TITLE: Effects of Turfgrass Species on Nitrous Oxide Fluxes Under Typical Nitrogen-management Regimes

OBJECTIVE: Investigate seasonal magnitude and patterns of nitrous oxide (N_2O) fluxes in one cool-season and two warm-season turfgrasses.

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SPONSORS: Kansas Turfgrass Foundation (KTF)

INTRODUCTION:

Different species of turfgrasses (for example, warm- and cool-season turfgrasses) may be fertilized with N at different rates and frequencies and irrigated with different amounts of water, all of which may affect N_2O emissions. Thus, the selection of different species of turfgrasses may be a useful management tool in mitigating N_2O emissions from turfgrass ecosystems. This study investigated N_2O emissions from three species of turfgrasses during 7 months (i.e., May through November) of the growing season.

MATERIALS AND METHODS:

Thirty-two plots, or eight plots per species, were arranged in previously established swards of one cool-season (perennial ryegrass; *Lolium perenne* L.) and two warm-season turfgrasses (bermudagrass [*Cynodon dactylon*] and zoysiagrass [*Zoysia japonica*]) in May 2005. Urea N fertilizer was applied to turfgrasses according to the schedule presented in Table 1. Soil fluxes of N_2O were measured weekly to biweekly from May 2 to November 18, 2005, by using static surface chambers and analyzing N_2O by gas chromatography. Volumetric soil water content from 0 to 20 cm was measured with time-domain reflectometry on the same days that N_2O measurements were collected. Air temperature during N_2O measurements was obtained from a weather station located at the research center. Clippings were collected from plots on eight days during the summer (June 10, 22, and 29; July 7, 14, and 29; and August 8 and 16) with a walk-behind rotary mower equipped with a modified collection bag that allowed for complete capture of clippings from each plot. Clipped biomass was determined gravimetrically after samples had been dried in a forced-air oven for 48 h at 65 C. Turfgrasses' irrigation requirements were determined with the Penman-Monteith equation (FAO-56), and all plots were irrigated once or twice weekly as needed, by hand to ensure uniformity; all plots received the same amount of irrigation. Statistical analyses of treatment differences were conducted with the mixed linear model of SAS, and correlation analyses were conducted with the correlation procedure of SAS.

RESULTS:

Daily fluxes of N_2O ranged from -2.6 mg N_2O-N m^{-2} h^{-1} on October 28 to 245 mg N_2O-N m^{-2} h^{-1} after N fertilization on June 17. Nitrogen fertilization increased N_2O emissions by up to 17 times within 1 day (Figure 1A), although the amount of increase differed after each fertilization. Emissions of N_2O were weakly correlated with soil water content during the 7-month study ($r = 0.10$; $p<0.02$), and the highest N_2O fluxes occurred when volumetric soil water content was also highest (Figure 1B; June 17). Air temperature was also weakly correlated with

N_2O emissions (r = 0.19; p<0.08; Figure 1C), whereas correlations between clipping biomass and N_2O emissions were not significant (Figure 1D). Direct correlations between N_2O fluxes and any one of these variables are typically low in N_2O studies, however, because N_2O production is determined by complex interactions among soil water content, temperature, organic matter, soil N concentration, etc.

Cumulative emissions of N_2O-N during the study differed significantly among species (Figure 2). Cumulative fluxes were 1.10 kg ha^{-1} in bermudagrass, 0.57 kg ha^{-1} in perennial ryegrass, and 0.82 kg ha^{-1} in zoysiagrass. Thus, N_2O-N emissions averaged 68% higher in warm-season than in cool-season turfgrass species. Because cool-season turfgrasses may require more irrigation than warm-season species do, however, the cool-season turfgrass in this study may have been insufficiently irrigated during the warmest periods (i.e., ryegrass may have required more water, but received only the same amount as the warm-season species). Because less irrigation may reduce N_2O emissions in turfgrasses, the fluxes from perennial ryegrass in this study may have been suppressed. Furthermore, perennial ryegrass was actively growing earlier in the spring than warm-season grasses were (e.g., during March and April), before measurements were collected in this study, so N_2O emissions may have been greater from perennial ryegrass during that period, which would have reduced the *observable* impact of seasonal N_2O fluxes from perennial ryegrass reported in this study.

Between the two warm-season species, cumulative N_2O emissions in bermudagrass were 34% higher than in zoysiagrass. Higher emissions in bermudagrass were likely the result of greater N fertilization in bermudagrass than in zoysiagrass (Table 1). Soil water content was greater in bermudagrass, however, which also may have inflated N_2O emissions, compared with those for zoysiagrass (Figure 1B). Greater soil water content in bermudagrass probably resulted from it using less water than zoysiagrass used; bermudagrass received the same amount of irrigation as zoysiagrass in this study. Results from this preliminary study indicate that turfgrass species may have significant impacts on N_2O emissions into the atmosphere, and suggest that turf species selection may be a useful management tool to mitigate greenhouse gas emissions and the greenhouse effect.

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Table 1. Fertilization schedule for bermudagrass, perennial ryegrass, and zoysiagrass in 2005.

	Bermudagrass	Perennial Ryegrass	Zoysiagrass
	------------------------- lb N/1,000 ft^{-2}	-------------------------------------	
May 5	1.0	1.0	1.0
June 16	1.0	--	--
July 21	1.0	0.5	1.0
August 11	1.0	--	--
September 19	--	1.5	–

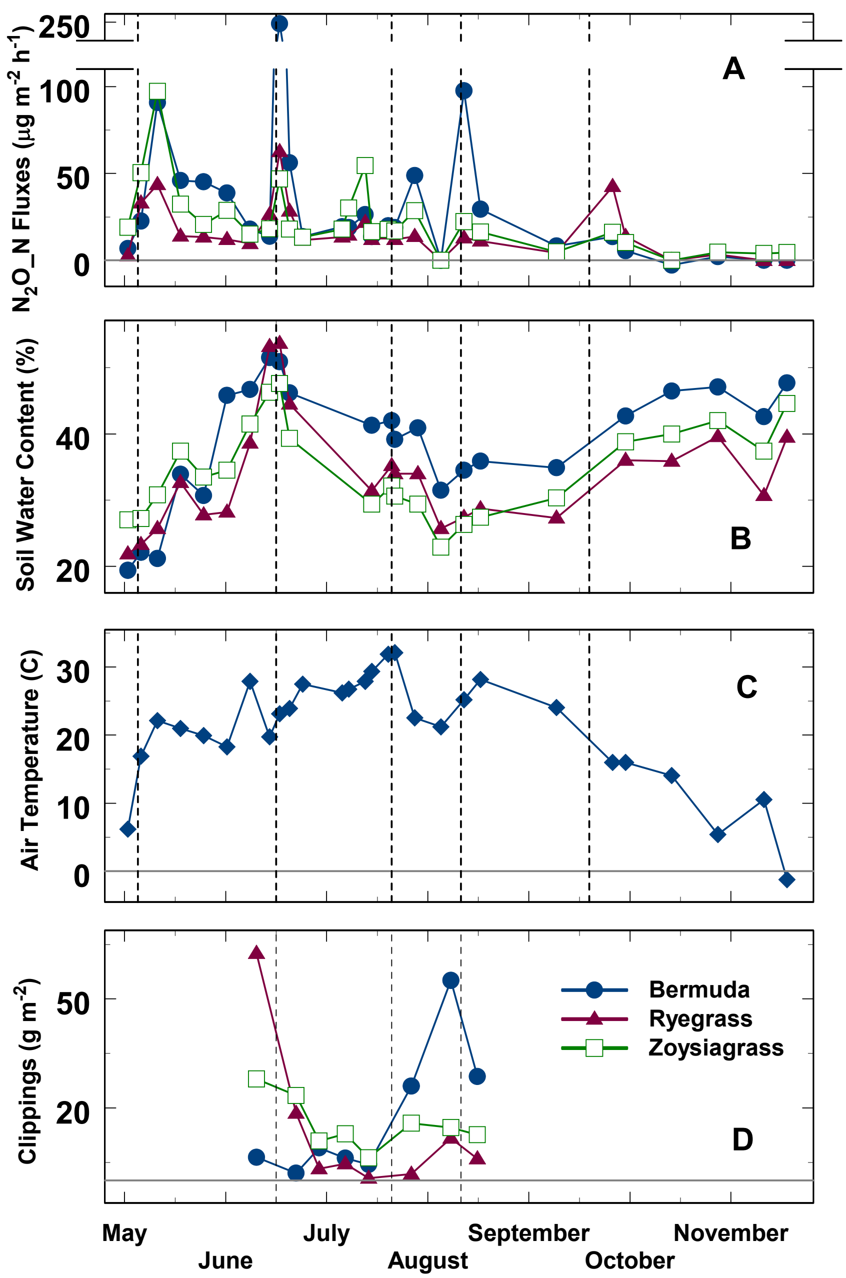

Figure 1. Patterns among turfgrass species of nitrous oxide nitrogen (N_2O-N; A) fluxes; volumetric soil water content in the 0- to 20-cm profile (B); average air temperature at 1.5 m above ground level (C); and clippings collected during mowing (D); from May 2 to November 18, 2005. Vertical dashed lines represent N-fertilization dates.

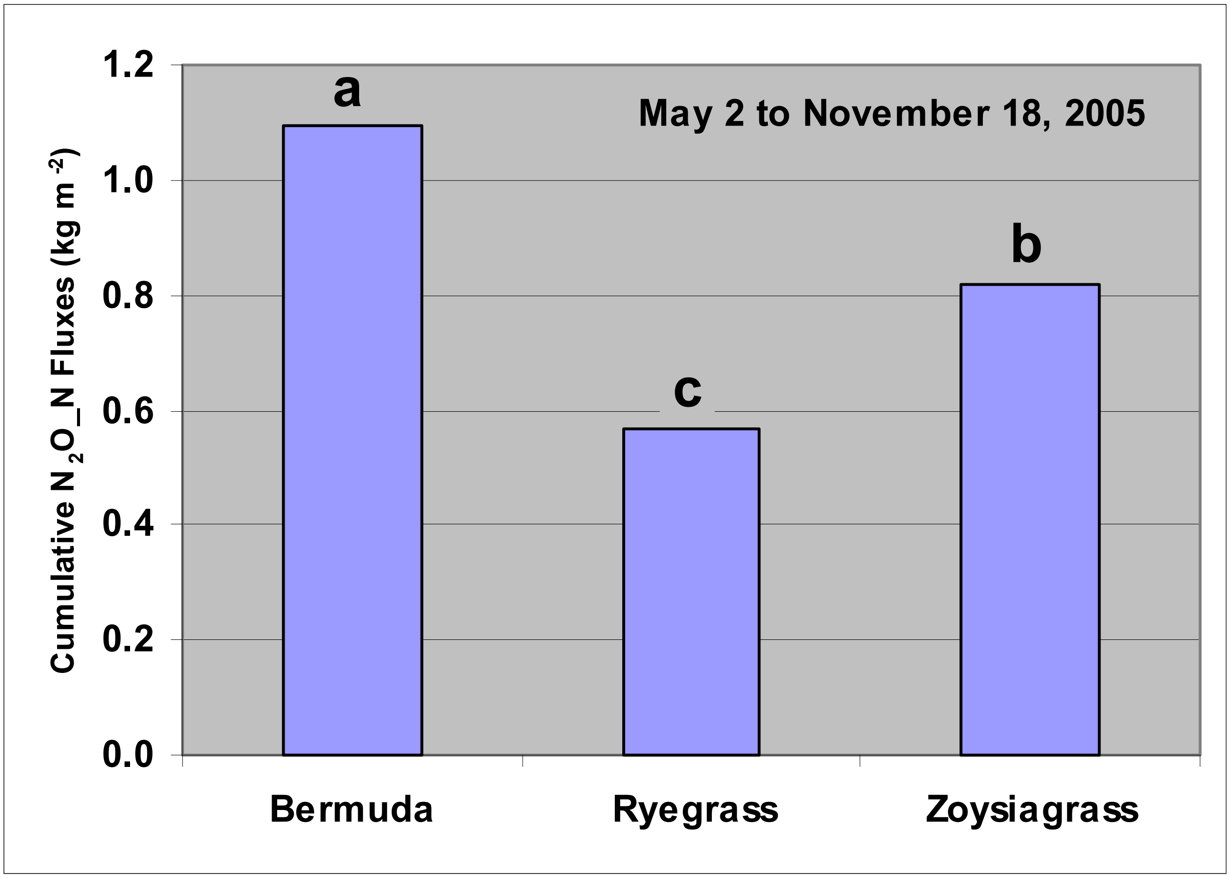

Figure 2. Cumulative emissions of of nitrogen (N_2O-N) from three species of turfgrasses during the summer and fall of 2005.