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Selectively Controlling Escaped Fountain Grass in Cool-Season Turf

Thomas B. Voigt, Associate Professor, Department of Natural Resources and Environmental Sciences, University of Illinois, Urbana, IL 61801; and
Zachary J. Reicher, Professor, Department of Agronomy, Purdue University, West Lafayette, IN 47907

Corresponding author: Zachary J Reicher. zreicher@purdue.edu

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Abstract
Fountain grass (*Pennisetum alopecuroides* L.) is commonly planted as a landscape ornamental in the Midwestern USA. However, due its tolerance to lawn-height mowing and reproduction by seed, it has has become invasive in lawns. The objective of this research was to evaluate herbicides that could control fountain grass without damaging cool-season lawn grasses. Plugs of *Pennisetum alopecuroides* were planted into cool-season turf and spot-sprayed once or twice at 2-week intervals with various turf herbicides in West Lafayette, IN, and Urbana, IL, in 2006 and 2007. In 2006, two applications of Acclaim Extra + Turflon Ester (0.64 oz/gal + 0.64 oz/gal per application) or two applications of Q4 (3 oz/gal per application) selectively provided adequate, though not complete control eight weeks after the initial application in 2006. Eight weeks after the initial applications in 2007, two applications of Drive (0.367 oz/gal per application) provided complete control. A single application of Roundup Pro (2.56 oz/gal) completely controlled fountain grass nonselectively in both years.

Introduction
Several grasses in the genus *Pennisetum* are planted in U.S. gardens and landscapes. For example, *Pennisetum setaceum* 'Rubrum' (purple fountain grass) is widely planted with annuals or in containers because of its attractive magenta foliage and flowers, but may not survive winters colder than USDA Hardiness Zone 9-10 (4). Another species, oriental fountain grass (*Pennisetum orientale)* is somewhat hardier (USDA Hardiness Zone 7-9) and is also used in landscape plantings because of its attractive purple-pink flowers and small size (4). Fountain grass (*Pennisetum alopecuroides*) may be the most common ornamental in the genus planted in the Midwestern USA. Most cultivars of this clump-forming warm-season grass grow three-to-four feet tall, up to four feet wide, and produce medium green ¼-to-5/8 inch wide foliage (2,4,9). In autumn, the foliage turns yellow and fades to tan and remains so through the winter (4). Its large (1-to-3 inch-long) foxtail-like flowers typically begin to appear in mid-summer (4) increasing its appeal as an ornamental through the fall and winter.

The flowers of *P. alopecuroides* are probably its most desirable ornamental features, but unfortunately, the flowers produce viable seeds that can lead to landscape problems. Greenlee (4) reports that seeds from shattered fountain grass flowers can reseed in gardens and Oakes (9) states that the species can become a nuisance if the seedheads are allowed to mature. Both Greenlee (4) and Oakes (9) recommend removing the seedheads before maturing if invading seedlings are problematic. Darke (2) states that fountain grass cv. 'Moudry' can seed heavily into lawns, and 'Moudry and 'National Arboretum' are particularly fertile and can be invasive. As turf extension specialists, we have received requests for identification and control of *P. alopecuroides* invading lawns and golf course roughs in the Midwest. The invading seedlings usually occur in the turf at edges of landscape plantings where fountain grasses are planted as facer or edge plants. In these settings, the fountain grass shades the turf and drops seeds into the thinned turf where they germinate and establish. Despite

Greenlee's (4) claim that the cultivar 'Hameln' does not reseed itself, the authors have observed fountain grass plants in turf areas near plantings of 'Hameln' or 'Caudatum' fountain grasses. Fountain grass does outcross readily (5) and thus invasive plants in the turf may be genetically different than the cultivar(s) planted in the neighboring beds. Fountain grass is usually coarser textured, lighter green, and faster growing in the summer compared to desired turf (Fig. 1). The most obvious characteristic of escaped fountain grass is leaf shredding after mowing (Fig. 2 and 3) and we have observed escaped fountain grass to survive in lawn height turf for many years.

Fig. 1. Fountain grass plants invading a perennial ryegrass stand. Fountain grass is usually lighter green, has slightly wider leaf blades, and is faster growing in summer compared to cool-season grasses.

Fig. 2. Significant invasion of fountain grass in turf on the prevailing downwind side of an ornamental bed. Photo taken in August and note the white appearance from "shredded" leaves after mowing.

Fig. 3. August photo of fountain grass invading turf-type tall fescue on the prevailing downwind side of an ornamental bed. Note the white appearance from shredded leaves after mowing.

Previous research was conducted with fountain grass in containers to identify herbicides to safely apply over the top in nursery and landscape settings. Fountain grass is highly susceptible to Poast (sethoxydim), Fusilade (fluazifop), or Assure/Targa (quizalofop) when applied over the top of container-grown plants in nurseries (1,3,6). Unfortunately, these herbicides are also injurious to cool-season turf, making their use to control escaped fountain grass no more practical than glyphosate. However, Acclaim Extra (fenoxaprop) is only slightly less injurious to fountain grass than the previously mentioned herbicides and is labeled for applications in cool-season turfgrass (1,3,6). Additionally, other herbicides recently labeled for cool-season turf may be effective on fountain grass. Our objective was to evaluate spot applications of herbicides labeled for use in cool-season turfgrass for selective control of fountain grass.

Controlling Fountain Grass

One inch diameter by three inch deep plugs of *P. alopecuroides* with two to five tillers were planted 12 May 2006 and 15 June 2007 in West Lafayette, IN, at Purdue University's W. H. Daniel Turfgrass Research and Diagnostic Center and 25 May 2006 and 14 June 2007 in Urbana, IL, at the University of Illinois Landscape Horticulture Research Center. Transplanted fountain grass was obtained from Emerald Coast Growers (Pensacola, FL, www.ecgrowers.com) and was 2 to 4 tillers at transplanting, similar to what we normally observe in lawns. The species rather than a specific cultivar was selected for this work because fountain grass's ability to outcross (5) likely creates seedlings genetically different than commercially available cultivars. Soil type in Indiana was a Chalmers silt loam (fine silty, mixed, mesic Typic Haplaquoll) with a 7.0 pH, 4.7% organic matter, 195 lb P per acre, and 455 lb K per acre. Soil type in Illinois was Drummer silty clay loam (fine-silty, mixed, mesic Typic Endoaquolls) with a pH of 7.3, 2.5% organic matter, 55 lb P per acre, and 55 lb K per acre. Six plugs/plot were planted on one-foot centers in stands of perennial ryegrass (Indiana) or Kentucky bluegrass (Illinois). A 6 × 2 factorial design was used with six herbicides applied either once or twice, two weeks after the initial application. An untreated check was also included for comparison. Experimental design was a randomized complete block with three replications. Selective herbicides in 2006 included Tenacity (Syngenta), Q4 (PBI Gordon), Acclaim Extra (Bayer), Turflon Ester (DowAgroSciences) and Acclaim +Turflon Ester (Table 1). Herbicides were diluted in 20 oz water in a handheld spray bottle and then misted on to the point of run-off from leaves (approximately 3 ml/plant), as would be typical in commercial spot-spray applications. Roundup Pro was wicked on by hand with a dampened sponge. Application rates are listed in Table 1 and are either labeled use rates or recommendations from manufacturer technical personnel if no spot-application rates appeared on the label. Application methods were identical in 2007. Herbicide treatments were refined in 2007 based on 2006 results and two new herbicides were added for evaluation in 2007. Herbicides in 2007 included Q4, Drive (BASF), Dismiss (FMC), Certainty (Monsanto), and Acclaim Extra + Turflon Ester, plus Roundup Pro as a non-selective herbicide treatment (Table 1). Applications were made at both sites at least one month after planting and occurred on 22 June and 6 July 2006 and on 14 July and 1 August 2007.

Study sites in Indiana were irrigated to establish the plugs and then irrigated to avoid drought stress of the cool-season turf thereafter. The Illinois sites were irrigated to establish the plugs and unirrigated thereafter. Plots in both locations were mowed twice per week at 4 inches in 2006 and 2.5 inches in 2007 with clippings returned both years. Plots were unfertilized during the course of the studies. Fountain grass injury was recorded as a single rating per plot and reported at four and eight weeks after initial treatment (WAIT), on a scale of 9 to 1 with 9 = no injury and 1 = death. Errors were homogenous over locations and thus locations were combined for statistical analysis with PROC ANOVA (Version 9.1, SAS Institute Inc., Cary, NC) and injury means were separated with LSD at $P \leq 0.05$.

Table 1. Herbicides, rates, and active ingredients evaluated in 2006 or 2007 for control of fountain grass in Indiana and Illinois. Rates are either labeled use rates or recommendations from manufacturer technical personnel if no spot-application rates appeared on the label.

Year	Herbicide	Rate (formulation/ gal H2O spray)	active ingredient
2006	Acclaim Extra	0.64 fl oz/gal (label rate)	0.57 lb/gal fenoxaprop-p-ethyl (d isomer)
	Turflon Ester	0.64 fl oz/gal (label rate)	4 lb/gal acid equivalent triclopyr
	Acclaim + Turflon Ester	0.64 fl oz/gal + 0.64 fl oz/gal (label rates)	0.57 lb/gal fenoxaprop-p-ethyl (d isomer) + 4 lb/gal acid equivalent triclopyr
	Q4	3 fl oz/gal (label rate)	0.5 lb/gal quinclorac; 0.06 lb/gal sulfentrazone 0.88 lb/gal acid equivalent 2,4-D 0.1 lb/gal acid equivalent dicamba
	Tenacity 4SC	0.09 fl oz/gal (per Syngenta)	4 lb/gal mesotrione
	Roundup Pro	2.56 fl oz/gal (label rate)	4 lb/gal isopropylamine salt of glyphosate
2007	Acclaim Extra + Turflon Ester	0.64 fl oz/gal + 0.64 fl oz/gal (label rates)	0.57 lb/gal fenoxaprop-p-ethyl (d isomer) + 4 lb/gal acid equivalent triclopyr
	Certainty 70WDG	0.28 dry oz/gal (label rate)	70% sulfosulfuron
	Dismiss	0.18 fl oz/gal (per FMC)	4 lb/gal sulfentrazone
	Drive 75DF	0.367 dry oz/gal (label rate)	75% quinclorac
	Q4	3 fl oz/gal (label rate)	0.5 lb/gal quinclorac 0.06 lb/gal sulfentrazone 0.88 lb/gal acid equivalent 2,4-D 0.1 lb/gal acid equivalent dicamba
	Roundup Pro	2.56 fl oz/gal (label rate)	4 pounds isopropylamine salt of glyphosate

Results of Trials on Selective Controll of Fountain Grass

2006 results. The highest order interaction at 4 WAIT that was significant in 2006 was location × herbicide × application (Table 2). Fountain grass was recovering by 4 WAIT from single applications in Indiana, and injury increased with a second application of almost all herbicides in Indiana (Table 3). The exceptions to this were Q4 and Roundup, which killed fountain grass after one application. Similar to Indiana, the initial application of Roundup Pro also killed fountain grass in Illinois and thus injury at 4 WAIT was not affected by a second application. However, Tenacity was the only herbicide where the second application increased 4 WAIT injury compared to one application in Illinois. Drought conditions in Illinois limited recovery after the initial applications and thus visible effect of sequential applications was marginal by 4 WAIT.

Table 2. ANOVA for injury to fountain grass after one or two applications of herbicides in Indiana and Illinois in 2006 and 2007.

	2006		2007	
sv	4 WAIT	8 WAIT	4 WAIT	8 WAIT
Herbicide (H)	*	**	**	NS
Applications (A)	NS	NS	NS	NS
H × A	NS	NS	*	*
Location (L)*H	**	NS	**	**
L × A	**	NS	NS	NS
L × H × A	*	NS	NS	NS

WAIT = weeks after initial treatment.
**, *, NS = significant at $P < 0.01$, $P < 0.05$, and non significant, respectively.

Table 3. Effect of herbicide and number of applications on injury to fountain grass in Indiana and Illinois, recorded four weeks after initial treatment in 2006.

	Indiana		Illinois	
Herbicide	1 app	2 apps	1 app	2 apps
Acclaim Extra	8.0 ab*	5.0 c	4.3 b	3.7 bc
Turflon	7.3 b	3.0 d	5.3 ab	5.3 ab
Acclaim Extra + Turflon	3.3 d	1.3 e	3.0 cd	3.0 cd
Q4	1.0 e	1.0 e	2.3 de	2.3 de
Tenacity	9.0 a	7.3 b	6.3 a	4.3 b
Roundup Pro	1.0 e	1.0 e	1.0 e	1.0 e

* Injury is rated on a scale of 9 to 1 with 9 = no injury and 1 = death. Means are of three replications and means followed by the same letter within a state are not significantly different at $P < 0.05$. Injury rating means of check plots were 8.3 in Indiana and 8.6 in Illinois.

Averaged over location and number of applications, Roundup Pro, Q4, and Acclaim + Turflon provided the best control at 8 WAIT in 2006 (Table 4). Tenacity and Acclaim Extra were the least effective herbicides, even though Acclaim has been shown to cause up to 78% injury in container-grown fountain grass (1,3). Turflon or Acclaim Extra applied separately were not nearly as effective (injury ratings of 4.7 and 7.1, respectively) as when applied together (injury rating of 1.3). This is similar to that found by McElroy and Breeden (7) when attempting to control bermudagrass selectively in zoysiagrass with combinations of Turflon and Acclaim Extra.

Table 4. Main effect of herbicide on injury 8 weeks after intial treatment to fountain grass after two applications of herbicides in Indiana and Illinois in 2006.

Herbicide	Injury
Acclaim Extra	7.1 a*
Turflon	4.7 b
Acclaim Extra + Turflon	1.3 c
Q4	1.0 c
Tenacity	8.5 a
Roundup Pro	1.0 c

* Injury is rated on a scale of 9 to 1 with 9 = no injury and 1 = death. Means are over two locations, three replications/ location, and two application levels/herbicide. Means followed by the same letter are not significantly different at $P < 0.05$. Injury rating mean of the check plots was 9.0.

2007 results. Significant herbicide × application interactions occurred at 4 and 8 WAIT (Table 2) where Roundup Pro or Drive provided complete or almost complete control with one application and thus there was no benefit from the second application (Table 5). Conversely, Dismiss was not effective on fountain grass at this use rate regardless if one or two applications were made. Fountain grass injury increased with second applications of Acclaim Extra + Turflon, Certainty, or Q4 at both 4 and 8 WAIT. Injury 8 WAIT from Certainty, in particular, increased dramatically with the second application and this is similar to the effect of single versus multiple applications of Certainty on rough bluegrass (8).

Table 5. Main effect of herbicide and number of applications on injury to fountain grass Indiana and Illinois recoded 4 and 8 weeks after initial treatment (WAIT) in 2007.

	4 WAIT		8 WAIT	
Herbicide	**1 app**	**2 apps**	**1 app**	**2 apps**
Acclaim Extra + Turflon	5.2 b*	3.5 c	6.0 bcd	4.2 cde
Certainty	3.8 c	2.8 d	7.0 abc	1.5 fg
Dismiss	8.0 a	8.3 a	8.8 a	8.8 a
Drive	2.0 de	1.7 ef	1.0 g	1.0 g
Q4	3.8 c	2.3 d	5.0 cd	2.5 efg
Roundup Pro	1.0 f	1.0 f	1.0 g	1.0 g

* Injury is rated on a scale of 9 to 1 with 9 = no injury and 1 = death. Means are over two locations, three replications/location, and two application levels/herbicide. Means followed by the same letter within a rating date are not significantly different at $P < 0.05$. Injury rating mean of the check plots was 9.0 at both 4 and 8 WAIT.

Averaged over the number of applications, Roundup Pro, Q4, and Drive were most effective at 4 WAIT in Indiana, while Drive and Roundup Pro were the best performers in Illinois (Table 6). At 8 WAIT, Roundup Pro, Q4, Drive, and Acclaim Extra + Turflon were most effective in Indiana, but only Drive and Roundup Pro provided complete control (injury rating = 1.0). Similarly in Illinois, Drive and Roundup Pro were most effective and provided complete control at 8 WAIT (Table 6).

Table 6. Main effect of herbicide on injury to fountain grass after two applications of herbicides at 14-day interval in Indiana and Illinois in 2007.

	4 WAIT		8 WAIT	
Herbicide	**IN**	**IL**	**IN**	**IL**
Acclaim Extra + Turflon	3.2 b[wxyz]	5.5 b	2.2 c	8.0 a
Certainty	3.2 b	3.5 c	3.8 b	4.7 c
Dismiss	7.5 a	8.8 a	8.7 a	9.0 a
Drive	1.7 c	2.0 d	1.0 c	1.0 d
Q4	1.7 c	4.5 bc	1.3 c	6.2 b
Roundup Pro	1.0 c	1.0 d	1.0 c	1.0 d

* Injury is rated on a scale of 9 to 1 with 9 = no injury and 1 = death. Means are over two locations, three replications/location, and two application levels/herbicide. Means followed by the same letter within a rating date are not significantly different at $P < 0.05$. Injury rating mean of the check plots was 9.0 at both 4 and 8 WAIT.

Conclusions

Complete control (injury ratings = 1) would be most acceptable for lawn care operations to limit retreatment over years. Though Acclaim + Turflon significantly injured fountain grass in 2006 at both locations and in Indiana in 2007, it did not kill the fountain grass under the conditions of our study. Therefore, we would not recommend Acclaim Extra + Turflon for fountain grass

control. While Q4 provided complete control of fountain grass in Indiana and Illinois in 2006, it was less injurious in 2007 for unknown reasons. Drive provided complete control in 2007 at both locations and thus it is apparent that quinclorac is the active ingredient in Q4 most responsible for injury to fountain grass. Drive was applied at 0.0172 lb quinclorac/gal while the Q4 rate was slightly lower at 0.0117 lb quinclorac/gal and thus likely explains more severe injury of fountain grass from Drive compared to Q4 in 2007. Increasing the rate of Q4 to higher than the 3.0 oz/gal used in this study may improve control of fountain grass, but is above label recommendations. Roundup Pro wicked on with a sponge or Drive applied selectively over the top were the most effective controls of fountain grass under the conditions of this study. Though no phytotoxicty on the desired species was seen in this study with herbicides other than Roundup, benefits of Drive are that it will not injure most cool-season turfs and it will also control crabgrass at this rate. Since fountain grass outcrosses readily (5), specific cultivars in neighboring beds may potentially affect genetic makeup of plants. The genetic makeup may ultimately determine susceptibility to selective herbicides, so our results may not apply to every location. However, our study appears to be the initial report on controlling fountain grass in cool-season turf and provides a number of herbicide options for controlling invading fountain grass.

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