

Control of Johnsongrass (*Sorghum halepense*) in tall fescue (*Festuca arundinacea*) stands

Introduction

Johnsongrass is a nonnative invasive species introduced as a forage crop from the Mediterranean region (Miller and Miller 1999). This perennial species has become naturalized and is found in 47 of the 50 United States (Alaska, Minnesota, and Maine being the exceptions) (USDA 2004). Johnsongrass has become problematic along roadsides in Kentucky due to its aggressive and prolific nature and rapid growth habit. Johnsongrass reproduces by seed and by rhizomes which adds to its invasive nature. This plant can cause line of sight issues, maintenance concerns along guardrails, and unsightly rights-of-way. The past management regime for Johnsongrass for the Kentucky Transportation Cabinet has been chemical treating infestations with an ACCase type herbicide (e.g. Fusion®, a.i. fluazifop + fenoxaprop) along the guardrails and vehicle recovery areas and mowing operations for areas outside these areas. Unfortunately, there have been reported cases of Johnsongrass developing resistance to the ACCase type herbicides in agricultural settings in Kentucky (Obermeier et al 1998). Graminicide resistant Johnsongrass has also been reported in Mississippi, Tennessee, Virginia, Louisiana, and Texas (weedsience.org 2003). Although no cases have been officially documented on KTC property, the potential for herbicide resistance exists to make this invasive species more of a problem. Evaluation of herbicide chemistries with modes of action different to that of graminicides (ACCase inhibitors) needs to be evaluated for efficacy to provide the KTC a cost effective alternative to Fusion for an annual application rotation.

Outrider® (a.i. sulfosulfuron) was shown to be an effective control option for Johnsongrass. Outrider has a different mode of action (ALS inhibitor) than that of graminicides and may prove to be a feasible control option and/or rotation partner with current control strategies. The goal of the trials presented here was to evaluate the efficacy of Envoy (a.i. clethodim), Fusion, and Outrider in controlling Johnsongrass and the effect that the compounds have on tall fescue stands.

General Methods and Materials

Several studies were initiated in the 2004 growing season. One study was located in western Kentucky and three studies were located in central Kentucky. All studies were similar in that each contained at least one clethodim (Envoy) treatment, one fluazifop + fenoxaprop (Fusion) treatment, and one sulfosulfuron (Outrider) treatment. All studies were randomized complete block designs with three replications of each treatment and had plot sizes 5' X 20'. The western Kentucky (Central City) study was treated at 25 GPA while the three central Kentucky studies (Spindletop, Main Chance, I 75) were treated at 20 GPA. All studies were treated with a CO₂ powered hip sprayer using two TeeJet 8004 flat fan tips. Data collected included visual percent control (0 – 100 %) and visual estimation of fescue damage using a 0 – 9 color index scale (0 = dead, 9 = green). Data sets were analyzed using Agricultural Research Manager (ARM) software and treatment comparisons were made using Fisher's LSD test at the p = 0.05 level for

significance. Percent control data of the untreated check treatments was removed from analysis to reduce variation (all had 0 % control) while color measurements of untreated check plots were retained. Data were transformed using the arcsine transformation when data sets did not meet Bartlett’s test for homogeneity of variance. Results presented here show the untransformed treatment means and the transformed data mean comparisons when transformations were necessary. Results are presented for each separate study.

Site Specific Methods and Results

Central City

The Central City study utilized 8 chemical treatments and 1 untreated control treatment (Table 1). Estimated cost per acre for each treatment is included **for comparison purposes only**.

Table 1: Treatment list for Central City Johnsongrass trial

Treatment	Compounds	Rate per acre	Cost per acre
1	Envoy + COC	13 fl oz + 1% v/v	\$12.00
2	Envoy + COC	15 fl oz + 1% v/v	\$14.00
3	Envoy + COC	17 fl oz + 1% v/v	\$15.00
4	Outrider + NIS	0.5 oz + 0.5% v/v	\$5.00
5	Outrider + NIS	0.75 oz + 0.5% v/v	\$8.00
6	Outrider + NIS	1 oz + 0.5% v/v	\$10.00
7	Fusion + NIS	7 fl oz + 0.25% v/v	\$6.00
8	Fusion + NIS	9 fl oz + 0.25% v/v	\$8.00
9	MSMA	32 fl oz	\$4.00
10	Untreated		

The trial was installed on June 17th, 2004. Plots were rated 28, 62, and 96 days after treatment (DAT). All Envoy treatments and Fusion treatments had > 90% control of Johnsongrass 28 DAT (Table 2). All Envoy treatments were able to maintain a relatively high degree of control at 96 DAT. Fusion treatments; however, appeared to decrease in their overall effectiveness by 96 DAT as control responses were below 90 %. A rate response was observed for the Outrider treatments as there was an increase in percent control as rates increased from 0.5 oz / ac to 1 oz / ac. Control of Johnsongrass ranged from 63 – 82 % for rates of Outrider tested at 28 DAT and increased to 89 – 98 % control by 96 DAT. Outrider at 1 oz / ac provided the best amount of Johnsongrass control by 96 DAT at 98 % control. The MSMA treatments did provide comparable Johnsongrass control.

All Envoy and Outrider treatments realized a negative effect on fescue color (Table 2). This may have been influenced by the environmental conditions as western Kentucky experienced a relatively dry summer in 2004. Fusion treatments appeared to have allowed the fescue to effectively rebound from the initial damage as did the MSMA treatment.

Notes: The following was observed at the last measurement interval (96 DAT). These observations were not analyzed statistically.

- Envoy appeared to control yellow foxtail while Outrider did not.
- Yellow foxtail seems rate sensitive to Fusion as foxtail was present in the 7 oz / ac plots and absent in the 9 oz / ac plots.
- Broomsedge appears to be tolerant to Outrider while rate sensitive to Envoy. Envoy never controlled broomsedge but the high rate (17 oz / ac) appeared to have a stunting effect.

Table 2: Summary of Central City Johnsongrass Trial

Trt No.	Treatment Type	Treatment Name	Rate	Rate Unit	Percent control			Color ratings								
					28 DAT	62 DAT	96 DAT	28 DAT	62 DAT	96 DAT						
1	HERB	Envoy	13	fl oz/a	98	a	87	a	90	ab	4	cde	2	de	2	de
	ADJ	COC	1	% v/v												
2	HERB	Envoy	15	fl oz/a	93	abc	80	a	96	ab	3	de	2	de	2	de
	ADJ	COC	1	% v/v												
3	HERB	Envoy	17	fl oz/a	98	a	87	a	94	ab	3	e	2	de	1	e
	ADJ	COC	1	% v/v												
4	HERB	Outrider	0.5	oz/a	63	e	72	a	89	ab	5	bc	3	cd	3	cd
	ADJ	NIS	0.5	% v/v												
5	HERB	Outrider	0.75	oz/a	75	de	80	a	96	ab	4	cde	1	e	3	c
	ADJ	NIS	0.5	% v/v												
6	HERB	Outrider	1	oz/a	82	cde	92	a	98	a	5	bcd	1	e	3	c
	ADJ	NIS	0.5	% v/v												
7	HERB	Fusion	7	fl oz/a	96	ab	70	a	64	b	4	bcde	5	bc	6	b
	ADJ	NIS	0.25	% v/v												
8	HERB	Fusion	9	fl oz/a	93	abc	88	a	80	ab	4	bcde	7	ab	7	ab
	ADJ	NIS	0.25	% v/v												
9	HERB	MSMA	32	fl oz/a	82	bcd	70	a	89	ab	6	b	4	c	8	a
10	CHK	Untreated Check			0		0		0		9	a	8	a	8	a

Note: Values followed by the same letter at a given time interval are not statistically significantly different at the $p = 0.05$ level using Fishers LSD test.

Spindletop

The Spindletop study utilized 11 chemical treatments and 1 untreated control (Table 3). Estimated cost per acre for each treatment is included **for comparison purposes only**. The Spindletop trial included an Outrider spot treatment (treatment 7). The trial was installed on August 16th, 2004. Plots were rated 31 and 67 DAT for percent control of Johnsongrass and turf injury. A 90 DAT was not taken due to the potential of frost injury confounding the data. All Envoy treatments showed similar control results here as in the Central City trial. Treatments exhibited a quick control response at 31 DAT and then decreased slightly at 67 DAT yet still had control greater than 90 % (Table 4). The Outrider treatments maintained percent control greater than 90 % throughout the study and began to exhibit the same rate response as at Central City at 67 DAT. The Outrider spot treatment also exhibited control greater than 90 %. This treatment is **extremely** dependent on accurate identification of Johnsongrass. Fusion treatments exhibited

excellent control as well throughout the trial with results similar to other treatments here and Fusion treatments at Central City. MSMA appears to have an antagonistic effect on Outrider when the two are mixed as control responses with this treatment were significantly lower than that of Outrider alone at 0.5 oz / ac throughout the trial while statistically similar to that of the MSMA alone treatment.

Table 3: Treatment list for Spindletop Johnsongrass trial

Treatment	Compounds	Rate per acre	Cost per acre
1	Envoy + COC	13 oz + 1% v/v	\$12.00
2	Envoy + COC	15 oz + 1% v/v	\$14.00
3	Envoy + COC	17 oz + 1% v/v	\$15.00
4	Outrider + NIS	0.5 oz + 0.5% v/v	\$5.00
5	Outrider + NIS	0.75 oz + 0.5% v/v	\$8.00
6	Outrider + NIS	1 oz + 0.5% v/v	\$9.10
7	Outrider + NIS	1 oz / 100 gal + 0.5 % v/v	\$12.00 per 100 gal
8	Fusion + NIS	7 oz + 0.25% v/v	\$6.00
9	Fusion + NIS	9 oz + 0.25% v/v	\$8.00
10	Outrider + MSMA	0.5 oz + 32 oz	\$8.00
11	MSMA	32 oz	\$4.00
12	Untreated		

Table 4: Summary of Spindletop Johnsongrass Trial

Trt No.	Treatment Type	Treatment Name	Rate	Rate Unit	Percent control		Color ratings		
					31 DAT	67 DAT	31 DAT	67 DAT	
1	HERB	Envoy	13	fl oz/a	96 a	90 ab	3 d	8	ab
	ADJ	COC	1	% v/v					
2	HERB	Envoy	15	fl oz/a	96 a	93 ab	3 d	5	ab
	ADJ	COC	1	% v/v					
3	HERB	Envoy	17	fl oz/a	98 a	96 a	3 d	5	ab
	ADJ	COC	1	% v/v					
4	HERB	Outrider	0.5	oz/a	91 abc	92 ab	4 cd	8	a
	ADJ	NIS	0.5	% v/v					
5	HERB	Outrider	0.75	oz/a	92 ab	93 ab	5 bcd	7	ab
	ADJ	NIS	0.5	% v/v					
6	HERB	Outrider	1	oz/a	90 abc	98 a	4 cd	4	b
	ADJ	NIS	0.5	% v/v					
7	HERB	Outrider Spot	1	oz/100 gal	91 abc	93 ab	5 bc	8	a
	ADJ	NIS	0.5	% v/v					
8	HERB	Fusion	7	fl oz/a	95 a	96 a	3 d	8	ab
	ADJ	NIS	0.25	% v/v					
9	HERB	Fusion	9	fl oz/a	95 a	98 a	3 d	8	ab
	ADJ	NIS	0.25	% v/v					
10	HERB	Outrider	0.5	oz/a	75 c	77 bc	5 bcd	8	ab
	HERB	MSMA	32	fl oz/a					
11	HERB	MSMA	32	fl oz/a	78 bc	70 c	6 ab	8	a
12	CHK	Untreated Check			0	0	8 a	8	a

Note: Values followed by the same letter at a given time interval are not statistically significantly different at the $p = 0.05$ level using Fishers LSD test.

Fescue injury appeared to decrease as the trial progressed through 2 months for all treatments except Outrider at 1 oz / ac (Table 4). This is unlike the response seen at Central City. This again may be due to the different environmental conditions between the two sites as central Kentucky received a considerable amount of precipitation throughout the summer as compared to Central City. The Outrider spot treatment (treatment 7) appears to effective in controlling Johnsongrass while minimizing fescue injury. This control option is dependent on accurate identification and cost efficacy is dependent on plant density.

Summary

Outrider appears to be an effective control option for Johnsongrass. Fescue injury will occur initially but lessens as time after treatment increases. Fescue injury appears to be affected by the amount of precipitation after application. In areas of the state that are prone to dry summers this response may have to be accepted as injury occurred with all treatments tested. There was no statistically significant difference of control between the Outrider 0.75 and 1 oz / ac treatments approximately 2 months after application at both the Central City and Spindletop trials. Outrider at 0.75 oz / ac is similar in cost to Fusion at 9 oz / ac and produces similar results. This treatment appears to be suitable as a annual rotation partner with Fusion reduce the probability of resistant Johnsongrass from appearing on KTC rights-of-way.

The Outrider spot treatment was effective in controlling Johnsongrass and reducing fescue injury by eliminating the broadcast application. This treatment would be effective in small infestations.

It is unclear if Outrider would provide residual control of Johnsongrass rhizomes and regrowth of Johnsongrass the season following application. The Spindletop trial will be maintained throughout the winter of 2004 – 2005 and examined in the spring / summer of 2005.

Literature Cited

Miller, J.H. and K.V. Miller, 1999. Forest Plants of the Southeast and Their Wildlife Uses. Champaign, IL. Southern Weed Science Society. pp 258-259.

Obermeier, M.R., S.A. Avdiushko, and M. Barrett., 1998. *Comparative sequences of the acetyl CoA binding site of acetyl CoA carboxylase genes isolated from ACCase inhibitor resistant and susceptible Johnsongrass biotypes.* Proc. South. Weed. Sci. Soc. 51: 248-249.

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