Tolerance of Ornamental Grasses to Preemergence Herbicides[1]

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Abstract

Tolerance of ornamental grasses to preemergence herbicides commonly-used in nursery crop production and turfgrass maintenance was evaluated in container studies. Gallery controlled the broadleaf weeds tested but did not control large crabgrass. Surflan at 2.2 kg ai/ha (2.0 lb ai/A) controlled all weeds except rice flatsedge. Pennant at 2.2 kg ai/ha (2.0 lb ai/A) controlled rice flatsedge but not eclipta. Pendulum, Ronstar, Barricade and OH2 also did not control eclipta at the lower use rate. Although growth suppression and stand reduction was observed in certain herbicide/ornamental grass combinations, the species tested generally exhibited good tolerance to the chemicals tested. Ornamental grass tolerance improved by the second herbicide application. After two applications, no rate of Surflan, Pendulum, or Barricade caused a significant reduction in growth of any of the five ornamental grass species tested.

Index words: container production, preemergence herbicides, weed control.

Species used in this study: dwarf fountain grass [*Pennisetum alopecuroides* (L.) Spreng. 'Hameln']; feather reed grass [*Calamagrostis* x *acutiflora* (L.) Roth 'Karl Foerster']; silver variegated maiden grass (*Miscanthus sinensis* Anderss. 'Morning light'); silver arrow miscanthus (*Miscanthus sinensis* Anderss. 'Silberfeil'); and zebra grass (*Miscanthus sinensis var. zebrinus* Beal).

Herbicides used in this study: Barricade (prodiamine), N,N-di-n-propyl-2,4-dintiro-6-(trifluromethyl)-m-phenylenediamine; Gallery (isoxaben), N-[3-(1-ethyl-1-methylpropyl)-5-isoxazolyl]-2,6-dimethoxybenzamide; Pennant (metolachlor), 2-chloro-N-(2-ethyl-6-methylphenyl)-N-(2-methoxy-1-ethylethyl)acetamide; Pendulum (pendimethalin), N-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine; Surflan (oryzalin), 4-(dipropylamino)-3,5-dinitrobenzenesulfonamide; Ronstar (oxadiazon), 3-[2,4-dichloro-5(methylethoxy)phenyl]-5-(1,1-dimethylethyl)-1,3,4-oxadiazol-2-(3H)-one; Ornamental Herbicide 2 (OH2) (oxyfluorfen + pendimethalin), 2-chloro-1-(3-ethoxy-4-nitrophenoxy)-4-(trifluromethyl)benzene + N-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobezeneamine.

Significance to the Nursery Industry

Ornamental grasses have become increasingly popular as landscape plants. To meet this demand, nurseries are commonly producing these plants in containers. There is a need for effective weed management in nursery production of these plants. Preemergence herbicides are generally used to control weeds in container production. Little information exists about the tolerance of ornamental grasses to herbicides commonly used by the container industry. Ornamental grasses exhibited generally good tolerance to the herbicides tested in this research. Stunting of growth or stand reduction occurred in some cases, suggesting that delayed herbicide application after transplanting could be beneficial. Ornamental grasses tested exhibited greater herbicide tolerance following the second herbicide application, supporting this conclusion. Use of lower application rates should also improve crop tolerance as growth reductions were more likely to occur at higher labeled rates of the herbicides tested.

Introduction

Ornamental grasses have increased in popularity as landscape plants because of their aesthetic values and low maintenance requirements (14). To meet this demand, these species are commonly grown in containers by commercial nurseries. Annual weeds are common pests in container production, for which preemergence herbicides are commonly applied for control.

Preemergence herbicides are commonly used for weed control in turf, especially for annual grasses such as large crabgrass (1). Ornamental grasses may have similar tolerance to preemergence herbicides as turfgrass species. These grasses also may tolerate preemergence herbicides commonly used in container nursery production. Limited information is available on the safety of preemergence herbicides to ornamental grass species.

Turfgrass species as well as ornamental grass species differ in their tolerance to herbicides (1, 2). Six ornamental grass species tolerated the preemergence herbicides Pendulum, Barricade, Treflan (trifluralin), Gallery, and OH2 at labeled rates (12). However, sprayed applications of Pennant and Surflan severely injured all species in that container study. Pennant and Barricade reduced the shoot weight of sea oats (*Uniola paniculata* L.) compared to the untreated control (7).

Since selective postemergence control is not available for most weeds in container nursery production, growers rely on preemergence herbicides for weed control (4). Gallery is used in ornamentals and turf for preemergence control of annual broadleaf weeds (1, 3, 4, 13). Surflan, Ronstar, Pendulum and Barricade are used for annual grass control in ornamentals and established turfgrass (1, 4, 8, 9). Pennant and OH2 are used for weed control in nursery production (4). Ornamental grasses may be able to tolerate these chemicals following transplanting of divisions, but little research has been conducted in this area. The objective of this study was to evaluate the tolerance of container-grown ornamental grasses to these commonly-used preemergence herbicides in the turf and nursery industries.

[1]Received for publication October 1, 2001 and in revised form April 4, 2002.
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Materials and Methods

General conditions. The ornamental grass species used in this study were dwarf fountain grass [*Pennisetum alopecuroides* (L.) Spreng. 'Hameln'], feather reed grass [*Calamagrostis* x *acutiflora* (L.) Roth 'Karl Foerster'], silver variegated maiden grass (*Miscanthus sinensis* Anderss. 'Morning light'), silver arrow miscanthus (*Miscanthus sinensis* Anderss. 'Silberfeil'), and zebra grass (*Miscanthus sinensis* var. *zebrinus* Beal). Grasses that had been grown in 4-liter (one gal) containers were divided into separate, single-shoot plants in May for the first study and in July for the second trial. These bare-root divisions were transplanted into 4-liter (one gal) containers in a pine bark:sand medium (4:1 by vol). Pots were fertilized at the rate of 9 g/container (0.3 oz/container) using a 17–6–12 slow release-fertilizer containing micronutrients (the Scotts Company, Marysville, OH).

Spotted spurge (*Euphorbia maculata* L.) and yellow woodsorrel (*Oxalis stricta* L.) were seeded into ornamental grass pots. Eclipta (*Eclipta alba* (L.) Hassk.), large crabgrass [*Digitaria sanguinalis* (L.) Scop.], and rice flatsedge (*Cyperus iria* L.) were seeded into separate pots containing no ornamental grasses. Seeding rate for each species was approximately 0.6 ml (1/8 teaspoon) per pot.

Herbicides were applied 4 to 5 days after transplanting. Heights at first treatment were: dwarf fountain grass 12.5 cm (5 in), feather reed grass 22.5 cm (9 in), morning light miscanthus 30 cm (12 in), silver arrow miscanthus 32.5 cm (13 in) and zebra grass 32.5 cm (13 in). Experimental design was a randomized complete block with four replications and three pots of each species per plot and the experiment was repeated.

The herbicides and rates tested were: Ronstar 2G at 2.24, 4.48 and 8.96 kg ai/ha (2.0, 4.0 and 8.0 lb ai/A), Gallery 75DF at 0.56, 1.12 and 2.24 kg ai/ha (0.5, 1.0, and 2.0 lb ai/A), Surflan 4L at 2.24, 4.48 and 8.96 kg ai/ha (2.0, 4.0 and 8.0 lb ai/A), Barricade 65 WDG at 0.84 and 1.68 kg ai/ha (0.75 and 1.5 lb ai/A), Pennant 8EC at 2.24, 4.48 and 8.96 kg ai/ha (2.0, 4.0 and 8.0 lb ai/A), Pendulum 60DG at 2.24, 4.48 and 8.96 kg ai/ha (2.0, 4.0 and 8.0 lb ai/A), and OH2 3G applied at 3.36 and 6.72 kg ai/ha (3.0 and 6.0 lb ai/A). Gallery, Surflan, Pennant and Ronstar were applied at the maximum use rate and at one half and twice that rate. OH2 was applied at one and two times the maximum use rate, while Barricade was applied at the anticipated use rate and twice that rate. However, the higher application rate chosen for Barricade corresponds to the maximum use rate. Sprayable herbicides were applied broadcast using a CO_2-pressurized backpack sprayer delivering 230 liters/ha. Granular herbicides were applied with a shaker jar. Plants were overhead-irrigated daily with 1.3 cm (0.5 in) of water.

Ornamental grass stand was recorded 2 months after the first and the second herbicide application. Shoot fresh weights for each ornamental grass species were measured 2 months after treatment by cutting the shoots at 7.5 cm (3 in) above the substrate surface. Shoot weights were recorded to quantify any adverse effect on crop growth by the herbicide treatments. Since most of the herbicides tested primarily impact root development, harvesting of ornamental grass shoots would not be expected to alter their tolerance to these chemicals. Containers were retreated two days later, and a second shoot fresh weight measurement was taken 2 months later. The experiment was repeated in July using the same techniques as the first study. Results from the two studies were similar and thus combined for analysis. Sufficient stand of large crabgrass was present in both studies so results were averaged across the two trials. Due to insufficient stand of the other weed species in the second trial, results are reported only for the first trial. Weed counts and ornamental grass stand and shoot weights were subjected to analysis of variance with mean separation by the Least Significant Difference Test at P = 0.05. Data for the three rates of each herbicide were subjected to linear regression to determine if a significant rate response had occurred.

Experiment 1. The first herbicide application was on May 18, 1993, under cloudy conditions and 24C (75F) air temperature. Plants were irrigated one hour after treatment. Shoot fresh weights were taken on July 19, 1993. All treatments were reapplied on July 21, 1993, under sunny conditions, 30C (86F), and the grasses were 7.5–12.5 cm (3–5 in) tall. Plants were irrigated 2 hours after treatment.

Experiment 2. The first herbicide application was made on July 16, 1993. under sunny conditions, air temperature 29C (84F) , irrigated one hour after treatment. Shoot fresh weights were taken on September 15, 1993, and plants were retreated on September 17, under cloudy conditions, and air temperature 26C (79F), and the grasses were 7.5–12.5 cm (3–5 in) tall. Plants were irrigated 2 hours after treatment.

Results and Discussion

Gallery, even at twice the maximum use rate, provided poor control of large crabgrass (Table 1), although large crabgrass stand decreased linearly with increasing rate. Neal and Senesac also reported poor annual grass control with Gallery (13). The lower rate of OH2 did not provide acceptable large crabgrass control. All other treatments controlled this annual grass. Pennant, Ronstar, and OH2 controlled rice flatsedge. The maximum use rate of Pendulum and Barricade was required for excellent (> 90%) control of rice flatsedge. Gallery and Surflan did not provide excellent rice flatsedge control at the maximum use rate.

All treatments except for the lowest rate of Ronstar gave excellent control of spotted spurge (Table 1). Surflan, the 2 higher rates of Pendulum and Barricade provided 100% control of spotted spurge, which is consistent with other published research (5). With the exception of the lowest rate of Pennant, all treatments gave complete control of yellow woodsorrel, although stand of this weed was low in untreated pots. This is consistent with other research, as Surflan, Ronstar, Pendulum, and Barricade provided complete control of yellow woodsorrel, but Pennant did not (5).

Pennant, Pendulum, Ronstar, Barricade, and OH2 at the lowest rate tested gave unacceptable (< 70%) control of eclipta (Table 1). Gallery and Surflan controlled eclipta at labeled rates, but twice the maximum use rate was required for complete control. Since eclipta grows to considerable size in containers and is difficult to hand weed when large, it is desirable to obtain complete control of this weed. These data show that no labeled treatment of these herbicides will completely control eclipta.

No treatment caused a significant reduction in ornamental grass stand across all application rates after the first or second herbicide application (data not shown). Silver arrow miscanthus stand was lower after two applications of Surflan at 4.48 kg/ha (4.0 lb/A), Pennant at 2.2 kg/ha (2.0 lb/A) or

Table 1. Weed counts one month after preemergence herbicide application[z].

	Rate		Number per plot				
Treatment	**lb ai/A**	**kg ai/ha**	**Large crabgrass**	**Rice flatsedge**	**Spotted spurge**	**Yellow woodsorrel**	**Eclipta**
Untreated			8.5	25.8	36.5	3.3	25.8
Gallery	0.5	0.56	9.9	11.5	1.8	0.0	1.8
Gallery	1.0	1.12	5.1	6.3	0.3	0.0	0.5
Gallery	2.0	2.24	3.4	0.3	0.0	0.0	0.0
Linear regression			*	*	*		
Surflan	2.0	2.24	0.0	12.0	0.0	0.0	0.5
Surflan	4.0	4.48	0.0	8.3	0.0	0.0	1.8
Surflan	8.0	8.96	0.1	3.0	0.0	0.0	0.0
Linear regression							
Pennant	2.0	2.24	1.5	0.0	3.3	1.0	16.3
Pennant	4.0	4.48	0.4	0.0	0.8	0.0	8.0
Pennant	8.0	8.96	0.0	0.3	0.3	0.0	0.0
Linear regression					*		*
Pendulum	2.0	2.24	0.3	9.5	0.3	0.0	17.0
Pendulum	4.0	4.48	0.0	1.5	0.0	0.0	18.3
Pendulum	8.0	8.96	0.0	0.8	0.0	0.0	7.5
Linear regression							
Ronstar	2.0	2.24	1.3	2.8	13.8	0.0	15.5
Ronstar	4.0	4.48	0.9	0.8	1.5	0.0	12.3
Ronstar	8.0	8.96	0.1	0.0	2.3	0.0	2.0
Linear regression				*	*		
Barricade	0.75	0.84	1.0	4.5	0.0	0.0	13.5
Barricade	1.5	1.68	0.6	0.3	0.0	0.0	7.8
OH2	3.0	3.36	2.6	0.0	3.5	0.0	12.5
OH2	6.0	6.72	0.6	0.0	0.5	0.0	8.0
LSD (0.05)			2.1	10.8	3.5	1.3	14.4

[z]A * denotes a significant linear regression at P = 0.05.

OH2 at 3.36 kg/ha (3.0 lb/A) compared to untreated pots. Since the response was not rate-related, reduced stand could have been due to smaller plants or plants with a less developed root system. Surflan caused severe mortality of pampas grass in a container study (10). In that research, Surflan, Barricade, OH2, and Pendulum reduced root development of pampas grass. Surflan, Barricade, and Gallery were shown to reduce root growth in certain container-grown nursery crops (6). Perhaps waiting for several weeks after transplanting before herbicide application would increase the tolerance of ornamental grasses to these herbicides. Pampas grass height and root ratings were greater when plants where treated at 30 days after planting compared to 1 day after planting (11).

Two months after the first application, the highest rate of Gallery, the maximum use rate of Surflan, the 2 lower rates of Pennant, the 2 higher rates of Ronstar, and the lower rates of Barricade and OH2 significantly reduced shoot weight of silver arrow miscanthus compared to untreated plants (Table 2). Silver arrow miscanthus appears to be sensitive to most herbicides when applied soon after transplanting. The higher shoot weight in the highest Pennant rate treatments compared to the two lower Pennant rates cannot be explained.

Zebra grass shoot weight was lower in pots treated with Gallery at 0.56 kg/ha (0.5 lb/A) or with Surflan at 4.48 kg/ha (4.0 lb/A), compared to untreated pots (Table 2). Morning light miscanthus plants treated with Gallery at 1.12 kg/ha (1.0 lb/A) or with Ronstar at 2.2 kg/ha (2.0 lb/A) had lower shoot weights than untreated plants (Table 2). Feather reed grass growth was less in pots treated with all rates of Surflan. Shoot weight of this species decreased as Pennant rate increased. Pendulum at 2.2 and 8.96 kg/ha (2.0 and 8.0 lb/A), Barricade at 0.84 and 1.68 kg/ha (0.75 and 1.5 lb/A), and OH2 applied at 6.72 kg/ha (6.0 lb/A) reduced shoot weight of dwarf fountain grass compared to untreated plants.

In other research, Pennant and Surflan injured fountain grass [*Pennisetum setaceum* (Forssk.) Chiov.], but Ronstar did not (12). Pendulum, Barricade, Gallery, and OH2 possessed safety to six ornamental grasses, while Surflan injured all six species and Pennant damaged five of the six species (12). Barricade reduced shoot weight of pampas grass (10), but application of Pendulum, OH2 or Ronstar did not reduce shoot weight.

Tolerance of the ornamental grasses appeared to increase with time, as generally less adverse effects were noted after the second herbicide application (Table 3). Silver arrow miscanthus growth was less in containers treated with the highest rate of Ronstar compared to those treated with the highest rate of Gallery, Surflan, or Pennant. For some unexplained reason, the lower rate but not the higher rate of OH2 reduced shoot weight of silver arrow miscanthus. No other treatment adversely impact silver arrow miscanthus growth when compared to untreated containers. No herbicide ad-

Table 2. Shoot fresh weight of ornamental grasses 2 months after herbicide application[z].

Treatment	Rate lb ai/A	Rate kg ai/ha	Shoot fresh weight per plant: Silver arrow miscanthus	Zebra grass	Morning light miscanthus	Feather reed grass	Dwarf fountain grass
Untreated			33.7	46.9	10.4	13.3	14.4
Gallery	0.5	0.56	30.1	34.3	7.2	11.9	13.9
Gallery	1.0	1.12	28.8	42.3	6.1	12.5	13.8
Gallery	2.0	2.24	19.6	38.0	7.4	11.7	15.8
Surflan	2.0	2.24	27.4	39.9	10.1	9.5	13.3
Surflan	4.0	4.48	17.3	35.2	8.9	9.5	10.4
Surflan	8.0	8.96	25.8	40.1	8.8	7.4	13.7
Pennant	2.0	2.24	18.5	45.8	9.0	12.5*	14.5
Pennant	4.0	4.48	18.4	48.9	8.2	10.2*	14.8
Pennant	8.0	8.96	34.8	42.6	9.5	7.9*	12.5
Pendulum	2.0	2.24	27.6	46.6	7.3	12.3	9.3
Pendulum	4.0	4.48	25.9	41.6	7.5	12.2	12.0
Pendulum	8.0	8.96	28.6	37.8	7.7	11.9	9.0
Ronstar	2.0	2.24	24.3	45.0	5.6	11.7	12.4
Ronstar	4.0	4.48	18.2	37.0	8.2	14.4	11.8
Ronstar	8.0	8.96	19.6	45.1	6.2	10.6	13.1
Barricade	0.75	0.84	16.1	40.9	9.6	10.1	6.9
Barricade	1.5	1.68	26.6	43.4	10.5	14.6	9.1
OH2	3.0	3.36	17.4	47.1	13.5	11.4	14.8
OH2	6.0	6.72	22.6	43.9	7.1	12.8	8.7
LSD (0.05)			12.3	10.3	4.3	3.5	4.9

[z]A * indicates a significant linear regression at P = 0.05.

versely affected growth of zebra grass after two applications. Gallery at 1.12 kg/ha (1.0 lb/A) and Ronstar at 8.96 kg/ha (8.0 lb/A) reduced shoot weight of morning light miscanthus. Feather reed grass shoot weight decreased as the Pennant rate increased. No treatment adversely affected growth of dwarf fountain grass after the second application.

No herbicide possessed safety to all five species as each one tended to reduce shoot weight for at least one ornamental grass species. Generally greater shoot weight reductions were noted following the first than the second application, suggesting that plant tolerance increased with time. However, after two applications, no rate of Surflan, Pendulum, or Barricade caused a significant reduction in growth of any of the five species tested. After transplanting, a waiting period before herbicides are applied may improve crop tolerance by allowing for development of the root system.

Table 3. Shoot fresh weight of ornamental grasses 2 months after the second herbicide application[z].

Treatment	Rate lb ai/A	Rate kg ai/ha	Shoot fresh weight per plant: Silver arrow miscanthus	Zebra grass	Morning light miscanthus	Feather reed grass	Dwarf fountain grass
Untreated			69.5	83.3	36.6	23.9	15.2
Gallery	0.5	0.56	70.2	90.0	26.9	27.5	13.3
Gallery	1.0	1.12	76.0	93.9	23.0	28.3	18.2
Gallery	2.0	2.24	73.6	88.8	30.4	29.8	19.0
Surflan	2.0	2.24	75.3	90.4	38.2	23.6	18.2
Surflan	4.0	4.48	53.2	75.9	26.5	24.8	15.7
Surflan	8.0	8.96	76.2	76.9	33.4	24.2	16.9
Pennant	2.0	2.24	63.1	101.6	38.0	25.1*	20.0
Pennant	4.0	4.48	53.2	102.1	31.0	23.3*	17.7
Pennant	8.0	8.96	92.5	95.5	33.2	16.1*	19.8
Pendulum	2.0	2.24	81.7	96.6	25.9	29.0	17.4
Pendulum	4.0	4.48	71.3	84.2	32.1	27.3	18.5
Pendulum	8.0	8.96	81.2	78.8	31.1	26.4	16.1
Ronstar	2.0	2.24	68.5	95.5	26.4	24.7	16.7
Ronstar	4.0	4.48	52.4	92.8	39.0	32.0	20.3
Ronstar	8.0	8.96	45.9	92.3	21.2	21.8	18.3
Barricade	0.75	0.84	60.1	87.4	35.5	31.1	14.0
Barricade	1.5	1.68	69.3	83.0	34.5	30.3	16.4
OH2	3.0	3.36	39.6	87.5	38.7	23.4	15.6
OH2	6.0	6.72	60.0	83.1	24.9	28.1	14.7
LSD (0.05)			24.8	17.0	12.1	6.7	4.6

[z]A * indicates a significant linear regression at P = 0.05.

No herbicide controlled all the weeds tested. Gallery provided good broadleaf weed control but did not control large crabgrass. Surflan applied at use rates did not completely control rice flatsedge or eclipta. Pennant controlled rice flatsedge but not eclipta at use rates. Pendulum, Ronstar, Barricade and OH2 did not control eclipta when applied at the common use rate. Combinations of these herbicides would be expected to provide broader spectrum weed control than the individual herbicides.

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