.1bc	1.2bc	1.2ef	1.9abc	2.0c	35.25a
Ronstar	4.5	55.5a	126.5ab	1.5b	4.1abc	2.4abc	4.6a	34.33a
Regal O-O	3.4	59.4a	129.6ab	1.7a	4.6a	2.8a	4.6a	39.47a
Control	—	54.3a	132.6a	1.4b	4.5ab	2.5ab	4.8a	34.33a

[z]1–5 rating scale = 0, 25, 50, 75, and 100% root coverage at the container-medium interface.

[y]DAT= days after treatment.

[x]OWC = Ornamental Weedgrass Control.

[w]Mean separation using Duncan's multiple range test (P = 0.05).

lodged plants were short, stubby, and enlarged at the distal ends. Lack of development of these roots probably contributed to lodging.

Experiment 2. Data from the Auburn experiment generally concurred with that from experiment 1. Only Rout 3G and Surflan 4AS suppressed plant height at 30 DAT; both continued to suppress height at 60 DAT along with Ornamental Weedgrass Control, Factor 65 WG, and Pendulum 60 WDG (Table 3). Rout 3G- and Surflan 4AS- treated plants also exhibited less upper root [5.1 cm (2 in)] development at 30 DAT when compared to the controls. Upper root development in plants treated with Regal O-O actually exceeded that of control plants. Rout 3G and Surflan 4AS continued to suppress upper root development at 60 DAT along with Ornamental Weedgrass Control, OH-2, Factor 65 WG, Pendulum 60 WDG and Pendulum 2G.

Rout 3G was the only herbicide to suppress lower root development at 30 DAT compared to the control (Table 3). Rout 3G also suppressed lower root development at 60 DAT along with Factor 65 WG, Pendulum 60 WDG, Surflan 4AS, and Ornamental Weed Grass Control. Significant decreases in foliar dry weights were evident in plants treated with Ornamental Weed Grass Control, Rout 3G, and Surflan 4AS at 60 DAT.

At 60 DAT, mortality was 70% and 10% for plants treated with Surflan 4AS and Rout 3G, respectively (Table 2). Of the plants treated with Ornamental Weed Grass Control, Rout 3G, and Pendulum 60 WDG, 50% had lodged at 60 DAT, along with 90% of those treated with Factor 65 WG.

Results of these two experiments showed Surflan 4AS, Rout 3G, and Factor 65 WG caused poor root development, extensive lodging, or death of pampas grass. At termination, Pendulum 60 WDG-treated pampas grass generally had less root development than plants treated with granular formulations of pendimethalin, Ornamental Weedgrass Control or Pendulum 2G; 50% of WDG-treated plants had lodged compared to 19% of plants treated with granular pendimethalin (average of Pendulum 2G and Ornamental Weedgrass Control). These data concur with work by Stamps and Neal (6),

Table 3. Lodging and mortality of pampas grass following application of selected preemergence herbicides in experiment 1 and 2[z].

Treatment	Rate kg ai/ha	Experiment 1		Experiment 2	
		Lodging	Mortality	Lodging	Mortality
		%			
OWC[y]	3.4	12.5	0.0	50.0	0.0
Pendulum 2G	3.4	0.0	0.0	10.0	0.0
Pendulum 60 WDG	3.4	50.0	0.0	50.0	0.0
OH-2 3G	3.4	0.0	0.0	10.0	0.0
Surflan 4AS	3.4	—	100.0	20.0	70.0
Rout 3G	3.4	0.0	12.5	50.0	10.0
Factor 65 WG	1.7	100.0	0.0	90.0	0.0
Ronstar	4.5	0.0	0.0	0.0	0.0
Regal O-O	3.4	0.0	0.0	0.0	0.0
Control	—	0.0	0.0	0.0	0.0

[z]8 and 10 single-plant replications in experiments 1 and 2, respectively.

[y]OWC = Ornamental Weedgrass Control.

who reported the water dispersable granular formulations of Pendulum and Factor were phytotoxic to *Photinia* x *fraseri* Dress while the granular formulations were not. Granular herbicides containing pendimethalin were the least injurious among the dinitroaniline herbicides; however, all granular formulations containing pendimethalin caused some lodging during this study. Consequently, granular pendimethalin formulations should not be used at potting of small pampas grass liners. The non-dinitroaniline herbicides (Ronstar and Regal O-O) appear safe for use on small pampas grass liners at potting.

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Nitrogen Nutrition of Containerized *Cupressus arizonica* var. *glabra* 'Carolina Sapphire'[1]

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Abstract

Rooted stem cuttings of 'Carolina Sapphire' smooth Arizona cypress [*Cupressus arizonica* var. *glabra* (Sudw.) Little 'Carolina Sapphire'] grown in calcined clay in 3.8 liter (#1) containers were fertilized daily for 16 weeks with a complete nutrient solution containing 0, 20, 40, 80 or 160 mg N/liter supplied as ammonium nitrate. Plant heights and stem diameters were unaffected by N rate suggesting that a daily nutrient application of 20 mg N/liter was adequate for maximizing growth. Nitrogen fertilization increased heights and stem diameters by 71% and 56%, respectively, compared to the nontreated controls (0 mg N/liter). Even though shoot growth was unaffected by increasing N levels, foliage N concentration was positively correlated ($r = 0.75$, $P < 0.0001$) to N levels. As N concentration increased, total root area and total root length increased quadratically. Nitrogen fertilization increased root area and root length 119% and 108%, respectively, compared to the nontreated controls. Phosphorus concentration of shoots increased quadratically with increasing N levels. Nitrogen rate failed to affect K concentration of shoots. Shoot Ca and Mg concentrations decreased with increasing N levels.

Index words: fertilization, conifer, foliar analysis, arcillite, container production, mineral nutrition.

Significance to the Nursery Industry

'Carolina Sapphire' smooth Arizona cypress [*Cupressus arizonica* var. *glabra* (Sudw.) Little] is a versatile, fast growing evergreen tree which can be utilized as a specimen plant, an attractive screen or as a Christmas tree. Since its introduction in 1987, interest and subsequent demand for this cultivar have increased, accompanied by a need for information related to container production. Maximum shoot growth and excellent root growth of 'Carolina Sapphire' were realized by daily application of a complete nutrient solution containing 20 mg N/liter. Rates of N > 20 mg/liter failed to stimulate additional shoot growth although N concentrations of shoots increased with higher rates of N. Even though additional N was absorbed at higher rates, there were no further growth benefits, and leaching of N would certainly increase with increasing N concentration. Thus, high N substrate concentrations should be avoided during production of 'Carolina Sapphire' smooth Arizona cypress.

[1]Received for publication August 26, 1996; in revised form December 18, 1996. This research was funded by the North Carolina Agricultural Research Service, Raleigh, NC 27695-7643. Technical assistance of William Reece, Diane Mays, and the Analytical Service Laboratory, Department of Soil Science, North Carolina State University is gratefully acknowledged. Statistical guidance of William H. Swallow is greatly appreciated.

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