Seasonal Timing of Glyphosate Application Influences Control of *Poa trivialis*

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ROUGH BLUEGRASS (RBG; *Poa trivialis* L.) is a perennial cool-season turfgrass and a problematic weed in cool-season turf due to suboptimal color, invasive stoloniferous growth, and sensitivity to heat and drought. Naturalized populations spread vegetatively during routine aeration and from contamination in seed lots (Reicher et al., 2011).

Bispyribac-sodium (Velocity) is the only product currently labeled for selective RBG removal in cool-season turf and is effective, but it can damage desirable species (McCullough and Hart, 2011) and is only labeled for sod-farm and golf-course use. Nonselective herbicides are often the only option for RBG control in home lawns, but it is unclear if efficacy varies with seasonal application timing, like RBG response to bispyribac-sodium (McCullough and Hart, 2011). Rough bluegrass persistence is anecdotally reported after late-summer glyphosate application. Adkins and Barnes (2013) observed better Kentucky bluegrass (*Poa pratensis* L.) control with spring treatments of imazapic plus glyphosate, but tall fescue (*Festuca arundinacea* Schreb.) control was better following summer applications. Therefore, our objective was to determine if the seasonal timing of glyphosate application influences RBG control.

SITE DESCRIPTION AND MANAGEMENT

Studies were conducted at the Rocky Ford Turfgrass Research Center in Manhattan, KS and at the John Seaton Anderson Turf Research Center in Mead, NE. Research plots (3 × 3 ft in Manhattan and 5 × 5 ft in Mead) were arranged in a randomized complete block design with four replications, irrigated to prevent drought stress, and mowed weekly at 2.5 inches. Clippings were not collected. In Manhattan, two separate studies (2011 and 2012) were conducted on 'Laser' RBG seeded in the fall of 2009. Each year, polymer-coated urea (41-0-0 N-P-K; Polyon, Agrium Advanced Technologies, Loveland, CO) was applied in May and urea (46-0-0) was applied in March, September, and November to provide N at 174 lbs acre^{-1} year^{-1}. In

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Abbreviations: GDD, growing degree days; RBG, rough bluegrass.

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Table 1. Effect of glyphosate application timing on green RBG cover in Manhattan, KS and Mead, NE, rated the spring following application.

	Manhattan (2011)	Manhattan (2012)	Mead (2012)
	————% green RBG cover[†]————		
Timing[‡]	30 May 2012	24 May 2013	3 June 2013
Untreated	80 a[§]	100 a	95 a
Spring	1 c	1 b	31 b
Midsummer	9 b	86 a	68 a
Late summer	6 bc	47 a	58 ab

[†]Data for percentage green RBG cover were visually estimated. Data were subject to a $\log_{10}(y + 1)$ transformation to normalize before analysis and then back-transformed for presentation.

[‡]Glyphosate was applied at 3 lbs a.i. acre^{-1} on each of the three timings. In Manhattan (2011), applications were made on 21 May (spring), 26 July (midsummer), and 25 August (late summer). In Manhattan (2012), application dates were 23 April (spring), 27 July (midsummer), and 30 August (late summer). In Mead (2012), application dates were and 4 May (spring), 31 July (midsummer), and 6 September (late summer).

[§]Within columns, means with the same letter are not statistically different according to Fisher's protected LSD ($P \leq 0.05$).

Mead, the study was conducted in 2012 on 'Winterstar' RBG seeded in the fall of 2010. Polymer-coated urea was applied in May, September, and November to provide N at 131 lbs acre^{-1} year^{-1}.

APPLICATION TIMINGS

Glyphosate (Glyphomate 41, PBI/Gordon Corporation, Kansas City, MO) was applied in spring, midsummer, or late summer at 3 lbs a.i. acre^{-1} with no additional adjuvant in 35 gal acre^{-1} spray solution with a CO_2–powered sprayer with XR TeeJet 8002 flat spray nozzles at 30 PSI. In Manhattan (2011), applications were made on 21 May (spring, 96% green coverage), 26 July (midsummer, 51% green coverage), and 25 August (late summer, 9% green coverage).

Growing degree days (GDD; base temperature = 10°C) were monitored beginning 1 January at each site each year and were used to schedule initial spring applications in Manhattan and Mead in 2012 to match the 263 GDD that accumulated in Manhattan in 2011; spring applications were made on 23 April in Manhattan and 4 May in Mead in 2012. Mid- and late-summer applications in 2012 were made when RBG decline was as near as possible to that in Manhattan (2011). These 2012 dates were 27 July (midsummer, 38% green cover) and 30 August (late summer, 37% green cover) in Manhattan, and 31 July (midsummer, 70% green cover) and 6 September (late summer, 75% green cover) in Mead.

The percentage green RBG cover was visually estimated monthly and approximately 1 year after initial spring treatments. Data were subjected to a $\log_{10}(y + 1)$ transformation before analysis of variance with the GLIMMIX procedure of SAS. Fisher's Protected LSD ($P \leq 0.05$) was used to detect treatment differences in each site-year combination. There were statistical differences in RBG cover among treatments after application and before the final rating date, but the focus of this report will be on the final rating date.

EFFECT OF GLYPHOSATE TIMING ON ROUGH BLUEGRASS CONTROL

Glyphosate reduced green RBG cover, with recovery varying with application timing. In all three studies, spring-applied glyphosate consistently reduced green RBG cover the following spring compared with untreated RBG and with RBG treated with glyphosate in midsummer (Table 1). In Manhattan (2011), untreated plots averaged nearly 80% green RBG cover by 30 May 2012, and all glyphosate timings reduced green RBG cover to <10%. Spring-applied glyphosate also resulted in lower green RBG cover compared to the midsummer application. In Manhattan (2012) and Mead, untreated plots averaged 100 and 95% green cover the spring following treatment, respectively, and only spring-applied glyphosate reduced green RBG cover.

Even though glyphosate application in mid- to late summer can temporarily reduce RBG cover, glyphosate should be applied in the spring for optimum RBG control, an effect that could be due to increased absorption and translocation of herbicide associated with higher growth rates (Ruiter and Meinen, 1998) and/or additional green leaf area.

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