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Nitrous Oxide Emissions and Carbon Sequestration in Turfgrass: Effects of Irrigation and Nitrogen Fertilization (Year 2)

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Nitrous Oxide Emissions and Carbon Sequestration in Turfgrass: Effects of Irrigation and Nitrogen Fertilization (Year 2)

Ross Braun and Dale Bremer

Summary. This study was conducted from 2013–2016 to determine how irrigation and N fertilization may be managed to reduce N_2O emissions and enhance carbon sequestration. In this study, annual nitrous oxide (N_2O) emissions were greatest in urea and the least in unfertilized (no N) among treatments. During summer, the lower irrigation treatment resulted in less N_2O emitted. All fertilizer and irrigation treatments maintained acceptable quality and high levels of percent green cover; however, the controlled-release fertilizer resulted in more consistent turf quality and green cover compared to urea and unfertilized. Urea fertilizer had higher peak fluxes after fertilization and overall annual emissions than polymer-coated nitrogen (N) fertilizer. Thus, controlled-release N fertilizers, such as polymer-coated urea, and/or lower irrigation may reduce N_2O emissions in turfgrass.

Rationale. Nitrous oxide (N_2O) and carbon dioxide (CO_2) are important greenhouse gases that have been implicated in global climate change. Turfgrass is typically fertilized with nitrogen (N) and irrigated. Turfgrass has the potential to emit N_2O at similar rates as other agricultural soils and, thus, plays an important role in atmospheric N_2O budgets. Turfgrass also has the capacity to sequester or emit CO_2 from/into the atmosphere via photosynthesis and respiration. The development of management practices, such as controlled-release N fertilizer and/or deficit irrigation, may mitigate N_2O emissions but also affect carbon sequestration in turf soils.

Objective. To quantify the magnitude and patterns of N_2O emissions and carbon sequestration in turfgrass and to determine how irrigation and N fertilization may be managed to reduce N_2O fluxes and enhance carbon sequestration.

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Study Description. This 2-yr field study was conducted under an automated rainout shelter at the Rocky Ford Turfgrass Research Center, Manhattan, KS (Figure 1). By shielding turfgrass from rainfall, researchers can control the amount of water applied to plots. 'Meyer' zoysiagrass was sodded June 4, 2013, and maintained at a 2.54-cm mowing height. During the summer (June-August) of 2014, 2015, and 2016, two irrigation treatments were applied, including medium (66% reference evapotranspiration [ET_0] replacement) and medium-low (33% ET_0 replacement) (Figure 2). Three N-fertilization treatments included urea and polymer-coated urea (PCU), both at 98 kg N hectare (ha^{-1}) yr^{-1} (49 kg N ha^{-1} = 1 lb. N 1000 ft^{-2}) and unfertilized control with no N applied (UF).

Nitrous oxide emissions were measured with static chambers placed over the turfgrass surface and then analyzed with gas chromatography (Figure 3). Measurements began on October 29, 2014 (DOY 302), and continued weekly-to-monthly until October 19, 2016 (DOY 293), concluding the two full years of data. Carbon sequestration in the upper soil profile (0 to 30 cm) was measured by sampling soil C prior to treatments in August 28, 2013, and again at the conclusion of the study in October 2016. Ancillary measurements included soil moisture, temperature, nitrate, ammonium, mowing frequency, visual quality, and percent green cover using digital image analysis.

Results. Greater N_2O emissions resulted from the higher irrigation (66% ET_0) treatment during the summer period; for the combined summer periods from year 1 and year 2, N_2O emissions were 2.88 kg ha^{-1} in 66% ET_0 and 2.71 kg ha^{-1} in 33% ET_0. Overall, the majority of the differences in daily N_2O fluxes and cumulative N_2O emissions were due to the fertilizer main effect. Similar to year 1, cumulative annual emissions of N_2O for year 2 were significantly greatest in urea and least in unfertilized (no N) zoysiagrass among treatments. Annual emissions of N_2O-N for year 2 were 2.24 kg ha^{-1} yr^{-1} in UF, 2.41 kg ha^{-1} yr^{-1} in PCU, and 2.85 kg ha^{-1} yr^{-1} in urea; each statistically different from one another. Cumulative emissions of N_2O-N for the entire 2-yr period were 4.06 kg ha^{-1} in UF, 4.5 kg ha^{-1} in PCU, and 5.62 kg ha^{-1} in urea, each statistically different from one another (Figure 4). Annual emissions were similar to those reported in other turfgrass studies, which generally ranged from 1 to 3.85 kg N_2O-N ha^{-1} yr^{-1} across various turfgrass species and under different fertilization regimes (Bremer, 2006; Kaye et al., 2004; Lewis and Bremer, 2013). Over the 2-yr study, the percentage of applied N fertilizer emitted as N_2O in this study was 2.3% from polymer-coated urea (PCU) and 2.9% from urea fertilizer. The highest fluxes and majority of emissions occurred in the summer because of the fertilization events and, presumably, higher soil temperatures. There were spikes after applications of urea fertilizer, but increases were much smaller with application of controlled-release (PCU) N fertilizer. Both urea and controlled-release N fertilizer treatments resulted in higher turfgrass quality than the unfertilized control; however, all three treatments maintained acceptable turfgrass quality and greater than 75% percent green cover during deficit irrigation treatments in 2016 (Figures 5 and 6). After a

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3-yr period, zoysiagrass exhibited enhanced soil organic carbon content and an average carbon sequestration rate 0.952 of Mg C ha^{-1} yr^{-1}.

References

Bremer, D.J. 2006. Nitrous oxide fluxes in turfgrass: Effects of nitrogen fertilization rates and types. J. Environ. Qual. 1678-1685.

Kaye, J.P., I.C. Burke, A.R. Mosier, and J.P. Guerschman. 2004. Methane and nitrous oxide fluxes from urban soils to the atmosphere. Ecol. Appl. 14:975-981.

Lewis, J.D. and D.J. Bremer. 2013. Different nitrogen management regimes affect nitrous oxide emissions among one cool-season and two warm-season turfgrasses. Int. Turf. Soc. Res. J. 12:31-38.

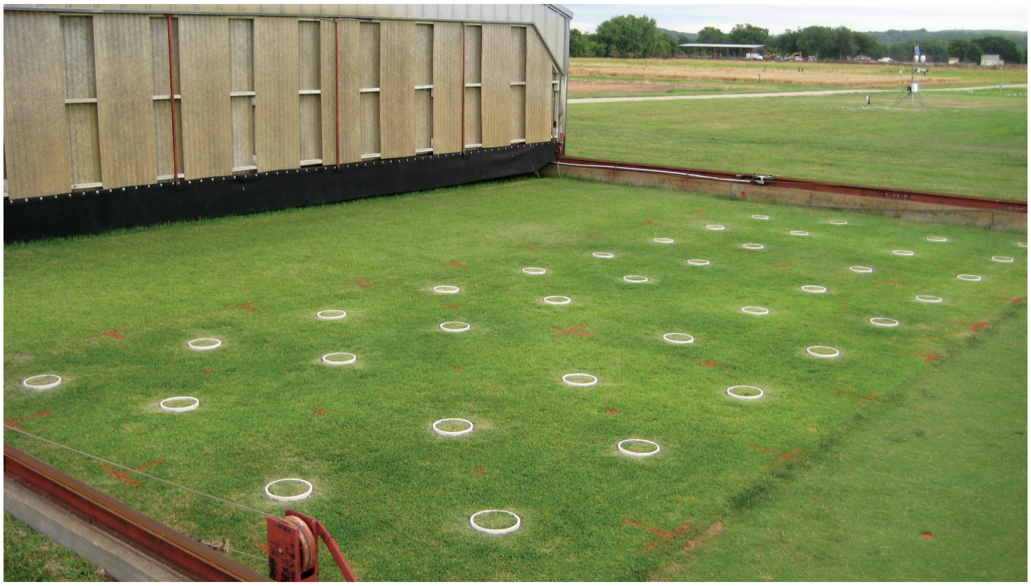

Figure 1. Automated rainout shelter that is activated by 0.254 mm of rain.

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Figure 2. Plots received precise irrigation amounts based on daily reference evapotranspiration during the summer period.

Figure 3. Close-up of one of twelve static chambers and vials used for sampling N_2O.

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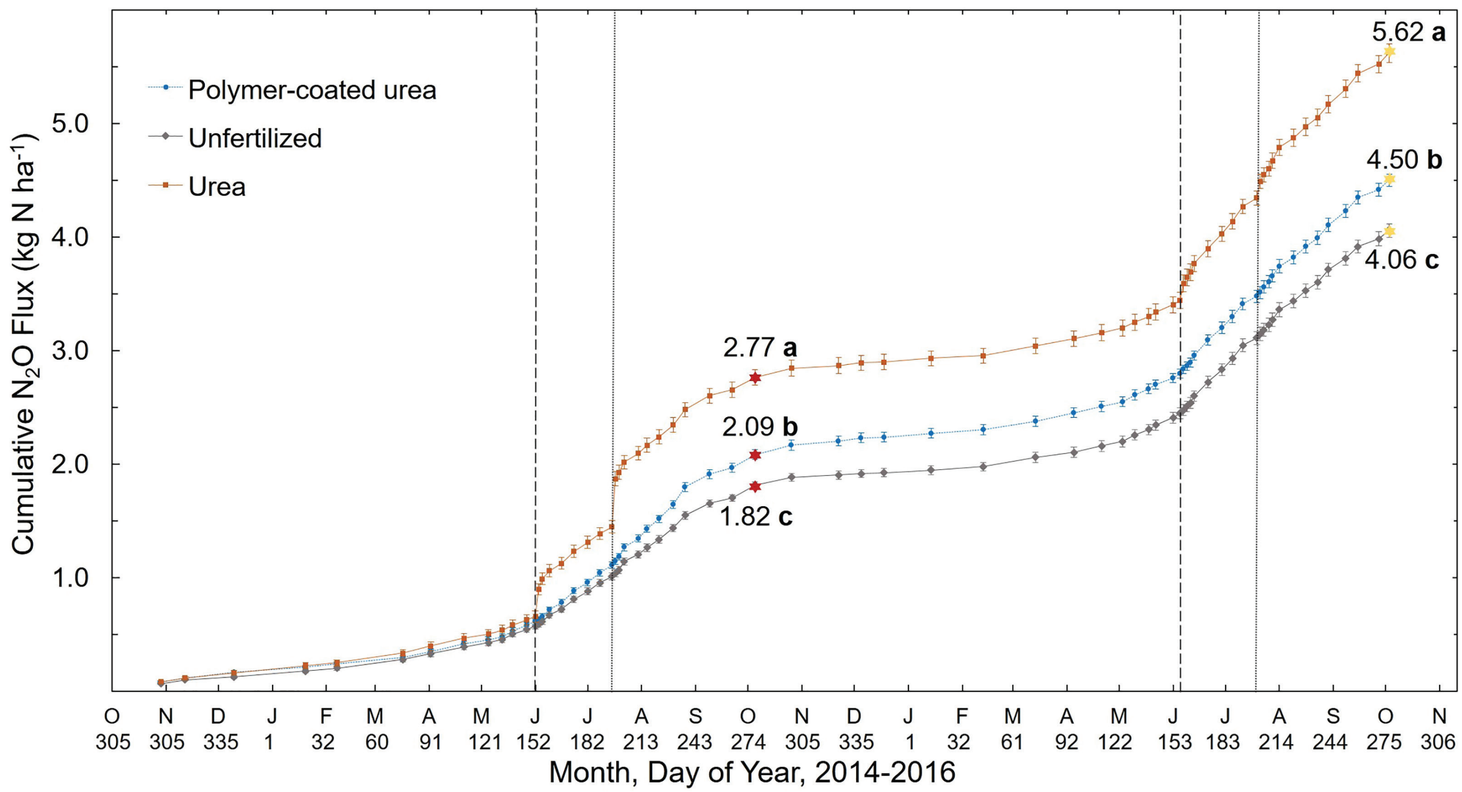

Figure 4. Cumulative fluxes of N_2O-N over a two-year period from zoysiagrass plots treated with polymer-coated urea, unfertilized (no fertilizer), and urea under an automatic rainout shelter in Manhattan, KS. Dashed vertical lines at June dates represent fertilization (urea (46-0-0) applied a rate of 49 N hectare (ha^{-1}) yr^{-1} (49 kg N ha^{-1} = 1 lb. N 1000 ft^{-2}) and polymer-coated urea fertilizer (41-0-0) applied at a rate of 98 kg N ha^{-1}. Dotted vertical lines at July dates represent the 2nd urea application at a rate of 49 kg N ha^{-1}. Vertical error bars at each mean represent the standard error of the mean. At each date (the end of year 1 and the end of the two-year study), means followed by the same letter are not significantly different according to Fisher's protected least significant difference ($P \leq 0.05$).

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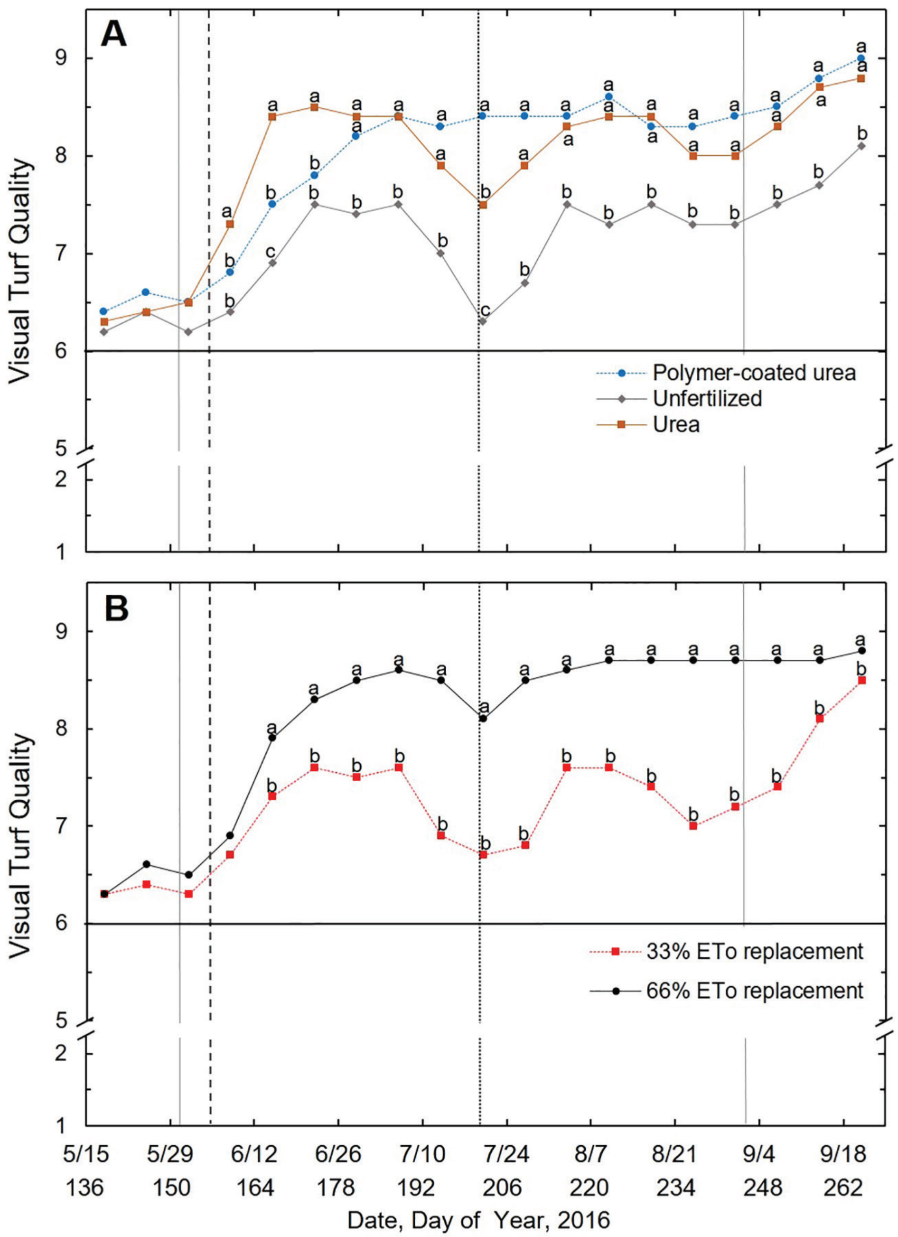

Figure 5. Effects of the (A) fertilizer main effect and (B) irrigation main effect on visual turf quality of zoysiagrass in Manhattan, KS, in 2016. Solid vertical lines represent the summer period when the rainout shelter was activated to prevent precipitation on plots and irrigation treatments were applied twice a week by hand-watering. Dashed vertical line at June 6 represents fertilization (urea (46-0-0) applied a rate of 49 kg N hectare (ha^{-1}) yr^{-1} (49 kg N ha^{-1} = 1 lb. N 1000 ft^{-2}) and polymer-coated urea fertilizer (41-0-0) applied at a rate of 98 kg N ha^{-1}. Dotted vertical line at July 20 represents the 2nd urea application at a rate of 49 kg N ha^{-1}. Solid horizontal black line signifies minimum rating for acceptable turf quality. Within each main effect, means at each date with the same letter are not significantly different according to Fisher's protected least significant difference (P ≤ 0.05).

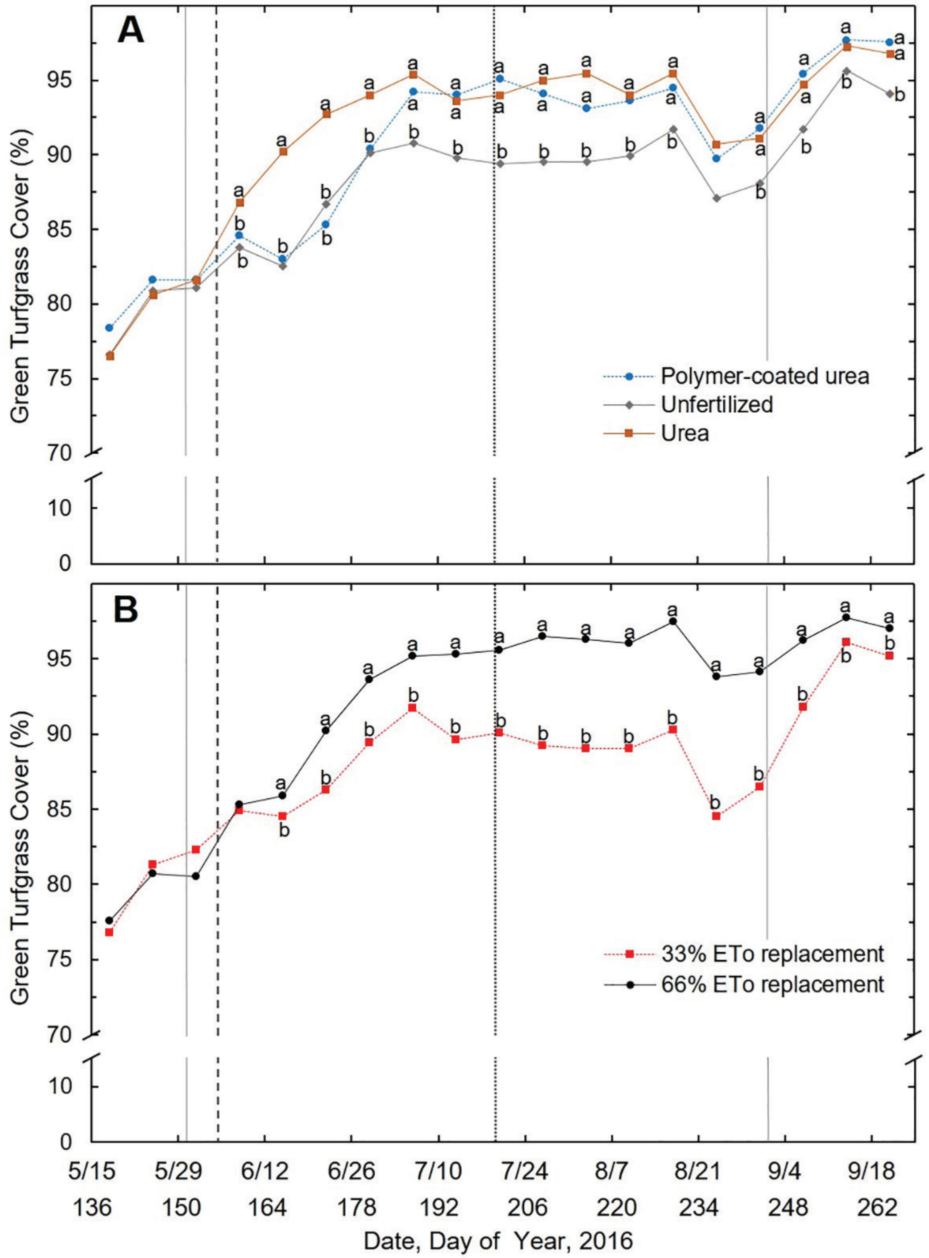

Figure. 6. Effects of the (A) fertilizer main effect and (B) irrigation main effect on percent green turfgrass cover of zoysiagrass in Manhattan, KS, in 2016. Solid vertical lines represent the summer period when the rainout shelter was activated to prevent precipitation on plots and irrigation treatments were applied twice a week by hand-watering. Dashed vertical line at June 6 represents fertilization (urea (46-0-0) applied a rate of 49 kg N hectare (ha^{-1}) yr^{-1} (49 kg N ha^{-1} = 1 lb. N 1000 ft^{-2}) and polymer-coated urea fertilizer (41-0-0) applied at a rate of 98 kg N ha^{-1}. Dotted vertical line at July 20 represents the 2nd urea application at a rate of 49 kg N ha^{-1}. Within each main effect, means at each date with the same letter are not significantly different according to Fisher's protected least significant difference ($P \leq 0.05$).

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