Characterization of Dissolved Organic Nitrogen in Leachate from a Newly Established and Fertilized Turfgrass

Lusk, M.G. (U. of Florida, Soil and Water Sciences); Toor, G.S. (U. of Maryland, Environmental Science and Technology); Inglett, P.W. (U. of Florida, Soil and Water Sciences)

Introduction

We investigated the fate of fertilizer nitrogen (N) applied to a newly-established St. Augustine turfgrass. St. Augustine is the dominant urban land cover in Florida, and understanding the fate of N applied via fertilizers to urban turfgrass is an important part of developing urban landscape practices that reduce N losses via leaching to groundwater. While losses of inorganic N (nitrate and/or ammonium) have been widely studied for turfgrass systems, very few studies have quantified organic N losses from urban turf, limiting N mass balance studies and our ability to fully constrain the fate of fertilizer N in urban ecosystems. Our specific objective was to quantify the leaching losses of dissolved organic N (DON) from St. Augustine turfgrass that was amended with N fertilizer as either urea or ammonium sulfate, with the goal of better constraining the total N mass balance. Additionally, we used FTICR-MS to characterize the molecular composition of leached DON, as a preliminary investigation of the chemical characterization of bulk DON leached from an urban ecosystem.

Experimental

Soil lysimeters were packed with a Seffner fine sand soil and sodded with St. Augustine turfgrass. Turf was treated with labeled ^{15}N urea or ammonium sulfate N fertilizer at a rate consistent with University of Florida/IFAS fertilizer recommendations and grown for 92 days during a summer rainy season. Lysimeters were placed outside and exposed to natural rainfall and only irrigated as necessary to maintain at least 1 inch of water per week. The isotopically labeled N was traced in the following environmental pools: lysimeter leachate, soil, sod/thatch, and grass clippings. Positive-mode atmospheric pressure photoionization, using the 9.4 T FTICRMS, was employed to identify various biomolecular classes in the leached dissolved organic N (DON) from one lysimeter for each treatment and a non-fertilized control.

Results and Discussion

The ^{15}N fertilizer recovery was greatest in soil (44-48%), followed by sod/thatch (18-33%), grass clippings (10-13%), and leachate (<3%). A fraction of ammonium sulfate fertilizer was recovered as DON in the leachate, likely after uptake and conversion of inorganic fertilizer to organic plant exudates and/or microbial byproducts. FTICR-MS identified N-bearing organic molecular formulas in the leachate from urea and ammonium sulfate treatments, providing evidence of N leaching from newly established turfgrass of DON compounds in a range of biomolecular compositions such as lipid-, protein-, carbohydrate-, and lignin-like molecules. Van Krevelen plots of DON formulas identified in the leachate indicate that fertilizer treatments may shift the molecular character of leached organic N, and future work should be done to further characterize the mechanisms, extent, and ecological implications of these potential changes to the bulk DON pool exported from urban turfgrass systems.

Management Implications

One important implication of this work is that a portion of the inorganic N added to urban landscapes as fertilizer will be recovered as DON, likely root or microbial exudates. We observed portions of the fertilizer N in leached DON pools just days after adding fertilizer, and these materials may be sources of reactive N to groundwater. A second important implication of this work is that the newly established turfgrass system leached very little inorganic N, even during the summer rainy season. Our findings suggest that urban watersheds have a high capacity for inorganic N retention, especially during the season of active turf growth. However, increased N mineralization with time has been reported for turfgrass soils, such that N retention in turfgrass systems may decrease as the turf ages.

Acknowledgements

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References

[1] Lusk, M. G., *et al*., Water Research, **131**, 52-61 (2018).