Nitrous Oxide Emissions and Carbon Sequestration in Turfgrass: Effects of Irrigation and Nitrogen Fertilization

Dale Bremer, Ross Braun, and Jack Fry
Kansas State University

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Objectives:

1. *The main goals include evaluating the effects of irrigation on N_2O emissions and CO_2 fluxes over two years.*
2. *Cumulative N_2O emissions among treatments will be estimated over the entire study to determine how much emissions can be reduced under various irrigation levels.*
3. *The effects of irrigation on turfgrass quality and survivability will also be evaluated. Fluxes of CO_2 will be investigated with emphasis given to rates of photosynthesis (CO_2 intake) compared with respiration (CO_2 emissions) to determine the irrigation level(s) with the greatest likelihood of sequestering more carbon.*

Nitrous oxide (N_2O) and carbon dioxide (CO_2) are important greenhouse gases that have been implicated in global climate change. Nitrous oxice is also the most important ozone-depleting substance in the atmosphere. Turfgrass is typically fertilized with nitrogen (N) and irrigated, which may result in significant N_2O emissions. Turfgrass also has the capacity to sequester or emit CO_2 from/into the atmosphere via photosynthesis and respiration. Because turfgrass covers ~50 million acres in the USA, turfgrass may have significant impacts on global atmospheric N_2O and CO_2 inventories.

The development of management practices that reduce N_2O emissions from turfgrass and enhance carbon sequestration in turf soils may help mitigate climate change and atmospheric ozone destruction. The use of slow-release N fertilizer may mitigate N_2O emissions from turf by reducing ammonium and nitrate levels in the soil immediately after fertilization. Deficit irrigation may mitigate N_2O emissions by reducing denitrification in turfgrass soils, although deficit irrigation may also reduce carbon (C) sequestration by its impact on CO_2 fluxes (e.g., reducing photosynthesis and increasing respiration).

Figure 1. Plots of Meyer zoysiagrass protected from rainfall by an automated rainout shelter. The white rings (one per plot) are PVC collars driven into the ground, on which static chambers are mounted when collecting N_2O flux measurements.

The primary goals of this study are to quantify the magnitude and patterns of N_2O emissions in turfgrass and determine how irrigation and N fertilization may be managed to reduce N_2O emissions and enhance carbon sequestration. Carbon sequestration and N_2O fluxes will be measured in 'Meyer' zoysiagrass (Z. japonica) managed under deficit irrigation and fertilized with urea or slow-release N. Zoysiagrass is a warm-season turfgrass species that provides an excellent golfing surface that is commonly used for tees, fairways, and roughs in the transition zone. Fewer inputs are required in zoysiagrass, which may minimize its impacts on the environment compared to other turfgrasses.

The study is being conducted under an automated rainout shelter near Manhattan, Kansas (Figure 1). By shielding rainfall from turfgrass, researchers can control the amount of water applied to plots. Zoysiagrass was

Figure 2: The first measurements of N_2O emissions were obtained October 6, 2014. In the foreground, static chambers are mounted on the collars during N_2O flux measurements.

sodded June 4, 2013. During summer (June-Aug) 2014, two irrigation treatments were applied, including medium (80% evapotranspiration [ET] replacement) and medium-low (60% ET replacement). Three N-fertilization treatments included urea and polymer-coated N, both at 2 lb/1000 ft^2, and a control with no N applied. Because little drought stress was observed in the 60% ET treatment, irrigation amounts in that treatment may be reduced.

Measurements of N_2O emissions began October 6, 2014 and will continue weekly-to-monthly over 2 years with static chambers placed over the turfgrass surface and using gas chromatography (Figure 2). Carbon sequestration in the upper soil profile (0 to 12 inches) will be measured by sampling soil C at the beginning and end of the 3-year study; initial soil C was measured on Aug. 28, 2013. Ancillary measurements include soil moisture, temperature, nitrate and ammonium, visual quality, and percent green cover.

Summary Points:

- Carbon sequestration and N_2O emissions will be measured weekly to monthly for 2 years from plots receiving two irrigation and three N fertilization treatments.
- Initial measurements of soil C were obtained (0 to 12 inch profile) August 28, 2013.
- Initial N_2O flux measurements were obtained October 6, 2014.
- Results are expected to provide golf course superintendents with information on specific irrigation levels and N types that could reduce N_2O emissions and enhance carbon sequestration in zoysiagrass fairways and roughs.