TITLE: Emissions of Nitrous Oxide from Three Different Turfgrass Species and from Perennial Ryegrass under Different Irrigation Regimes

OBJECTIVES: Investigate: (1). the seasonal magnitude and patterns of nitrous oxide (N_2O) fluxes in one cool season and two warm season turfgrasses; and (2). effects of irrigation on N_2O emissions from perennial ryegrass

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INTRODUCTION:

Different species of turfgrasses (for example, warm- and cool-season turfgrasses) may be fertilized with nitrogen (N) at different rates and frequencies, and irrigated with different amounts of water, all of which may affect N_2O emissions. The selection of different species of turfgrasses may be a useful management tool in mitigating N_2O emissions from turfgrass ecosystems. Irrigation may also significantly impact N_2O emissions from turfgrass. Therefore, this study investigated (1) N_2O emissions from three species of turfgrasses during a 5-month period (i.e., June through October) of the 2006 growing season; and (2) the effects of irrigation on N_2O emissions in turfgrass during a 2-month period in the summer of 2006.

METHODS:

Study 1: Species effects. Eighteen plots, or six plots per species, were arranged and established in a repeated Latin square design (Fig. 1). The species investigated included one cool-season (perennial ryegrass, *Lolium perenne* L.) and two warm-season turfgrasses (bermudagrass [*Cynodon dactylon*] and zoysiagrass [*Zoysia japonica*]). 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 6 June to 25 October, 2006, using static surface chambers and analyzing N_2O by gas chromatography. Turfgrass irrigation requirements were determined with the Penman-Monteith equation (FAO-56), and all plots were irrigated one or two times weekly as needed, by hand to ensure uniformity. Plots were mowed at 7.62 cm twice a week with a walk-behind rotary mower.

Study 2: Irrigation effects. Eighteen plots were arranged in a previously established sward of perennial ryegrass. Three treatments were applied to the plots in a randomized block design. Irrigation amounts included (1) 100% evapotranspiration (ET) replacement; (2) 80% ET replacement; and (3) no irrigation. To determine irrigation requirements, evapotranspiration (ET) was calculated by using the Penman-Monteith equation (FAO, 1998) and climatological data obtained at a weather station located at Rocky Ford Turfgrass Research Center. Water was applied twice weekly as needed through a fan spray nozzle attached to a hose; a meter was attached to ensure proper application rate. Soil fluxes of N_2O were measured weekly to biweekly using the same technique as described above from 22 June to 17 August, 2006. Plots were mowed at 7.62 cm twice a week with a walk-behind rotary mower.

RESULTS:

Study 1: Species effects. Daily fluxes of N_2O ranged from 8 μg N_2O-N m^{-2} h^{-1} on 25 October to 1709 μg N_2O-N m^{-2} h^{-1} after N fertilization on 11 July (Fig. 2). Nitrogen fertilization increased N_2O emissions by up to 45 times within one day, although the amount of increase differed after each fertilization. Cumulative emissions of N_2O-N during the study differed slightly among species (Fig. 3). Cumulative fluxes were 2.60 kg ha^{-1} in bermudagrass, 2.31 kg ha^{-1} in perennial ryegrass, and 2.63 kg ha^{-1} in zoysiagrass. Thus, cumulative N_2O emissions were very similar between the two warm season turfgrasses (i.e., bermudagrass and zoysiagrass), and cumulative N_2O emissions averaged 13% higher in the warm-season species than in the cool-season turfgrass species. However, because perennial ryegrass was actively growing earlier in the spring than warm-season grasses (e.g., during March, April, and May), before measurements were collected in this study, N_2O emissions may have been greater from perennial ryegrass during that period. Therefore, data collected during this 5-month period likely do not represent cumulative fluxes from the entire season from March through November.

Study 2: Irrigation effects. Significant precipitation during much of the study period muted the effects of reduced and no irrigation on N_2O emissions (Fig. 4). Cumulative N_2O fluxes during the study period decreased by about 8% when irrigation was reduced to 80% ET and when irrigation was withheld, compared with well-watered plots (100% ET). No difference in N_2O emissions was observed between 80% and no irrigation treatments.

Note: These data are preliminary and therefore, not conclusive because the study was still underway at the writing of this report. Results from the completed study will be presented in the 2008 K-State Turfgrass Research Report.

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

	Bermudagrass	Perennial Ryegrass	Zoysiagrass
	.... lbs N 1000 ft^{-2}		
May	1.0	1.0	1.0
June	1.0	--	--
July	1.0	0.5	1.0
August	1.0	--	--
September	--	1.5	--

Figure 1. Plots of perennial ryegrass, zoysiagrass, and bermuda grass were established in 2005 and arranged in a Latin square design. Photo was taken in mid-November 2005, when zoysia and bermuda were dormant.

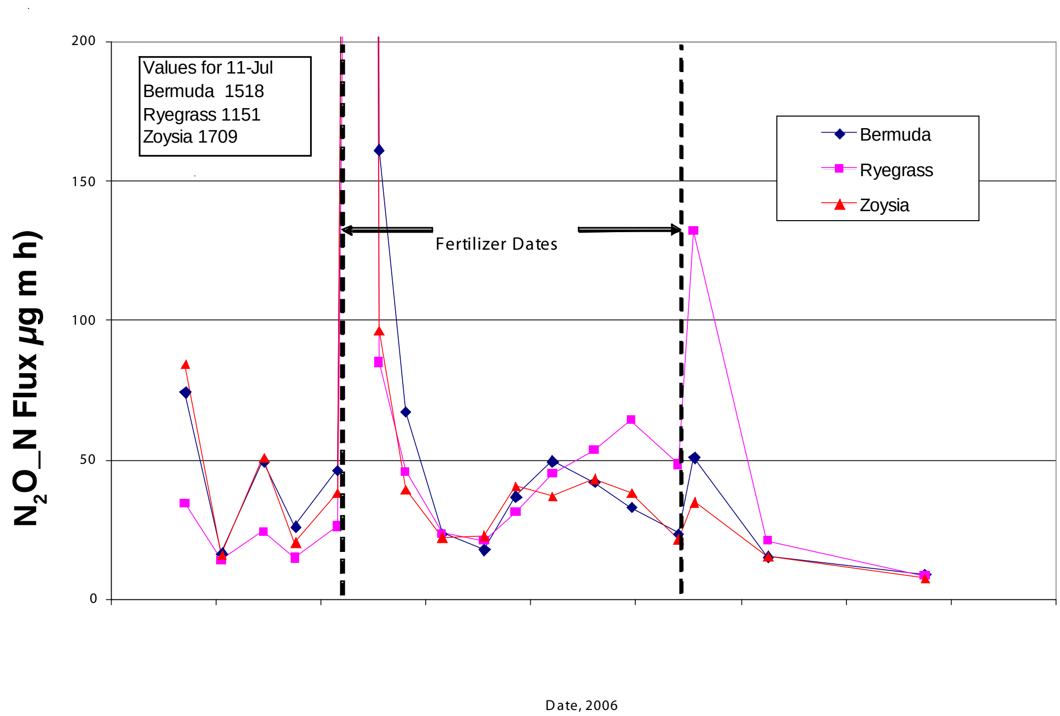

Figure 2. Patterns among turfgrass species of nitrous oxide nitrogen fluxes (μg N_2O_N m^{-2} h^{-1}) from 6 June to 25 October, 2006. Vertical dashed lines represent N-fertilization dates.

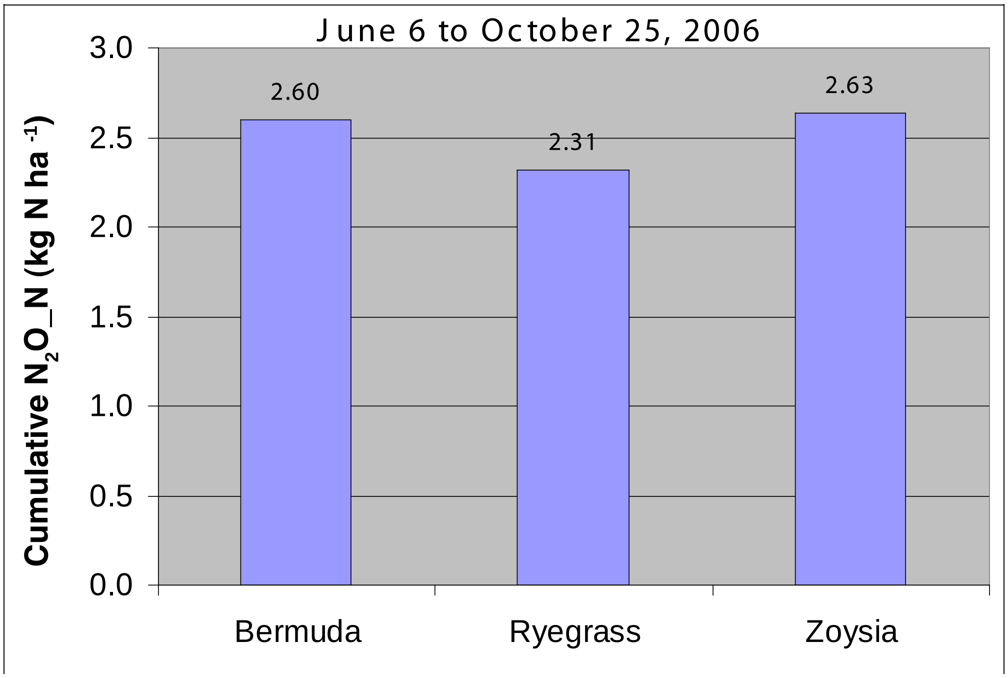

Figure 3. Cumulative emissions of of nitrogen (N_2O_N) from three species of turfgrasses during a 5-month period in the summer and fall of 2006.

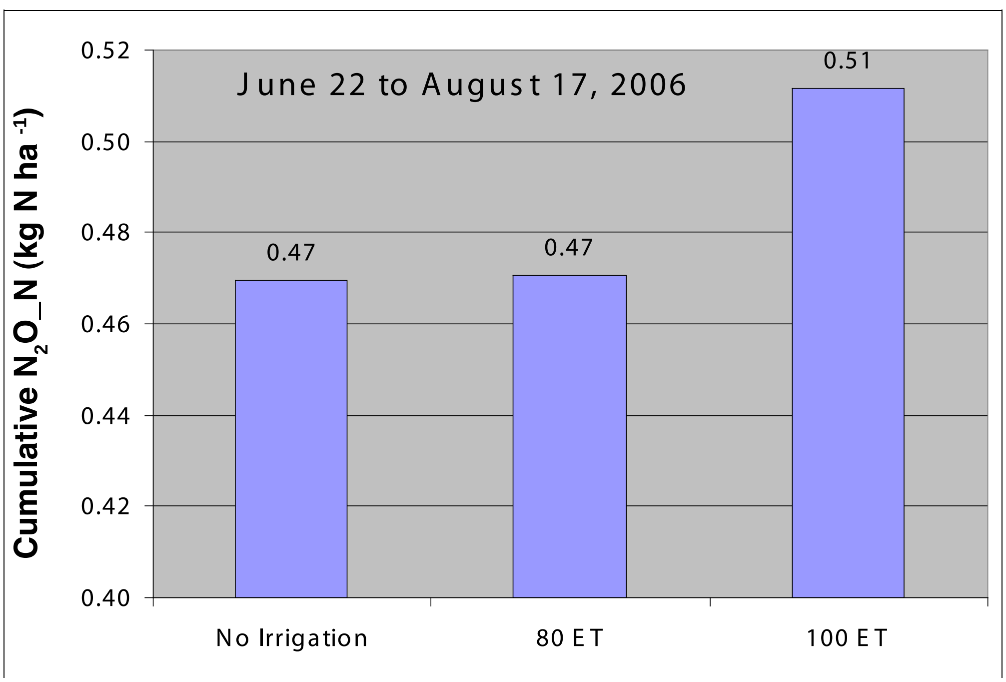

Figure 4. Cumulative emissions of of nitrogen (N_2O_N) from perennial ryegrass under three different irrigation regimes for a 2-month period in the summer of 2006.