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NOTES

Efficacy of Selected Aquatic Herbicides on Common Reed

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INTRODUCTION

Common reed (*Phragmites australis* [Cav.] Trin. ex Steud.) is an invasive perennial grass with a near-worldwide spread (Weakley 2008). It forms dense aggregations in fresh, salt, and brackish wet areas including marshes, stream and lake banks, drainage ditches, and roadsides (Mal and Narine 2004). Common reed has drastically increased in numbers and distribution over the past 150 years (Saltonstall 2002). It withstands salt and alkaline waters and can grow in still or flowing water (Uva et al. 1997), aggressively taking over these water areas and displacing native species (Weakley 2008).

Common reed is classified as a "cryptic" invader because it cannot be easily identified as native or introduced (Saltonstall 2002). A native form of *Phragmites australis* ([Cav.] Trin. ex Steud. ssp. *Americanus*) is rare and grows in freshwater marshes (Weakley 2008). This haplotype has been displaced from New England, and its numbers have greatly decreased in other parts of the country as the introduced aggressive haplotype has become dominant (Saltonstall 2002). The invasive haplotype is considered one of the most profuse plant species in coastal wetlands of the United States (Blossey 2002).

A primary concern with common reed is the invasion of coastal wetlands. Its presence is often considered a sign of wetland disturbance (Blossey 2002). Common reed invasion reduces floral and faunal biodiversity and changes the structure of the ecosystem (Mozdzer et al. 2008). It grows in waters of varying salinities and out-competes native brackish-water plant species, thus degrading habitat for native insects and animals. Vasquez et al. (2005) found that the invasive biotype of common reed tolerated much higher levels of salinity than did two native biotypes. On much of the eastern U.S. coast, common reed is replacing the dominant native plant *Spartina alterniflora* (Able and Hagan 2000). This shift was shown to have a negative effect on larval and small juvenile fish (Able and Hagan 2000).

Previous research has evaluated common reed management with herbicides, cutting, burning, and de-watering (Mal and Narine 2004). Selective grass herbicides often used in ornamentals and turf management (clethodim, dithiopyr, fenoxaprop, fluazifop, MSMA, and sethoxydim) did not provide control in greenhouse studies (Derr 2008a). Monteiro et al. (1999) found that cutting or mowing in the fall before a spring herbicide application improved control. In that study, both isopropylamine (2.9 kg ai/ha) and trimesium (2.6 kg ai/ha) salts of glyphosate provided equivalent control, but treatment rates of 2.5% v/v rather than 2% v/v (400 and 320 L/ha application volume, respectively) gave greater control (Monteiro et al. 1999). Ailstock et al. (2001) found common reed treatment with glyphosate or glyphosate plus burning, greatly reduced plant abundance and increased plant biodiversity. However, this study found frequent re-establishment due to the prolific nature of common reed rhizomes (Ailstock et al. 2001).

Virginia Cooperative Extension has recommended foliar applications of glyphosate at labeled rates for common reed control (Barnes 2003); however, Mozdzer et al. (2008) found that an imazapyr foliar application (2 to 5% v/v) was more effective than glyphosate (2% v/v). Kay (1995) found that wipe-on applications of imazapyr or glyphosate did not provide sufficient common reed control. Derr (2008b) evaluated postemergence herbicides with treatments in summer and fall. In field and greenhouse studies, glyphosate (2% v/v) and imazapyr (1% v/v) reduced Phragmites growth at least 80%. Fosamine treatments provided 68% control at 7 months after treatment (MAT) and 43% at 10 MAT (Derr 2008b). Imazapyr and glyphosate can be applied to foliage in summer or fall, with equivalent results the following year Derr (2008b). In summer, Phragmites plants are smaller and easier to spray compared to fall when plants are much taller (Derr 2008b).

Derr (2008a) also evaluated common reed response to mowing and herbicide applications. Plots treated with 2.24 kg ai/ha glyphosate had a higher control rating than those treated with 1.12 kg ai/ha glufosinate (96 vs. 71% control, respectively). Mowing every 2 weeks resulted in 93% common reed control at 4 MAT, while mowing every 4 or 8 weeks provided less control (81 and 69% at 4 MAT, respectively). At 12 MAT, plots that were mowed every 2, 4, or 8 weeks all had similar control levels. Mowing could be a control option for common reed where nonchemical options are preferred. Regardless of control method, this species needs to be monitored and managed for subsequent years to combat regrowth

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(Monteiro et al. 1999, Ailstock et al. 2001, Barnes 2003, Derr 2008a, 2008b).

While numerous herbicides have been evaluated for common reed control, the focus has often been on products labeled for terrestrial rather than aquatic sites. Triclopyr is registered for use on aquatic sites, and the product label also lists common reed as a species controlled. However, little information is available with regard to actual triclopyr efficacy on this weed. In addition, two herbicides recently registered for aquatic use, imazamox and penoxsulam, have not been fully evaluated. The objective of this research was to evaluate herbicides with aquatic site registrations for common reed control.

MATERIALS AND METHODS

Field Trial 1

A field herbicide trial was initiated on 6 June 2006, in a brackish marsh near Aurora, North Carolina, and on 7 July 2006, at a roadside in Mathews County, Virginia, to evaluate control with four different herbicides registered for application to aquatic sites. In North Carolina, plots were 7 m long by 3 m wide and were located in a well-established 2 to 3 m tall common reed stand. In Virginia, plots were 3 m long by 2 m wide and common reed was 1 m tall after being mowed 5 weeks prior. Treatments included glyphosate (Touchdown Pro, Syngenta Crop Protection, Inc., Greensboro, NC) at 1.25 and 2.5% v/v, imazapyr (Habitat, BASF Corporation, Research Triangle Park, NC) at 1.25 and 2.5% v/v, imazapyr (1.25% v/v) plus glyphosate (1.25% v/v), penoxsulam (Galleon SC, SePRO Corporation, Carmel, IN) at 0.5% v/v, and triclopyr (Renovate, SePRO Corporation, Carmel, IN) at 5.0% v/v. Herbicides were applied using a CO_2-pressurized backpack sprayer with an application volume of 280 L/ha. Treatments were applied by handgun to foliage and sprayed to wet, but not runoff. Each treatment included a non-ionic surfactant in North Carolina (Induce, Helena Chemical Co., Collierville, TN) at 0.25% v/v and in Virginia (Cide-Kick, Brewer International, Vero Beach, FL) at 0.5% v/v.

Experimental design was a randomized complete block with three treatment replications. Common reed control was estimated visually at 3 and 12 MAT on a 0 to 100% scale. Ratings compared treated plots to nontreated plots and considered chlorosis, necrosis, and stunting, with 0% corresponding to no control and 100% corresponding to complete plant death.

Field Trial 2

In 2007, a separate trial was initiated on two sites at Carolina Beach and Wilmington, North Carolina. Experimental plots were 6 m long by 3 m wide and located in a well-established 1 to 3 m tall stand of common reed. Five currently registered aquatic herbicides were selected including glyphosate, imazamox, imazapyr, penoxsulam, and triclopyr. Treatments included glyphosate at 1.25 and 2.5% v/v, imazamox (Clearcast, BASF Corporation, Research Triangle Park, NC) at 0.63 and 1.25% v/v, imazapyr at 1.25 and 2.5% v/v, penoxsulam at 0.5% v/v, and triclopyr at 5% v/v. All treatments included 0.25% v/v nonionic surfactant (Induce, Helena Chemical Co., Collierville, TN). A nontreated control was also included. Study design was a randomized complete block with four treatment replications. Experimental treatments were applied to foliage with 280 L/ha spray volume. Applications were sprayed to wet, but not runoff. Plots were rated at 3 and 12 MAT on a 0 to 100% scale as described in field study 1.

Statistical Analysis

Data were subjected to analysis of variance, and means were separated using Fisher's Protected LSD ($P \le 0.05$) in SAS v. 9.1 (SAS Institute Inc., Cary, NC). Nontreated controls were not included in statistical analysis of visual ratings. Data were combined across study repetitions because no treatment by year interaction occurred.

RESULTS AND DISCUSSION

Field Trial 1

At 3 MAT, control with all imazapyr and glyphosate treatments was at least 78%, with 93% control obtained with 1.25% v/v imazapyr plus 1.25% v/v glyphosate (Table 1). Common reed, however, was not controlled with penoxsulam, and control with triclopyr was only 52%. At 12 MAT, control was 74 to 86% with treatments containing glyphosate or imazapyr. Control with triclopyr and penoxsulam did not exceed 2%.

Field Trial 2

At 3 MAT, common reed control was 93% or greater with imazapyr (Table 2). Control with glyphosate and triclopyr treatments was 73 to 79%, while imazamox and penoxsulam did not control common reed more than 51%. At 12 MAT,

Table 1. Phragmites control with selected postemergent herbicides in field study 1.[a,b]

Treatment[c]	Rate	3 MAT[d,e]	12 MAT
	% v/v	%	
Glyphosate	1.25	78 c	74 b
Glyphosate	2.5	85 b	86 a
Imazapyr	1.25	86 b	83 ab
Imazapyr	2.5	88 ab	78 ab
Imazapyr + glyphosate	1.25 + 1.2	93 a	80 ab
Penoxsulam	0.5	8 e	2 d
Triclopyr	5.0	52 d	0 d

[a]Results pooled across Aurora, NC, and Mathews, VA, locations due to no treatment by location interaction.
[b]MAT = months after treatment.
[c]NIS at 0.25% v/v included with all treatments in the North Carolina study and NIS at 0.5% v/v included with all treatments in the Virginia study.
[d]Weed control rated on 0 to 100% scale; 0% equals no plant response and 100% equals plant death.
[e]Means within a column followed by the same letter are not significantly different according to Fisher's Protected LSD ($P \le 0.05$). Nontreated control not included in statistical analysis of visual ratings.

TABLE 2. PHRAGMITES CONTROL WITH SELECTED POSTEMERGENT HERBICIDES IN FIELD STUDY 2.[A,B]

Treatment[c]	Rate	3 MAT[de]	12 MAT
	% v/v	%	
Glyphosate	1.25	73 b	88 a
Glyphosate	2.5	78 b	90 a
Imazamox	0.63	47 c	49 b
Imazamox	1.25	51 c	48 b
Imazapyr	1.25	94 a	95 a
Imazapyr	2.5	93 a	95 a
Penoxsulam	0.5	23 d	0 e
Triclopyr	5.0	79 b	12 d

[a]Results pooled across Carolina Beach and Wilmington, NC, locations due to no treatment by location interaction.
[b]MAT = months after treatment.
[c]NIS at 0.25% v/v included with all treatments.
[d]Weed control rated on 0 to 100% scale; 0% equals no plant response and 100% equals plant death.
[e]Means within a column followed by the same letter are not significantly different according to Fisher's Protected LSD ($P \leq 0.05$). Nontreated control not included in statistical analysis of visual ratings.

control with all imazapyr and glyphosate treatments was significantly highest and at least 88%. Control with imazamox was 48 to 49% and was 12% or less with triclopyr and penoxsulam.

In both trials, imazapyr controlled common reed at least 78% the year following treatment. Greater than 90% control has been reported previously (Derr 2008b, Mozder et al. 2008; J. Whetstone, pers. comm.). The high level of long-term glyphosate control (74 to 90%) was slightly greater than expected, and equivalent to imazapyr. Other researchers have reported common reed control to be equivalent with imazapyr and glyphosate (Derr 2008b) or for imazapyr to provide slightly better control (Mozder et al. 2008; J. Whetstone, pers. comm.).

While triclopyr is labeled for common reed control (SePRO 2008), the initial control observed with triclopyr on this grass species was still surprising. Mervosh and Roach (2007) reported similar results with triclopyr field treatments, and Derr (2008b) reported a 92% fresh weight reduction in container-grown common reed regrowth. Mervosh and Roach (2007) established that timing, spray volume, and coverage are factors that likely influence triclopyr efficacy on common reed. Lewis et al. (2009) reported efforts to control bermudagrass (*Cynodon dactylon* [L.] Pers.) in desirable zoysiagrass (*Zoysia japonica* [Steud.]) with triclopyr plus aryloxyphenoxypropionate herbicide mixtures. The activity of triclopyr on certain grass species should be evaluated further as it could increase utility of this herbicide for selective grass removal from desirable grass species.

The two newly registered aquatic herbicides, imazamox and penoxsulam, did not control common reed at the rates evaluated. The maximum registered penoxsulam rate for aquatic sites is 0.1 kg ae/ha, less than the rate evaluated in these trials (SePRO 2007); thus, penoxsulam should not be expected to control this species. Burns (2008) did report imazamox activity on common reed, although application rate and level of control were not specified. Imazamox is registered for use on aquatic sites at rates as high as 5% v/v for spot applications (BASF 2008). This rate may be more effective than the 1.25% v/v high rate evaluated here. Additional research should evaluate maximum imazamox rates because the selectivity provided by this herbicide would generally be more preferable than the relatively nonselective options of glyphosate and imazapyr on sites containing a mixture of species.

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