Tolerance of Four *Festuca* Species to Ethofumesate and Proflaminate

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Abstract. *Festuca* species are being seeded into golf course roughs and natural or out-of-bound areas as alternative turfgrasses to replace perennial ryegrass (*Lolium perenne* L.) in the mid-Atlantic region. The tolerance of fine-leaf fescues to herbicides targeted for annual bluegrass (*Poa annua* L.) control, such as ethofumesate and proflaminate, is unknown. The objectives of this field study, therefore, were to assess the tolerance of 'Rebel II' tall fescue (*Festuca arundinacea* Schreb.), and the fine-leaf fescue species 'Reliant' hard fescue (*Festuca longifolia* Thuill.), 'Jamestown II' Chewings fescue (*Festuca rubra* L. ssp. *commutata* Gaud.), and 'MX 86' blue sheep fescue (*Festuca glauca* L.) to various rates, combinations, and times of application of ethofumesate and proflaminate. 'Rebel II' was most tolerant of ethofumesate; however, sequential rates $\geq 0.84 + 0.84 \text{ kg}\cdot\text{ha}^{-1}$ reduced quality for 1 or more weeks and $2.24 + 2.24 \text{ kg}\cdot\text{ha}^{-1}$ caused unacceptable injury. Single applications of ethofumesate at rates of 0.56, 0.84, and $1.12 \text{ kg}\cdot\text{ha}^{-1}$, and sequential treatments of $0.56 + 0.56$ and $0.84 + 0.84 \text{ kg}\cdot\text{ha}^{-1}$ reduced 'Reliant' quality temporarily. Sequential treatments of high rates (i.e., $1.12 + 1.12$ and $2.24 + 2.24 \text{ kg}\cdot\text{ha}^{-1}$), however, significantly reduced 'Reliant' cover. 'Jamestown II' was very sensitive to ethofumesate, but recovered from single applications of 0.56, 0.84, and $1.12 \text{ kg}\cdot\text{ha}^{-1}$; sequential applications ($\geq 0.84 + 0.84 \text{ kg}\cdot\text{ha}^{-1}$) caused unacceptable injury, and rates $\geq 1.12 + 1.12 \text{ kg}\cdot\text{ha}^{-1}$ caused significant loss of cover. The cultivar MX 86 tolerated single applications of 0.56 to $2.24 \text{ kg}\cdot\text{ha}^{-1}$ of ethofumesate, but sequential treatments generally reduced quality to unacceptable levels. In one study, 'Jamestown II' and 'MX 86' were more severely injured when ethofumesate (1.12 or $2.24 \text{ kg}\cdot\text{ha}^{-1}$) was applied in October rather than in November. The fescues generally best tolerated a single, November application of ethofumesate at $\leq 1.12 \text{ kg}\cdot\text{ha}^{-1}$. Proflaminate ($0.73 \text{ kg}\cdot\text{ha}^{-1}$) caused only short-term reductions in quality of 'Jamestown II', but was generally noninjurious to the other fescues. Ethofumesate tank-mixed with proflaminate ($0.84 + 0.36$ or $1.12 + 0.73 \text{ kg}\cdot\text{ha}^{-1}$) elicited some short-term reduction in quality, but the level of injury was generally acceptable and injured fescues had recovered by spring. Chemical names used: [$\pm$]2-ethoxy-2,3-dihydro-3,3-dimethyl-5-benzofuran-5-yl methanesulfonate (ethofumesate); N^3,N^3 -di-*n*-propyl-2,4-dinitro-6-(trifluoromethyl)-*m*-phenylenediamine (proflaminate); *S,S*-dimethyl 2-(difluoromethyl)-4-(2-methylpropyl)-6-(trifluoromethyl)-3,5-pyridine-dicarbothioate (dithiopyr).

Golf course superintendents in the mid-Atlantic region are searching for turfgrass species that will perform well with reduced management inputs in roughs and infrequently mowed natural areas. Research conducted in Maryland indicated that 'Reliant' hard fescue, 'Bighorn' blue sheep fescue, and 'Rebel II' tall fescue provided good quality under low maintenance (Dernoeden et al., 1998b). Perennial ryegrass is the dominant species grown in roughs in the region, but it was decimated by gray leaf spot [*Pyricularia grisea* (Cooke) Sacc.] epidemics in 1995 and 1998, and ice damage in the 1993–94 winter. Hard and blue sheep fescues are better suited to natural or out-of-play areas where there is little traffic or need for mowing during the summer (Dernoeden, 1998b). Tall fescue has better

summer mowing and wear tolerance than the aforementioned fescues, and would be suitable for rough areas mowed above 6.0 cm.

Interest in using fescue species for golf course roughs and other low-maintenance situations is increasing, but little is known regarding their tolerance to commonly used herbicides. Annual bluegrass is a major golf course weed problem, and huge reservoirs of seed are produced in roughs. Common herbicides used for annual bluegrass control in the region include ethofumesate (ETHO) and proflaminate, which are used postemergence and preemergence, respectively. Both chemicals generally are applied between late summer and early winter (Dernoeden, 1998a; Dernoeden and Turner, 1988); therefore, grasses grown in roughs and natural areas on golf courses should be tolerant of these herbicides. Among fescue species, ETHO is labeled for use only on tall fescue. The focus of this study was to assess the tolerance of four fescue species to ETHO and proflaminate alone and to mixtures of both chemicals, as the combination of herbicides may provide early postemergence and subsequent preemergence control of annual bluegrass.

Monostands of 'Jamestown II' Chewings fescue, 'Rebel II' tall fescue, 'Reliant' hard fescue, and 'MX 86' blue sheep fescue were established in Sept. 1995. The soil was a Chillum silt loam (fine silty, mixed mesic Typic Hapludult) with a pH of 5.5 and 21 mg organic matter per gram of soil. The monostands were fertilized in spring and fall with $50 \text{ kg}\cdot\text{ha}^{-1}$ N from urea. Initial soil P and K levels were 268 and $431 \text{ kg}\cdot\text{ha}^{-1}$, respectively. All stands were mowed to a height of $6.5 \pm 0.5 \text{ cm}$, but unless otherwise stated they were not irrigated during the study period. No other pesticides were applied to the research sites during the study.

In 1996, herbicides were applied 1 Oct., with four sequential ETHO treatments applied on 22 Oct. The sites used in 1996 were randomized and treated in 1997. Plots that were severely injured from the 1996 study were eliminated, but there were enough healthy, high-density plots present within each site to accommodate all 1997 treatments. In 1997, different rates of the herbicides were assessed alone or in combination. Two application dates (October vs. November) were compared in 1997 to determine if phytotoxicity were influenced by application timing. All monostands were irrigated within 48 h of herbicide treatment. Plots were $1.5 \times 1.5 \text{ m}$, and were arranged in a randomized complete block with three replications. Turf quality was assessed visually using a 0 to 10 scale where 0 = entire plot area brown or dead, 7.0 = minimum acceptable quality for golf course roughs, and 10 = optimum color and density. Percentage of plot area brown, dead, or bareground was rated on a visual 0% to 100% linear scale where 0 = entire plot area green and healthy, and 100 = entire plot area brown, dead, or bareground. Data were subjected to analysis of variance and significantly different means were separated at $P \leq 0.05$ by the least significant difference *t* test.

Results

Study I (1996–97)

Data are shown only when treatment effects were significant. Dithiopyr was evaluated only in Study I. Dithiopyr and proflaminate applied alone caused no discoloration or loss of density. Ethofumesate data are discussed below for each cultivar. Most of the ETHO-induced injury took the form of an initial blue-green or pale-green discoloration, followed in some cases by a browning of foliar tissues. In more extreme cases, plants were killed and this injury is reported as percentage of plot area bareground.

'Rebel II' tall fescue. Ethofumesate applied once did not reduce tall fescue quality significantly on any date (Table 1). Conversely, all sequential treatments reduced quality on at least one rating date. Rates $\geq 0.84 + 0.84 \text{ kg}\cdot\text{ha}^{-1}$ reduced quality from 28 Oct. to 2 Dec. 1996, particularly in plots treated twice with $2.24 \text{ kg}\cdot\text{ha}^{-1}$. By 20 Feb. 1997, reduced quality

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was observed only at the high sequential rate. While none of the treatments resulted in a loss of turf density (data not shown), the high sequential rate caused commercially unacceptable levels of discoloration. The ETHO + prodiamine tank-mix treatment did not injure 'Rebel II'.

'Reliant' hard fescue. 'Reliant' tolerated a single application of ETHO regardless of rate, but was injured by sequential treatments (Table 1). Most initial injury (28 Oct. and 4 Nov.) was evident with the higher two rates (1.12 and 2.24 kg·ha⁻¹). The lower, sequential rate treatments, however, eventually caused discoloration and reduced quality from 12 Nov. 1996 to 20 Feb. 1997. Data collected 20 Feb. showed that all sequential ETHO treatments had reduced turf quality, particularly with 2.24 + 2.24 kg·ha⁻¹. All sequentially treated plots had unacceptable quality (i.e., ≤7.0) on the final rating date, and therefore these treatments were judged to be too phytotoxic for hard fescue. The ETHO + prodiamine tank-mix did not adversely affect 'Reliant' quality.

'Jamestown II' Chewings fescue. Only the single, 0.56 kg·ha⁻¹ rate of ETHO did not injure or reduce the quality of 'Jamestown II' (Table 2). A single application of high rates of ETHO generally reduced quality within a 2-week period from 14 to 28 Oct. Sequentially treated plots showed some loss in quality, but

quality was unacceptable on most rating dates at rates ≥0.84 + 0.84 kg·ha⁻¹ from 28 Oct. 1996 to 20 Feb. 1997 (data for some dates not shown). On 6 May 1997, all plots had recovered except those sprayed with the two highest sequential rates. Plots treated with 1.12 + 1.12 kg·ha⁻¹ had 8% bareground, whereas the highest sequential rate had caused a 70% loss of 'Jamestown II' cover (data not shown). 'Jamestown II' plots treated with 0.56 + 0.56 kg·ha⁻¹ of ETHO had marginally unacceptable quality, but higher rates caused an unacceptable loss of quality and/or cover. The ETHO + prodiamine tank-mix was relatively safe, but had reduced quality when plots were rated on 14 and 28 Oct.

'MX 86' blue sheep fescue. The 2.24 kg·ha⁻¹ ETHO rate was the only single application treatment that had reduced quality as of 28 Oct. (Table 2). All sequential treatments reduced quality from 28 Oct. 1996 to 20 Feb. 1997, with the 2.24 + 2.24 kg·ha⁻¹ treatment causing significant turf loss (7% bareground, data not shown). The ETHO + prodiamine tank-mix was noninjurious.

Study II (1997–98)

The injury associated with the sequential treatments in Study I was probably the result of higher total amounts of herbicide being

applied. However, fescue sensitivity to ETHO also may have been influenced by the time of application. Therefore, in Study II, the high ETHO rates (1.12 and 2.24 kg·ha⁻¹) were applied once in either October or November, whereas the lower rates were reevaluated only as sequential treatments.

'Rebel II' tall fescue. Significant injury was evident from 23 Oct. through 5 Dec. in plots treated with either 1.12 or 2.24 kg·ha⁻¹ of ETHO (Table 3, some data not shown), but quality was equivalent to that of nontreated plots by 14 Jan. 1998. Among the other treatments, only ETHO + prodiamine applied in November had reduced quality on 19 Nov. and 5 Dec., and the tank-mix applied in October at 1.12 + 0.73 kg·ha⁻¹ had reduced quality on 14 Jan. None of the treatments reduced quality to unacceptable levels, and quality in all herbicide-treated plots was equivalent to that of nontreated turf by 6 Feb. (data not shown).

'Reliant' hard fescue. Ethofumesate applied alone on 8 Oct. at 1.12 and 2.24 kg·ha⁻¹ reduced quality by 23 Oct. (data not shown). Plots treated with 2.24 kg·ha⁻¹ alone generally were more severely damaged than those sprayed with 1.12 kg·ha⁻¹ from 19 Nov. to 6 Mar. (Table 3). Turf in plots treated with 1.12 kg·ha⁻¹ had recovered by 14 Jan. 1998. The sequential ETHO (0.84 + 0.84 kg·ha⁻¹) and ETHO + prodiamine treatments, except 0.84 +

Table 1. 'Rebel II' tall fescue and 'Reliant' hard fescue quality^a as influenced by ethofumesate and prodiamine application, 1996–97.

Herbicide	Rate (kg·ha ⁻¹)		Rebel II					Reliant				
	1 Oct.	22 Oct.	1996		1997			1996		1997		
			28 Oct.	4 Nov.	12 Nov.	2 Dec.	20 Feb.	28 Oct.	4 Nov.	12 Nov.	2 Dec.	20 Feb.
Ethofumesate	0.56	---	8.7 a ^y	8.6 a	8.7 a	8.2 ab	6.5 ab	8.6 ab	8.8 ab	8.6 a	8.8 a	7.6 a
	0.84	---	8.6 a	8.4 a	8.5 ab	8.2 ab	6.5 ab	8.5 a-c	8.8 ab	8.7 a	8.8 a	7.4 a
	1.12	---	8.4 ab	8.6 a	8.4 ab	8.2 ab	6.6 a	8.6 ab	8.8 ab	8.6 a	8.6 a	7.5 a
	2.24	---	8.4 ab	8.4 a	8.2 b	8.2 ab	6.5 ab	8.7 ab	8.9 a	8.6 a	8.7 a	7.6 a
	0.56	0.56	8.0 b	8.4 a	8.4 ab	8.2 ab	6.6 a	8.4 bc	8.4 a-c	7.8 b	7.9 b	6.9 b
	0.84	0.84	7.2 c	7.7 b	7.8 c	7.9 b	6.4 b	8.2 ab	8.1 cd	6.4 c	6.3 c	6.4 c
	1.12	1.12	7.1 c	7.1 c	7.6 c	7.9 b	6.4 b	8.2 c	7.8 d	6.1 c	6.1 c	6.0 c
	2.24	2.24	6.1 d	5.6 d	6.0 d	7.4 c	6.0 c	7.7 d	6.1 e	2.8 d	2.8 d	4.0 d
Prodiamine	0.73	---	8.5 a	8.5 a	8.5 ab	8.2 ab	6.4 b	8.6 ab	8.6 ab	8.6 a	8.6 a	7.5 a
Dithiopyr	0.56	---	8.6 a	8.5 a	8.4 ab	8.4 a	6.5 ab	8.4 bc	8.8 ab	8.6 a	8.7 a	7.6 a
Ethofumesate + prodiamine	0.84 + 0.36	---	8.6 a	8.5 a	8.4 ab	8.1 ab	6.5 ab	8.8 a	8.8 ab	8.4 a	8.5 a	7.7 a
Not treated	---	---	8.6 a	8.4 a	8.5 ab	8.2 ab	6.5 ab	8.6 ab	8.7 ab	8.6 a	8.8 a	7.6 a

^aTurf quality was assessed visually using a 0 to 10 scale where 0 = entire plot area brown or dead, and 10 = optimum color and density.

^yMean separation within columns by LSD, $P \leq 0.05$.

Table 2. 'Jamestown II' Chewings fescue and 'MX 86' blue sheep fescue quality^a as influenced by ethofumesate and prodiamine application, 1996 and 1997.

Treatment	Rate (kg·ha ⁻¹)		Jamestown II					MX 86			
	1 Oct.	22 Oct.	1996		1997			1996		1997	
			14 Oct.	28 Oct.	4 Nov.	2 Dec.	20 Feb.	28 Oct.	4 Nov.	2 Dec.	20 Feb.
Ethofumesate	0.56	---	8.8 a ^y	8.6 ab	8.8 a	8.6 a	7.5 a	8.0 a-c	8.6 a	8.6 a	7.0 a
	0.84	---	8.4 c-e	8.3 b-d	8.3 a-c	8.5 ab	7.5 a	8.2 ab	8.6 a	8.4 a	6.9 a
	1.12	---	8.2 de	8.1 c-e	8.5 ab	8.5 ab	7.5 a	8.0 a-c	8.6 a	8.6 a	7.0 a
	2.24	---	8.2 de	7.8 e	8.1 bc	8.0 b	7.0 ab	7.8 b-d	8.5 a	8.6 a	7.0 a
	0.56	0.56	8.6 a-d	8.0 de	7.7 c	8.0 b	6.6 b	7.5 de	7.8 b	7.4 b	6.5 b
	0.84	0.84	8.5 a-e	7.0 f	6.4 d	5.2 c	5.1 c	7.1 fg	6.5 c	5.6 c	5.5 c
	1.12	1.12	8.2 de	6.4 g	5.3 e	2.5 d	2.8 d	6.9 g	6.2 c	5.2 c	5.3 c
	2.24	2.24	8.1 e	5.1 h	2.8 f	0.0 e	0.0 e	6.4 h	5.2 d	1.8 d	2.2 d
Prodiamine	0.73	---	8.8 a-c	8.5 a-c	8.6 ab	8.2 ab	7.5 a	8.0 a-c	8.7 a	8.6 a	7.0 a
Dithiopyr	0.56	---	8.4 b-e	8.2 c-e	8.1 bc	8.4 ab	7.4 a	8.0 a-c	8.6 a	8.4 a	6.9 a
Ethofumesate + prodiamine	0.84 + 0.36	---	8.2 de	8.0 de	8.3 a-c	8.4 ab	7.3 a	8.1 ab	8.6 a	8.4 a	7.0 a
Not treated	---	---	8.8 ab	8.6 ab	8.6 ab	8.5 ab	7.5 a	8.3 a	8.6 a	8.6 a	7.0 a

^aTurf quality was assessed visually using a 0 to 10 scale where 0 = entire plot area brown or dead, and 10 = optimum color and density.

^yMean separation within columns by LSD, $P \leq 0.05$.

0.36 kg·ha⁻¹ applied in October, generally reduced quality from 19 Nov. 1997 to 6 Mar. 1998. Except for the November application evaluated on 6 Mar., plots treated with prodiamine alone exhibited no reduction in quality. While all herbicide-treated plots had similar levels of quality on 2 Apr. and 4 May 1998, plots treated with 2.24 kg·ha⁻¹ ETHO in Oct. 1997 did not fully recover until 4 May 1998 (data not shown). None of the treatments caused reduced density significantly (data not shown).

'Jamestown II' *Chewings fescue*. Reduced turf quality was evident on 23 Oct. 1997 through 4 May 1998 in selected ETHO-treated plots, particularly at 2.24 kg·ha⁻¹ (Table 4, some data not shown). The 1.12 and 2.24 kg·ha⁻¹ rates applied in October elicited more injury than the November application from 6 Feb. to 4 May. On the final rating date (4 May), only plots treated with 2.24 kg·ha⁻¹ in October had quality ratings inferior to that of the nontreated control. Application of prodiamine in October did not reduce quality; however, application in

November reduced quality from 14 Jan. 1997 to 2 Apr. 1998, but ratings remained in the acceptable range (i.e., >7.0). Only the 2.24 kg·ha⁻¹ rate of ETHO applied in October caused a significant loss of turf (4% bareground) when plots were rated on 4 May 1998 (data not shown).

'MX 86' *blue sheep fescue*. The 1.12 and 2.24 kg·ha⁻¹ rates of ETHO applied alone in October reduced quality on 23 Oct. (data not shown), and nearly all rates reduced quality from 19 Nov. to 6 Feb. (Table 4). Poorest quality was most often associated with the 2.24 kg·ha⁻¹ treatment during this period. Except for the 1.12 kg·ha⁻¹ (October timing) and the 2.24 kg·ha⁻¹ rates (both timings), most treated plots had recovered by 6 Mar. At the final rating, only 1.12 and 2.24 kg·ha⁻¹ applied in October had reduced quality ratings. Turf treated with 2.24 kg·ha⁻¹ in October had the highest bareground ratings (12%) on 6 Feb.; by 4 May, significantly higher ratings were noted in plots treated in October with 1.12 (3% bareground) and 2.24 (4% bareground) kg·ha⁻¹

(data not shown). Ethofumesate + prodiamine (all treatments) reduced quality on 5 Dec., but quality had generally recovered to control levels by 6 Feb. Prodiamine applied alone did not reduce quality or density on any date.

Discussion

Most ETHO treatments at rates ≥ 1.12 kg·ha⁻¹ reduced turf quality in all species on one or more rating dates. Prodiamine alone generally was safe, although it did cause some reduction in quality on a few rating dates in 'Jamestown II' and 'Reliant'. Ethofumesate + prodiamine and sequential treatment with ETHO reduced quality to levels similar to those obtained with ETHO applied alone at 1.12 kg·ha⁻¹, and were generally safer than ETHO applied alone at 2.24 kg·ha⁻¹. Ethofumesate + prodiamine reduced 'Reliant' quality to unacceptable levels in Study II on one rating date (6 Mar.), but loss of cover was nonsignificant for any of the fescues in any year.

'Rebel II' tolerated ETHO better than did

Table 3. 'Rebel II' tall fescue and 'Reliant' hard fescue quality^z as influenced by ethofumesate and prodiamine application, 1997–98.

Treatment	Rate (kg·ha ⁻¹)	Timing ^y	Rebel II			Reliant				
			1997		1998	1997		1998		
			19 Nov.	5 Dec.	14 Jan.	19 Nov.	5 Dec.	14 Jan.	6 Feb.	6 Mar.
Ethofumesate	1.12	Oct.	9.4 a ^w	9.5 a	7.8 a–d	8.9 b–e	9.1 a–c	8.0 a–d	7.6 ab	7.3 ab
	1.12	Nov.	8.6 c	8.8 cd	7.8 a–d	9.3 ab	8.5 c–e	8.1 ab	7.8 a	7.3 ab
	2.24	Oct.	9.3 a	9.1 a–d	7.7 c–e	6.9 g	7.0 f	7.1 f	6.3 d	6.4 d
	2.24	Nov.	7.8 d	7.8 e	7.9 ab	8.2 f	6.8 f	7.4 ef	6.9 cd	7.0 a–d
	0.56 + 0.56	Oct. + Nov. ^x	9.0 a–c	9.1 a–d	7.9 ab	9.1 a–c	9.0 a–c	8.0 a–d	7.6 a–c	7.1 a–c
Ethofumesate + prodiamine	0.84 + 0.84	Oct. + Nov. ^x	8.7 bc	9.0 b–d	7.9 a–c	8.5 d–f	7.9 e	7.6 e	7.1 bc	6.9 a–d
	0.84 + 0.36	Oct.	9.1 ab	9.1 a–d	7.7 b–e	9.2 a–c	9.2 ab	8.0 a–c	7.7 ab	7.1 a–c
Ethofumesate + prodiamine	1.12 + 0.73	Oct.	9.1 ab	9.5 a	7.5 e	8.4 ef	8.6 b–d	7.6 de	7.0 bc	6.5 cd
Ethofumesate + prodiamine	0.84 + 0.36	Nov.	8.8 bc	8.8 d	8.0 a	8.7 c–f	8.6 b–d	7.6 de	7.0 bc	6.5 cd
Ethofumesate + prodiamine	1.12 + 0.73	Nov.	8.7 bc	8.8 cd	7.9 ab	9.0 a–d	8.0 de	7.7 c–e	7.0 b–d	6.5 cd
Prodiamine	0.73	Oct.	9.1 ab	9.3 a–c	7.6 de	9.5 a	9.0 a–c	7.8 b–e	7.2 a–c	6.9 a–d
Prodiamine	0.73	Nov.	9.3 a	9.5 a	7.7 c–e	9.3 ab	9.1 a–c	8.0 a–d	7.3 a–c	6.3 b–d
Not treated	---	---	9.4 a	9.3 ab	7.8 a–d	9.5 a	9.5 a	8.3 a	7.8 a	7.3 a

^zTurf quality was assessed visually using a 0 to 10 scale where 0 = entire plot area brown or dead, and 10 = optimum color and density.

^yHerbicides were applied on either 8 Oct. or 4 Nov. 1997.

^xHerbicides were applied to the same plots on 8 Oct. and 4 Nov. 1997.

^wMean separation within columns by LSD, $P \leq 0.05$.

Table 4. 'Jamestown II' *Chewings fescue* and 'MX 86' *blue sheep fescue* quality^z as influenced by ethofumesate and prodiamine application, 1997 and 1998.

Treatment	Rate (kg·ha ⁻¹)	Timing ^y	Jamestown II					MX 86				
			1997		1998			1997		1998		
			19 Nov.	14 Jan.	6 Feb.	2 Apr.	4 May	19 Nov.	5 Dec.	6 Feb.	6 Mar.	4 May
Ethofumesate	1.12	Oct.	8.8 bc ^w	8.1 a–d	7.1 c	7.8 c	7.7 d	8.8 bc ^x	8.5 cd	6.3 c–e	5.9 c	6.8 c
	1.12	Nov.	9.0 a–c	7.7 de	7.9 a	8.7 ab	8.3 a–c	8.9 a–c	7.8 de	7.0 a	6.9 ab	7.8 a
	2.24	Oct.	6.9 e	7.5 e	6.2 d	6.7 d	6.7 e	6.1 e	6.2 f	5.3 f	5.3 d	5.9 d
	2.24	Nov.	7.5 f	6.9 f	7.2 c	8.1 bc	8.2 a–d	7.8 d	6.1 f	6.0 e	6.0 c	7.0 bc
	0.56 + 0.56	Oct. + Nov. ^x	9.0 a–c	8.2 a–c	7.8 ab	8.6 ab	8.5 a	9.0 a–c	8.3 d	6.5 b–d	6.5 ab	7.5 ab
Ethofumesate + prodiamine	0.84 + 0.84	Oct. + Nov. ^x	8.5 c	7.7 de	7.5 a–c	8.2 bc	7.8 cd	8.6 c	7.2 e	6.0 d	6.4 bc	7.6 ab
	0.84 + 0.36	Oct.	9.3 ab	8.3 ab	7.6 a–c	8.1 bc	8.0 a–d	9.2 a–c	8.6 b–d	6.8 a–c	6.5 ab	7.5 ab
Ethofumesate + prodiamine	1.12 + 0.73	Oct.	8.7 bc	7.8 c–e	7.1 c	7.8 c	8.2 a–d	8.8 bc	8.5 b–d	6.5 b–e	6.6 ab	7.8 a
Ethofumesate + prodiamine	0.84 + 0.36	Nov.	8.8 bc	7.9 b–d	7.5 a–c	8.5 ab	8.5 ab	9.3 ab	8.4 d	6.9 ab	7.0 a	7.7 ab
Ethofumesate + prodiamine	1.12 + 0.73	Nov.	8.8 bc	7.6 de	7.3 c	8.4 ab	8.0 b–d	9.2 a–c	8.1 d	6.9 ab	6.8 ab	7.5 ab
Prodiamine	0.73	Oct.	9.3 ab	8.0 a–d	7.5 a–c	8.3 a–c	8.3 ab	9.4 ab	9.3 ab	6.8 a–c	6.6 ab	7.6 ab
Prodiamine	0.73	Nov.	9.3 ab	8.0 b–d	7.4 bc	8.2 bc	8.0 a–d	9.5 a	9.5 a	7.0 ab	6.9 ab	7.6 ab
Not treated	---	---	9.4 a	8.4 a	7.9 a	8.9 a	8.0 b–d	9.5 a	9.2 a–c	7.1 a	6.9 ab	7.6 ab

^zTurf quality was assessed visually using a 0 to 10 scale where 0 = entire plot area brown or dead, and 10 = optimum color and density.

^yHerbicides were applied on either 8 Oct. or 4 Nov. 1997.

^xHerbicides were applied to the same plots on 8 Oct. and 4 Nov. 1997.

^wMean separation within columns by LSD, $P \leq 0.05$.

the other species; however, objectionable discoloration occurred with single applications $\geq 1.12 \text{ kg}\cdot\text{ha}^{-1}$ or sequential rates of $\geq 0.84 + 0.84 \text{ kg}\cdot\text{ha}^{-1}$ (Table 1). The $2.24 + 2.24 \text{ kg}\cdot\text{ha}^{-1}$ treatment caused commercially unacceptable discoloration. The ETHO label allows for up to three applications at $2.24 \text{ kg}\cdot\text{ha}^{-1}$, however, this obviously would have been too injurious to 'Rebel II'. 'Reliant' appeared to tolerate ETHO better than either 'Jamestown II' or 'MX 86'. In Study I, 'Reliant' showed little injury following a single application of ETHO at 0.56 to $2.24 \text{ kg}\cdot\text{ha}^{-1}$ (Table 1). The sequential treatments, however, caused unacceptable quality and the $2.24 + 2.24 \text{ kg}\cdot\text{ha}^{-1}$ rate significantly reduced 'Reliant' cover (3% bareground). In Study II, only $2.24 \text{ kg}\cdot\text{ha}^{-1}$ caused unacceptable 'Reliant' quality on two or more rating dates (Table 4); however, plots had recovered fully by 4 May (data not shown).

'Jamestown II' was very sensitive to ETHO, and only $0.56 \text{ kg}\cdot\text{ha}^{-1}$ applied once did not elicit injury in Study I (Table 2). While the sequential $0.56 + 0.56 \text{ kg}\cdot\text{ha}^{-1}$ reduced quality on a few dates in Study I, sequential rates $\geq 0.84 + 0.84 \text{ kg}\cdot\text{ha}^{-1}$ reduced quality to unacceptable levels (ratings ≤ 5.3). Following treatment with $1.12 + 1.12$ and $2.24 + 2.24 \text{ kg}\cdot\text{ha}^{-1}$ 'Jamestown II' did not fully recover, and plots had 8% and 70% bareground, respectively. In Study II, only $2.24 \text{ kg}\cdot\text{ha}^{-1}$ caused unacceptable quality (Table 4). Single applications of 1.12 and $2.24 \text{ kg}\cdot\text{ha}^{-1}$ in October generally caused greater injury than did the same treatments applied in November. Only plots treated with $2.24 \text{ kg}\cdot\text{ha}^{-1}$ in October exhibited quality inferior to that of the control on the final rating date (4 May).

The cultivar MX 86 was tolerant of all single ETHO treatments in Study I, but the sequential treatments caused unacceptable injury. In Study II, 1.12 and $2.24 \text{ kg}\cdot\text{ha}^{-1}$ applied

once reduced quality to unacceptable levels on selected dates; however, both rates applied in October resulted in unacceptable quality and loss of turf cover (3% to 4% bareground) on the final rating date (4 May). In contrast, plots treated in November had recovered by 4 May. The nature of the increased sensitivity of 'MX 86' and 'Jamestown II' to treatment in October is unknown; however, warmer temperatures in October probably allowed for more foliar uptake of the herbicide.

In Maryland, ETHO is most effective in controlling annual bluegrass in perennial ryegrass when applied at $2.24 \text{ kg}\cdot\text{ha}^{-1}$ or sequentially at rates $\geq 1.12 + 1.12 \text{ kg}\cdot\text{ha}^{-1}$ (Dernoeden and Turner, 1988). While the high, single-application rate ($2.24 \text{ kg}\cdot\text{ha}^{-1}$) caused injury, all fescues recovered by spring in Study I, but only plots treated in November had recovered by spring in Study II. In this study, all fescues recovered from the $0.84 + 0.84 \text{ kg}\cdot\text{ha}^{-1}$ sequential (October and November) treatment, which would provide some annual bluegrass control, but the level of control probably would be inferior to more frequent applications or the use of higher rates (Branham, 1991; Dernoeden and Turner, 1988; Taylorson and Spak, 1994). Nevertheless, this study indicates that ETHO will probably cause objectionable injury to all fescue species evaluated. These data indicate that ETHO should be used with caution on fine-leaf fescues, and that sequential applications should be avoided. Unless further studies indicate otherwise, ETHO rates $> 1.12 \text{ kg}\cdot\text{ha}^{-1}$ probably should not be applied to 'Jamestown II', 'MX 86', or 'Reliant'. Only 'Rebel II' tolerated $1.12 + 1.12 \text{ kg}\cdot\text{ha}^{-1}$, but $2.24 + 2.24 \text{ kg}\cdot\text{ha}^{-1}$ was too injurious to tall fescue. Ethofumesate appears to be safer to apply in November than in October, but corroborative studies need to be performed to verify these observations.

Prodiamine applied preemergence in early to mid-September at $\geq 0.36 \text{ kg}\cdot\text{ha}^{-1}$ provided excellent control of the annual biotype of *Poa annua* in Maryland (Dernoeden, 1998). All fescues in this study tolerated prodiamine at $0.73 \text{ kg}\cdot\text{ha}^{-1}$. Therefore, a preemergence application of prodiamine would be the safest and possibly most efficacious method of annual bluegrass control in the fescues. Curiously, however, data also indicated that the fescues could be treated relatively safely with ETHO (0.84 or $1.12 \text{ kg}\cdot\text{ha}^{-1}$) tank-mixed with prodiamine. 'Reliant', however, was discolored to unacceptable levels by ETHO + prodiamine in Study II on one rating date (6 Mar.). Future research should assess the potential efficacy of ETHO tank-mixed with prodiamine to determine if early postemergence and subsequent preemergence control of annual bluegrass can be achieved safely in the fescues.

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