Weed Technology 2012 26:789–792

Cool-Season Turfgrass Reseeding Intervals for Methiozolin

Patrick E. McCullough and Diego Gómez de Barreda*

Methiozolin selectively controls annual bluegrass in cool-season turfgrasses, and practitioners may wish to reseed desirable species in treated areas. Field experiments were conducted to evaluate reseeding intervals for creeping bentgrass, perennial ryegrass, and tall fescue following methiozolin applications. Turfgrass establishment varied for species, application timing (0, 2, 4, or 6 wk before seeding, WBS), and rates tested (0.56, 1.12, or 2.24 kg ai ha^{-1}). Reductions in turf cover suggest that seeding of creeping bentgrass, perennial ryegrass, and tall fescue should be delayed 2 wk after methiozolin treatments at 0.56 kg ha^{-1}. However, reseeding should be delayed after methiozolin treatments at 1.12 kg ha^{-1} for approximately 4, 4, and 2 wk for creeping bentgrass, perennial ryegrass, and tall fescue, respectively. Similarly, establishment was reduced on all dates from the nontreated after 2.24 kg ha^{-1} was applied at 4 WBS, suggesting that reseeding should be delayed for at least 6 wk on all three species at the high rate.
Nomenclature: Annual bluegrass, *Poa annua* L.; creeping bentgrass, *Agrostis stolonifera* L.; perennial ryegrass, *Lolium perenne* L.; tall fescue, *Festuca arundinacea* Schreb.
Key words: Establishment, seed, turfgrass.

Methiozolin controla selectivamente *Poa annua* en céspedes de clima frío, y los usuarios estarían interesados en resembrar especies deseables en las áreas tratadas. Se realizaron experimentos de campo para evaluar los intervalos de resiembra de *Agrostis stolonifera*, *Lolium perenne* y *Festuca arundinacea* después de aplicaciones de methiozolin. El establecimiento de los céspedes varió según la especie, el momento de aplicación (0, 2, 4 ó 6 semanas antes de la siembra, WBS), y las dosis evaluadas (0.56, 1.12 ó 2.24 kg ai ha^{-1}). Las reducciones en la cobertura del césped sugieren que la resiembra de *A. stolonifera*, *L. perenne* y *F. arundinacea* debe ser retrasada 2 semanas después del tratamiento con 0.56 kg ha^{-1} de methiozolin. Sin embargo, después de tratamientos con methiozolin a 1.12 kg ha^{-1}, la resiembra debe ser retrasada al menos 4, 4 y 2 semanas para *A. stolonifera*, *L. perenne* y *F. arundinacea*, respectivamente. Similarmente en comparación con el testigo no tratado, en todas las fechas de aplicación se redujo el establecimiento después de que se aplicó 2.24 kg ha^{-1} a 4 WBS, lo que sugiere que la resiembra debe ser retrasada al menos 6 semanas en las tres especies cuando se use esta dosis alta.

Annual bluegrass is a troublesome weed that reduces turfgrass aesthetics, functionality, and surface quality (Beard 1970). Compared with most turfgrasses, annual bluegrass has a lighter green color, shallow root system, and produces unsightly seedheads (Sprague and Burton 1937). The presence of annual bluegrass in polyculture with other species may reduce turf quality due to poor disease, drought, and wear tolerances (Beard et al. 1978; Lush 1989). Thus, controlling annual bluegrass with POST herbicides and reseeding desirable turfgrasses is often necessary in management programs.

Application timing of POST-applied herbicides for annual bluegrass control has been reported to influence establishment of turfgrasses from seed. Lycan and Hart (2006a) noted reductions in creeping bentgrass, Kentucky bluegrass (*Poa pratensis* L.), and perennial ryegrass seedling cover from bispyribac applied 1 wk before seeding (WBS), but these grasses were safely established when herbicides were applied 2 WBS. Perennial ryegrass and tall fescue may be immediately reseeded after amicarbazone applications at 0.1 or 0.2 kg ai ha^{-1}, but seeding should be delayed by 2 wk after applications at 0.4 kg ha^{-1} (McCullough et al. 2010a). In other experiments, common bermudagrass (*Cynodon dactylon* L.) seedlings have shown significant injury and reduced establishment from rimsulfuron, simazine, and trifloxysulfuron applied 1 to 2 WBS (McCullough and Nutt 2010; Willis et al. 2007). Therefore, turfgrass reseeding intervals may vary by species, application timing, and herbicide chemistry used for POST annual bluegrass control.

Methiozolin is an isoxazoline herbicide currently under evaluation in the United States for POST annual bluegrass control in turfgrass. In field experiments, sequential methiozolin applications totaling 3.36 kg ai ha^{-1} have shown potential to control annual bluegrass with minimal injury ($\leq$ 10%) to creeping bentgrass (personal observation). From preliminary experiments, methiozolin appears safe and efficacious at various seasonal timings, which may provide greater application flexibility for POST annual bluegrass in cool-season turf compared with amicarbazone, bispyribac-sodium, or ethofumesate (Johnson et al. 1989; Lycan and Hart 2006b; McCullough et al. 2010b).

Reseeding desirable turfgrasses is often warranted after controlling weeds with herbicide applications. Although methiozolin has significant potential for POST annual bluegrass control, reseeding intervals for cool-season turfgrass establishment after applications have not been reported. The objective of this field experiment was to evaluate reseeding intervals of creeping bentgrass, perennial ryegrass, and tall fescue after methiozolin applications.

DOI: 10.1614/WT-D-12-00092.1
* Assistant Professor, University of Georgia, 1109 Experiment Street, Griffin, GA 30223; Associate Professor, Universitat Politècnica de València, Camino de Vera s/n, Edificio 3P, 46022 Valencia, Spain. Corresponding author's E-mail: pmccull@uga.edu

https://doi.org/10.1614/WT-D-12-00092.1 Published online by Cambridge University Press

Materials and Methods

Two separate field experiments were conducted from March to June of 2011 and 2012 in Griffin, GA. Soil was a Cecil sandy loam with 2% organic matter and pH of 6.0 and 5.8 in 2011 and 2012, respectively. Experiments were initiated on irrigated, mature tall fescue fields mowed weekly with a rotary mower at a 6.4-cm height with clippings returned. The experimental design was a randomized complete block with four replications. Plots used in 2011 were adjacent to plots in 2012.

Treatments. Three methiozolin rates were applied at four application timings before seeding, in addition to a nontreated control. Methiozolin (2.1 EC, Moghu Corp.) was applied at 0.56, 1.12, or 2.24 kg ha^{-1} at 0, 2, 4, or 6 WBS. Application dates are presented in Table 1. Treatments were applied to 0.9- by 3.6-m plots by making two passes in opposite directions with a single-nozzle (9504E flat-fan, TeeJet Spraying Systems Co., Roswell, GA 30075) CO_2-pressured sprayer calibrated to deliver 374 L ha^{-1}. A nonionic surfactant (Chem Nut 80-20, Chem Nut Inc., Albany, GA 31706) was included with methiozolin treatments at 0.125% v/v.

A broadcast glyphosate (Roundup Pro Max 5.5L, Monsanto Co., St. Louis, MO 63167) application was made at 4 kg ae ha^{-1} 1 WBS to kill existing vegetation and facilitate assessment of turfgrass seedling cover. On the day of seeding (Table 1), the field was scalped to 1.3 cm with a rotary mower, debris was removed, and the seedbed received two passes with a vertical mower set to a depth of $\approx$ 0.6 cm. 'Penn A-4′ creeping bentgrass, 'Manhattan IV' perennial ryegrass, and 'Titan' tall fescue were seeded separately and perpendicular to herbicide treatments at 49, 390, and 390 kg ha^{-1}, respectively, with a drop spreader. Herbicide treatments scheduled for the day of establishment were applied immediately after seeding the three grasses. Creeping bentgrass was mixed with a 5-2-0 (N–P_2O_5–K_2O) fertilizer (Milorganite, Milwaukee, WI 53204) at a 6 : 1 fertilizer : seed ratio to facilitate accuracy of the targeted seeding rate. After seeding, the grasses were irrigated daily to promote germination and establishment. Creeping bentgrass and perennial ryegrass were mowed twice per week with a reel mower at 1.3-cm height, whereas tall fescue was mowed weekly with a rotary mower at a 6.4-cm height with clippings returned for all grasses.

Data Collection and Analysis. Turfgrass cover was visibly measured for each species biweekly after seeding, where 0 equals no cover and 100 equals complete cover in each plot. Ratings were made until 8 wk after seeding (WAS). Grid counts were made for each species by counting the number of 232-cm^2 squares within a 0.84-m^2 grid (36 total squares per grid) with shoots present (yes/no) of the desirable turf species at 8 WAS in 2012. Data were subjected to ANOVA at the 0.05 probability level. Fisher's Protected LSD test was used to separate treatment means at the 0.05 probability level. Grasses were analyzed separately as randomized complete blocks. Year-by-treatment interactions were not detected, and thus, years were combined.

Table 1. Dates for herbicide applications and seeding in field experiments at Griffin, GA.

Application	2011	2012
0 WBS[a] treatments	April 13	April 11
2 WBS treatments	March 29	March 27
4 WBS treatments	March 14	March 14
6 WBS treatments	March 1	February 29
Glyphosate	April 6	April 4
Seeding	April 13	April 11

[a] Abbreviation: WBS, weeks before seeding.

Results and Discussion

Creeping Bentgrass. Rate-by-application timing interactions were detected for creeping bentgrass cover, and thus, results are presented across all possible combinations (Table 2). Creeping bentgrass in the nontreated plots increased in ground cover from 2 to 8 WAT, ranging 25 to 72%. Methiozolin at 0.56, 1.12, and 2.24 kg ha^{-1} applied the day of seeding reduced creeping bentgrass ground cover to $\leq$ 22% on all dates. Creeping bentgrass cover was reduced from the nontreated on every evaluation date from methiozolin at 1.12 and 2.24 kg ha^{-1} applied 2 WBS, but 0.56 kg ha^{-1} only reduced creeping bentgrass cover from the nontreated at 2 WAS.

Treatments applied at 4 and 6 WBS were less deleterious to creeping bentgrass establishment than other timings. Methiozolin at 1.12 kg ha^{-1} applied 4 or 6 WBS reduced creeping

Table 2. 'Penn A-4′ creeping bentgrass ground cover after seeding in fields treated with methiozolin in two combined experiments in Griffin, GA.

		Creeping bentgrass cover (WAS)[c]			
Timing[a]	Methiozolin rate[b]	2	4	6	8
WBS	kg ai ha^{-1}	%			
0	0.56	3	5	22	18
	1.12	3	5	7	6
	2.24	3	6	5	6
2	0.56	19	45	58	65
	1.12	12	35	48	58
	2.24	7	22	29	44
4	0.56	23	50	60	70
	1.12	17	46	57	66
	2.24	16	36	38	52
6	0.56	23	50	57	68
	1.12	19	43	50	60
	2.24	18	48	59	65
	Nontreated	25	53	57	72
	$LSD_{0.05}$	6	11	9	13
	Timing	*	*	*	*
	Rate	*	*	*	*
	Timing × rate	*	*	*	*

[a] Application dates for treatments applied 0, 2, 4, and 6 wk before seeding (WBS) were April 13, March 29, March 14, and March 1 in 2011, respectively, and April 11, March 27, March 14, and February 29 in 2012, respectively. Glyphosate was applied to the entire tall fescue field that received treatments on April 6, 2011 and April 4, 2012 to facilitate visible assessment of turf establishment.

[b] Methiozolin was applied with a nonionic surfactant at 0.125% v/v.

[c] Abbreviation: WAS, weeks after seeding. Fields were seeded April 13, 2011 and April 11, 2012.

* Significant at the 0.05 probability level.

https://doi.org/10.1614/WT-D-12-00092.1 Published online by Cambridge University Press

Table 3. 'Manhattan IV' perennial ryegrass cover after seeding in fields treated with methiozolin in two combined experiments in Griffin, GA.

		Perennial ryegrass cover (WAS)[c]			
Timing[a]	Methiozolin rate[b]	2	4	6	8
WBS	kg ai ha^{-1}	%			
0	0.56	3	3	21	19
	1.12	3	4	10	20
	2.24	3	5	8	9
2	0.56	41	66	75	75
	1.12	31	56	74	78
	2.24	12	24	40	47
4	0.56	53	76	82	87
	1.12	43	67	70	74
	2.24	29	53	56	63
6	0.56	53	76	80	85
	1.12	42	72	78	81
	2.24	43	65	78	80
	Nontreated	52	67	80	82
	$LSD_{0.05}$	10	13	9	13
	Timing	*	*	*	*
	Rate	*	*	*	*
Timing × rate		*	*	*	*

[a] Application dates for treatments applied 0, 2, 4, and 6 wk before seeding (WBS) were April 13, March 29, March 14, and March 1 in 2011, respectively, and April 11, March 27, March 14, and February 29 in 2012, respectively. Glyphosate was applied to the entire tall fescue field that received treatments on April 6, 2011 and April 4, 2012 to facilitate visible assessment of turf establishment.

[b] Methiozolin was applied with a nonionic surfactant at 0.125% v/v.

[c] Abbreviation: WAS, weeks after seeding. Fields were seeded April 13, 2011 and April 11, 2012.

* Significant at the 0.05 probability level.

Table 4. 'Titan' tall fescue ground cover after seeding in fields treated with methiozolin in two combined experiments in Griffin, GA.

		Tall fescue cover (WAS)[c]			
Timing[a]	Methiozolin rate[b]	2	4	6	8
WBS	kg ai ha^{-1}	%			
0	0.56	4	8	34	40
	1.12	3	7	17	20
	2.24	3	5	19	25
2	0.56	33	64	73	78
	1.12	21	58	79	83
	2.24	11	42	54	67
4	0.56	32	69	76	81
	1.12	28	63	76	82
	2.24	18	42	58	61
6	0.56	32	68	79	84
	1.12	28	63	79	80
	2.24	23	63	79	86
	Nontreated	23	63	74	78
	$LSD_{0.05}$	8	10	10	17
	Timing	*	*	*	*
	Rate	*	*	*	*
Timing × rate		*	*	*	*

[a] Application dates for treatments applied 0, 2, 4, and 6 wk before seeding (WBS) were April 13, March 29, March 14, and March 1 in 2011, respectively, and April 11, March 27, March 14, and February 29 in 2012, respectively. Glyphosate was applied to the entire tall fescue field that received treatments on April 6, 2011 and April 4, 2012 to facilitate visible assessment of turf establishment.

[b] Methiozolin was applied with a nonionic surfactant at 0.125% v/v.

[c] Abbreviation: WAS, weeks after seeding. Fields were seeded April 13, 2011 and April 11, 2012.

* Significant at the 0.05 probability level.

bentgrass cover from the nontreated only at 2 WAS (Table 2). Methiozolin at 2.24 kg ha^{-1} applied 4 WBS reduced creeping bentgrass cover on every evaluation date, but this rate applied 6 WBS reduced cover from the nontreated at 2 WAS only. Creeping bentgrass cover was similar to the nontreated on all dates from methiozolin applied 4 or 6 WBS at 0.56 kg ha^{-1}.

Perennial Ryegrass. Rate-by-application timing interactions were detected for perennial ryegrass cover, and thus, results are presented across all possible combinations. Perennial ryegrass in the nontreated plots increased in ground cover from 2 to 8 WAT, ranging 52 to 82% (Table 3). Methiozolin at 0.56, 1.12, and 2.24 kg ha^{-1} applied the day of seeding reduced perennial ryegrass ground cover to $\leq$ 21% on every evaluation date. Perennial ryegrass cover was reduced from the nontreated at every evaluation from methiozolin at 2.24 kg ha^{-1} applied 2 WBS, but 0.56 and 1.12 kg ha^{-1} only reduced perennial ryegrass cover from the nontreated at 2 WAS.

Treatments applied at 4 and 6 WBS appeared less detrimental to perennial ryegrass establishment than other timings. Methiozolin at 0.56 kg ha^{-1} applied 4 or 6 WBS did not reduce perennial ryegrass cover from the nontreated on any evaluation date, whereas 1.12 kg ha^{-1} reduced perennial ryegrass cover on one date (Table 3). Methiozolin at 2.24 kg ha^{-1} applied 4 WBS reduced perennial ryegrass cover from the nontreated on all evaluation dates, but this rate applied 6 WBS did not reduce cover.

Tall Fescue. Rate-by-application timing interactions were detected for tall fescue cover, and thus, results are presented across all treatments (Table 4). Tall fescue in the nontreated plots increased in ground cover from 2 to 8 WAT, ranging 23 to 78%. Methiozolin at 0.56, 1.12, and 2.24 kg ha^{-1} applied the day of seeding reduced tall fescue ground cover from the nontreated on every evaluation date to $\leq$ 40% (Table 4). Methiozolin at 0.56 and 1.12 kg ha^{-1} applied 2, 4, or 6 WBS did not reduce tall fescue cover from the nontreated. Tall fescue cover was reduced from the nontreated on four and three evaluation dates from methiozolin at 2.24 kg ha^{-1} applied 2 or 4 WBS, respectively, but treatments 6 WBS were similar to the nontreated on all dates.

Grid Counts. In the nontreated plots, 100, 100, and 98% of the grids had shoots of creeping bentgrass, perennial ryegrass, and tall fescue present at 8 WAS, respectively (Table 5). Methiozolin at 0.56 kg ha^{-1} applied the day of seeding reduced the presence of shoots from the nontreated for creeping bentgrass, perennial ryegrass, and tall fescue to 59, 20, and 88% of the sampled area, respectively. Methiozolin at 1.12 and 2.24 kg ha^{-1} applied the day of seeding reduced the presence of shoots to $<$ 36% of the sampled area for all grasses. All other treatments had similar grid counts to the nontreated. Results suggest that turf shoots were present throughout the plots despite reductions in ground cover from visible measurements.

In summary, the introduction of new POST-applied herbicides for annual bluegrass control in cool-season turf

https://doi.org/10.1614/WT-D-12-00092.1 Published online by Cambridge University Press

Table 5. Grid counts for the presence of shoots at 8 wk after seeding 'Penn A-4' creeping bentgrass, 'Manhattan IV' perennial ryegrass, and 'Titan' tall fescue after methiozolin treatments before establishment in a field experiment, 2012, Griffin, GA.

		Grid counts[c]		
Timing[a]	Methiozolin rate[b]	Creeping bentgrass	Perennial ryegrass	Tall fescue
WBS	kg ai ha^{-1}	% of grid		
0	0.56	59	20	88
	1.12	35	12	20
	2.24	33	29	8
2	0.56	95	96	97
	1.12	99	100	99
	2.24	4	92	94
4	0.56	99	100	99
	1.12	99	99	97
	2.24	94	100	97
6	0.56	97	100	98
	1.12	97	100	99
	2.24	96	100	97
	Nontreated	100	100	98
	$LSD_{0.05}$	22	16	8
	Timing	*	*	*
	Rate	*	*	*
Timing × rate		*	*	*

[a] Application dates for treatments applied 0, 2, 4, and 6 wk before seeding (WBS) were April 11, March 27, March 14, and February 29 in 2012, respectively. Glyphosate was applied to the entire tall fescue field that received treatments on April 4, 2012 to facilitate visual assessment of turf establishment. Turf was seeded April 11, 2012.

[b] Methiozolin was applied with a nonionic surfactant at 0.125% v/v.

[c] The presence of shoots (yes or no) was counted in 36 232-cm^2 squares per plot.

* Significant at the 0.05 probability level.

has promising implications for practitioners but each herbicide has specific intervals for safely reseeding desirable species (Lycan and Hart 2006a; McCullough et al. 2010a). Appropriate reseeding intervals of cool-season turfgrasses for methiozolin will vary on the basis of application rate, timing, and species. It appears that turf managers could safely reseed creeping bentgrass, perennial ryegrass, and tall fescue by 2 wk after methiozolin treatments at 0.56 kg ha^{-1}. However, reseeding should be delayed after methiozolin treatments at 1.12 kg ha^{-1} for approximately 4, 4, and 2 wk for creeping bentgrass, perennial ryegrass, and tall fescue, respectively. Similarly, reseeding should be delayed for at least 6 wk after a methiozolin application at 2.24 kg ha^{-1} on all three species. Preliminary research has shown that 2.24 to 3.36 kg ha^{-1} of methiozolin is required to control annual bluegrass and the influence of application rate appears critical for successful turf establishment after treatments. Further research is needed to evaluate the influence of application placement, different soils, cultural practices, and cultivars on the establishment of cool-season turfgrass after methiozolin applications.

Acknowledgments

The authors thank Bob Perry, Bill Nutt, and Seth Williams for technical support with this research and Moghu Corp. for partial funding.

Literature Cited

Beard, J. B. 1970. An ecological study of annual bluegrass. USGA Green Sect. Rec. 8:13–18.

Beard, J. B., P. E. Rieke, A. J. Turgeon, and J. M. Vargas. 1978. Annual bluegrass (*Poa annua* L.) description, adaptation, culture and control. Res. Rep. 352. Michigan.

Johnson, B. J., G. W. Landry, and K. J. Karnok. 1989. Tolerance of bentgrass to amount, frequency, and timing of ethofumesate applications. HortScience 24:102–104.

Lush, W. M. 1989. Adaptation and differentiation of golf course populations of annual bluegrass. Weed Sci. 37:54–59.

Lycan, D. W. and S. E. Hart. 2006a. Cool-season turfgrass reseeding intervals for bispyribac-sodium. Weed Technol. 20:526–529.

Lycan, D. W. and S. E. Hart. 2006b. Seasonal effects on annual bluegrass control in creeping bentgrass with bispyribac-sodium. Weed Technol. 20:722–727.

McCullough, P. E., J. T. Brosnan, and G. K. Breeden. 2010a. Tall fescue and perennial ryegrass reseeding intervals for amicarbazone. HortScience 47:648–650.

McCullough, P. E., S. E. Hart, D. Weisenberg, and Z. J. Reicher. 2010b. Amicarbazone efficacy on annual bluegrass and safety to cool-season turfgrasses. Weed Technol. 24:461–470.

McCullough, P. E. and W. Nutt. 2010. Bermudagrass reseeding intervals for rimsulfuron, simazine, and sulfosulfuron. HortScience 45:693–695.

Sprague, H. B. and G. W. Burton. 1937. Annual bluegrass (*Poa annua* L.), and its requirements for growth. New Jersey Agricultural Experiment Station Bulletin 630. New Brunswick, NJ: Pp. 1–24.

Willis, J. B., D. B. Ricker, and S. D. Askew. 2007. Sulfonylurea herbicides applied during early establishment of seeded bermudagrass. Weed Technol. 21:1035–1038.

Wood, A. 2010. Methiozolin. Compendium of Pesticide Common Names. (Online). http://www.alanwood.net/pesticides/index_cn_frame.html. Accessed: June 20, 2012.

Received June 21, 2012, and approved July 17, 2012.

https://doi.org/10.1614/WT-D-12-00092.1 Published online by Cambridge University Press