Characterization of reactive nitrogen emissions from turfgrass systems

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Abstract

This study was aimed at characterizing seasonal emissions of three reactive nitrogen species, i.e., ammonia (NH_3), nitric oxide (NO), and nitrous oxide (N_2O), from turfgrass systems. Soil emissions were measured using the dynamic chamber approach with three N fertilizer levels: 0, 36.5, and 73 kg N ha^{-1}. Seasonal intensives indicate a wide range of emissions for NH_3 (5.8-93.4 ng N m^{-2} s^{-1}), NO (2.0-47.9 ng N m^{-2} s^{-1}), and N_2O (15.3-35.0 ng N m^{-2} s^{-1}). Highest NH_3 and NO emissions were observed from the highest N fertilizer treatment, while the relationship between N_2O emissions and fertilizer amount was less consistent.

Keywords: reactive nitrogen, turfgrass, N fertilizer

1. Introduction

Intensive use of irrigation, fertilizers, and pesticides for maintaining the aesthetic value of turfgrass is often viewed as an environmental impact, particularly with respect to carbon and nitrogen biogeochemical cycles. This study was conducted at the Lake Wheeler Turfgrass Field Laboratory in Raleigh, NC and seasonal emissions of three reactive nitrogen (Nr) species, i.e., ammonia (NH_3), nitric oxide (NO), and nitrous oxide (N_2O), from turfgrass over the course of one year.

2. Measurement methods

Soil emissions were measured using the dynamic chamber approach following a randomized complete block design with 10 replicates of three N fertilizer levels (2.3% ammoniacal N, 22.7% urea N). Emissions of NH_3 and NO were measured continuously using a chemiluminescence analyser, while discrete air samples are collected for N_2O analysis using a gas chromatography equipped with an electron capture detector.

3. Reactive nitrogen emissions

Overall, NH_3 emissions accounts for about 47% of the total Nr emissions measured in this study. The highest emissions were observed during Summer, followed by Fall, Winter and Spring.

The NO emissions from this study was the smallest among all species, which accounted for 23% of the total Nr measured emissions. The highest NO emissions occurred during Fall, followed by Summer, Winter and Spring.

Emissions of N_2O contributed to 30% of the total Nr emissions. The highest N_2O emission observed during Spring, whereas the lowest occurred in Winter. There is no obvious temperature-related period in which N_2O was predominantly emitted. In addition, there is no discernable pattern shown from the N fertilizer treatment on N_2O emissions.

4. Effects of soils condition

Soil conditions affect Nr emissions through their effects on regulating N cycling processes, particularly processes that involve microbial activity (Bauer et al., 2012; Izaurralde et al., 2017; Shi et al., 2006a, 2006b). Soil temperature was used as a surrogate, as chemical reactions in the soils driven by soil microbes are temperature dependent (Firestone and Davidson, 1989; Bijoor et al., 2008; Schlesinger and Bernhardt, 2013). The results suggest that the emissions of all Nr species are positively correlated with the soil temperature. Of the three species, however, the correlation between N_2O emission and soil temperature is the weakest, indicating N_2O emissions are less sensitive to the change of soil temperature.

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