CONTROL OF PEST SPECIES

Effects of a Selective Herbicide, Sethoxydim, on Reed Canarygrass

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Practitioner finds sethoxydim effective in controlling reed canarygrass, although multi-year applications may be needed.

Reed canarygrass (*Phalaris arundinacea*) is a cool-season, perennial grass that threatens the diversity of native wetland vegetation, particularly in sedge meadows and wet prairies (Galatowitsch and others 1999). This widely distributed species forms dense monocultures capable of displacing native vegetation and altering restoration trajectories (Apfelbaum and Sams 1987, Galatowitsch and others 2000, Maurer and others 2003).

Field managers and researchers have tested a variety of methods to control reed canarygrass, including flooding, manual removal, tarping, removal and replacement of topsoil, cultivating, mowing, reverse fertilization, controlled burns, and application of herbicides (Hodgson 1968, Comes and others 1981, Apfelbaum and Sams 1987, Gillespie and Murn 1992, Hutchison 1992, Lyford 1993, Preuninger and Umbanhowar 1994, Kilbride and Paveglio 1999, Paveglio and Kilbride 2000, Perry and Galatowitsch 2002). The relative success of each control method often depends on site factors, such as size of the native seed bank, local hydrology, frequency and severity of disturbance regimes, extent of invasion, and potential for subsequent reinvasion when control measures are discontinued. In general, efforts to eradicate reed canarygrass have had limited long-term success. Hutchison (1992) suggested that reed canarygrass control is problematic because of a lack of selective treatments.

Moderate, short-term success in controlling reed canarygrass has been achieved with herbicides (Hodgson 1968, Comes and others 1981, Apfelbaum and Sams 1987, Hutchison 1992, Kilbride and Paveglio 1999, Paveglio and Kilbride 2000). Few herbicides have been thoroughly evaluated for this purpose, however. In addition, chemical control of reed canarygrass is often hindered by the use of nonselective (broad-spectrum) herbicides, such as glyphosate (Roundup) and imazapic (Plateau) (Lovett-Doust and Lovett-Doust 1995). Nonselective herbicide applications can result in weed resurgence (Strand 1993) because an aggressive species may expand in response to open space created by the removal of non-target species. Some managers apply broad-spectrum herbicides after native species have set seed to minimize risks to populations of non-target species (Paveglio and Kilbride 2000). However, this timing schedule varies among non-target species and may not match the optimum window for reed canarygrass control. Pizzo and Schroeder (2001) recommended treating reed canarygrass with a low concentration of glyphosate to avoid collateral damage to native species. But, Comes and others (1981) have previously demonstrated that lower levels of control are achieved when low concentrations of glyphosate are used. Thus, it would seem that finding selective herbicide treatments for reed canarygrass would be beneficial to control efforts, which is why we decided to test sethoxydim.

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Sethoxydim: Does it Affect Reed Canarygrass?

Sethoxydim is a post-emergence, systemic herbicide that selectively kills most annual and perennial grasses. Grass-specific herbicides of this type have been used successfully to suppress biomass production in several troublesome grass species, including quackgrass (*Elytrigia repens*) (Harker and Vanden Born 1997) and crabgrass (*Digitaria sanguinalis*) (Johnson 1997). However, to the best of our knowledge, no literature exists that documents or describes their effectiveness on reed canarygrass or their effect on associated native species. We conducted a feasibility study to quantify the effects of sethoxydim on a reed canarygrass-dominated community and determine if this herbicide has potential for short-term reed canarygrass control and passive reestablishment of native vegetation. Our objectives were to determine the effect of sethoxydim on inflorescence density and aboveground biomass of reed canarygrass and its effect on aboveground biomass of associated herbaceous species.

Methods

Site Description

Our 0.8-acre (2-ha) study site was located along the La Crosse River in west-central Wisconsin, about 2 miles (3 km) northeast of its confluence with the Mississippi River. Soils at the site were moderately well drained silt loams of the Sparta and Plainfield series (USDA 1960), with moderate to high fertility (Annen 2002). Mean seasonal temperature and precipitation did not deviate significantly from the normals period during the experiment (Annen, unpublished data). Initial site reconnaissance revealed that reed canarygrass accounted for 92.3 percent of the total aboveground herbaceous species biomass. The remaining species were uncommon—50 percent of species were sampled in less than 25 percent of quadrats (Annen 2002). Giant goldenrod (*Solidago gigantea*) and tussock sedge (*Carex stricta*) were the most abundant native species present.

Table 1. Summary of treatment effects on reed canarygrass inflorescence density in 2001. Values (back-transformed from $\log_{10}$ scale) represent the number of seed heads/m² in each treatment.

Treatment	Mean	95% Confidence Interval
Control	53.1	(39.9 – 70.7)
Early Summer Application	2.8	(1.2 – 6.3)
Early + Late Summer Applications	2.1	(1.0 – 4.7)

Experimental Design

In 2001 and 2002, we tested the effects of sethoxydim on reed canarygrass with four treatments: 1) control (no applications), 2) early summer sethoxydim application (May 29, 2001), 3) early + late summer sethoxydim applications (May 29, 2001 and August 2, 2001), and 4) late summer mowing (July 28, 2001) followed by late summer sethoxydim application (August 2, 2001). For the experiment, we established a randomized complete block design with each block consisting of one main plot (4 m x 28 m) and four subplots (4 m x 4 m). We randomly assigned the treatments to subplots and replicated each treatment eight times. In order to assess possible carryover effects from a single application, we only applied the herbicide in 2001.

We used Vantage herbicide, a 120 g active ingredient/L commercial formulation of sethoxydim. The herbicide was applied as a broadcast spray at a rate of 3.75 pints/acre (4.45 L/ha) with a 2.5-gallon (9.45-L) small-capacity pump sprayer and a flat fan spray nozzle. We added LI 700 (Loveland Industries, Inc., Greeley, CO), a nonionic surfactant and penetrant, at a rate of 0.03 pints/gallon (3.75 ml/L). In the mowing treatment, we mowed the plots with a Weedax (Council Tool Company, Inc., Lake Waccamaw, NC) to a height of 2-4 inches (5-10 cm) from the soil surface, and left the clippings in place. Mowed plots were treated with sethoxydim five days after mowing, when reed canarygrass began to reemerge.

Data Analysis

In August 2001, we sampled inflorescence density (the number of seed heads per m²) in all but the mowed plots. We used inflorescence density as an indicator of treatment effectiveness on seed head suppression in the same growing season as herbicide application.

We sampled reed canarygrass aboveground biomass twice—first in mid-September 2001 and again in mid-June 2002. We did not sample biomass from mowed plots in 2001. We used reed canarygrass biomass as an indicator of treatment effectiveness on total seasonal growth in the same growing season as herbicide application and in the peak production period of the subsequent growing season. In 2002, we also collected biomass samples of all other herbaceous species to determine if treatment with sethoxydim affected growth of non-target species. We used Gleason and Cronquist (1991) for

Table 2. Summary of treatment effects on reed canarygrass aboveground biomass (g/m²) in 2001 and 2002.

Treatment	Mean (± 1 SE)	95% Confidence Interval
2001 (season of application)		
Control	1078.9 (74.3)	(903.1 – 1254.6)
Early Summer Application	555.4 (29.0)	(486.8 – 623.9)
Early + Late Summer Applications	544.4 (34.9)	(461.9 – 626.8)
2002 (season after application)		
Control	189.9 (14.2)	(156.1 – 223.4)
Early Summer Application	179.3 (7.2)	(162.2 – 196.5)
Early + Late Summer Applications	177.6 (17.5)	(136.4 – 218.9)
Mow + Late Summer Application	163.2 (14.6)	(128.7 – 197.6)

plant species nomenclature. We measured biomass on a dry mass basis.

To determine if treatment with sethoxydim influenced herbaceous species composition, we measured species density (the number of species/m^2) for each treatment plot, and then calculated the exponentiated Shannon-Wiener index ($e^{H'}$ where $H' = -\sum p_i \ln p_i$) for each plot. Herbaceous species biomass estimates from 2002 were used as indicators of species abundance for diversity estimates.

We tested treatment effects with an analysis of variance (ANOVA) for a randomized complete block design. Subplot means for all response variables were used in our data analysis. Inflorescence density data were transformed ($\log_{10}$) to meet the assumptions of the ANOVA, and treatment means were separated with Tukey's HSD procedure. We tested for statistical significance at the $\alpha = 0.05$ level.

Results

We found that sethoxydim reduced reed canarygrass inflorescence density in both herbicide treatments ($F_{(2,14)} = 24.795$, $p < 0.001$, Table 1), and that the effects of the different treatments did not differ significantly from one another ($p = 0.870$). The early summer sethoxydim application reduced inflorescence density by 91 to 97 percent of the control, while the early + late summer sethoxydim applications reduced inflorescence density by 93 to 98 percent of the control.

In 2001, both the early summer and early + late summer applications of sethoxydim significantly reduced reed canarygrass biomass ($F_{(2,14)} = 37.983$, $p < 0.001$, Table 2). These effects were statistically indistinguishable from one another ($p = 0.987$), both reducing reed canarygrass biomass by about 50 percent. In 2002, reed canarygrass biomass did not differ among the treatments ($F_{(3, 21)} = 0.663$, $p = 0.584$, Table 2). Mean species density and diversity did not differ among treatments ($F_{(3,21)} < 1.4$ and $p > 0.20$, Table 3). Although non-target species biomass was up to 99 percent higher in sethoxydim-treated plots, these results were statistically insignificant ($F_{(3,21)} = 2.211$, $p = 0.117$, Table 3) and reed canarygrass remained the dominant species in all research plots at the conclusion of the experiment.

Table 3. Summary of herbaceous species density, non-target species aboveground biomass, and diversity in treatment plots in 2002. Values represent treatment means ± 1 SE, n = 8.

Response Variable	Control	Early Summer Application	Early + Late Summer Applications	Mow + Late Summer Application
Herbaceous spp. density	3.75 (0.53)	3.50 (0.38)	3.25 (0.62)	4.25 (0.65)
Non-target biomass	11.71 (4.46)	16.53 (5.46)	23.32 (10.15)	7.24 (3.38)
Herbaceous spp. diversity	1.26 (0.10)	1.37 (0.12)	1.42 (0.17)	1.25 (0.11)

Discussion

Reed canarygrass stands can produce 180 lbs/acre (160 kg/ha) of seed in a single growing season (Piper 1949), resulting in seedbank densities in the neighborhood of 438 viable seeds/m^2 in wetland communities (Galatowitsch and van der Valk 1996). These figures represent considerable potential for reinvasion and dispersal of reed canarygrass propagules within riparian corridors (Planty-Tabacchi and others 1996). The results of this short-term study suggest that a single application of sethoxydim can greatly reduce this source of propagules. We observed that a single application reduced inflorescence density by greater than 90 percent of the control, although there was no additional seed head suppression from a second application. It is likely that the second application failed to improve seed head suppression because flowering and seed production were completed prior to the second application. In 2001, sethoxydim application reduced reed canarygrass biomass to half of its untreated level in both application regimes, but biomass suppression was not improved by follow-up applications within the same growing season. The standing dead reed canarygrass stems that resulted from the first application may have intercepted herbicide spray during the second application resulting in the apparent lack of additional effect in the late summer treatment.

We also noted that herbicide effects on reed canarygrass biomass did not carryover into the year following initial application. This, however, is not uncommon (Hodgson 1968, Comes and others 1981, Kilbride and Paveglio 1999, Paveglio and Kilbride 2000), and sometimes leads to an increased abundance of reed canarygrass. For example, Kilbride and Paveglio (1999) reported increases in reed canarygrass stem density for two consecutive years after glyphosate treatment. Our findings suggest that treatment with sethoxydim significantly reduces both seed production and biomass of reed canarygrass, although this effect is limited to the year of application.

Some practitioners and researchers have found that mowing or cutting controls reed canarygrass (Gillespie and Murn 1992, Lyford 1993). Others suggest that canopy gaps created by mowing increase light transmission, which increases reed canarygrass germination and dominance (Lindig-Cisneros and Zedler 2002). In this study, we found no evidence that a single mowing enhances the effect of sethoxydim, although a variety of mowing and herbiciding schedules are possible and should be studied.

We were disappointed by the absence of significant increases in non-target species biomass and diversity. However, the lack of among-treatment differences suggests that sethoxydim did not harm the sedges and dicotyledonous species present in the plots, even though they were sprayed along with reed canarygrass. In addition, reed canarygrass debris may have limited germination of native species (Paveglio and Kilbride 2000), and thus may have contributed to the absence of differences in species density and diversity among treatments. Multiple-year applications of sethoxydim may increase the response of these species. Clearly, the potential selectivity of sethoxydim on non-target species requires additional study.

In conclusion, we suggest that treatment with sethoxydim can significantly reduce both seed production and aboveground biomass of reed canarygrass, although these effects are limited to the year of application. Effective treatment of reed canarygrass may require multi-year treatments. Whether long-term sethoxydim use will harm sedges and dicotyledonous species should be investigated further.

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