Nitrogen Release and Mineralization Rates of Various Fertilizers Applied on Kentucky Bluegrass

RFR-A2036

AJ Lindsey, graduate research assistant
Adam Thoms, assistant professor
Nick Christians, university professor
Ben Pease, research scientist
Department of Horticulture

Introduction

Enhanced efficiency fertilizers (EEF) allow increased plant uptake and reduce the potential of nutrient losses to the environment. This can be achieved by considering a controlled/slow release fertilizer or by using nitrification/urease inhibitors, which slow the conversion of nitrogen. Humic substances are organic compounds that have been shown to improve nutrient availability for plant absorption, increase soil water holding capacity, and increase cation exchange capacity of soils. There are many claims of the benefits of humic products on turfgrass, which include increased nutrient uptake and efficiency and increased effectiveness of fertilizers. The objective of this study is to determine if the addition of humic substances and poly/humic coatings can be classified as an EEF.

Materials and Methods

Research was conducted at the Iowa State University Horticulture Research Station, Ames, Iowa, on Kentucky bluegrass (*Poa pratensis* L.) growing on native soil. Turf was maintained at a 3-in. mowing height and received irrigation as needed.

Two experiments were conducted: 1) mesh bag technique to determine the percent of nitrogen (N) released of the fertilizers used in this study; and 2) ion exchange resin membranes (ion strips) to determine the N availability.

The mesh bag technique experimental design was a randomized complete block with four replications. Treatments included humic-coated urea (HCU), poly-coated humic-coated urea (PCHCU), urea + humic dispersing granules (HDG), XCU (slow-release fertilizer), Uflexx (stabilized nitrogen fertilizer), and urea. Mesh bags were made of polyethylene (1mm^2 hole openings) and filled with 3.5 g N. Fertilizer treatments were in separate mesh bags. Each fertilizer treatment was buried April 15, 2019 and 2020. Mesh bags were collected at 7, 14, 28, 56, 84, 112, and 168 days after buried (DAB). Fertilizer was removed from mesh bags, separated from the soil, and then weighed. Only PCHCU and XCU had fertilizer remaining in the mesh bag after the first collection date (7 DAB). Thus, only PCHCU and XCU were analyzed. Percent N released was determined using the weight-loss method. PCHCU and XCU were fit to a non-linear equation to determine the release curve. The best fit non-linear function was determined with the model having the lowest error sum of squares.

The ion strip experimental design was a randomized complete block with four replications. Ion strips were used to determine the amount of inorganic N accumulated over time. Ion strips act as “super sinks” for inorganic N in the soil. The dimensions of the ion strips were 2 by 4 cm. One cation and one anion ion strip were placed in the soil in randomly assigned locations within each plot. Fertilizer treatments were applied to the surface of each plot. Fertilizer treatments included the same as the mesh bag technique along with a nontreated control (Table 1). Ion strips were collected and replaced monthly. Collected ion strips were cleaned using deionized water and extracted using 2 M KCl. Ammonium and nitrate concentrations were measured using colorimetric analysis on a microplate reader. Turfgrass visual quality ratings (1-9, 6 minimally acceptable), percent green cover, and dark green color index (DGCI) were taken biweekly April-November 2019 and 2020. Digital images were collected with a light box and a digital camera. Digital image analysis was performed to get percent green cover and DGCI. All data were analyzed using SAS at the 0.05 level of significance and means separated with Fisher's LSD (least significant difference).

Results and Discussion

There was not a year by treatment interaction for percent green cover, resin membrane captured NO_3-N, NH_4-N, and total inorganic N in the ion strip experiment. The data were combined over years. Overall, all treatments had a higher percent cover compared with the nontreated (Table 2). PCHCU, XCU, and urea + HDG had the highest percent green cover. PCHCU also had the greatest cumulative resin membrane NO_3-N and total inorganic N. Uflexx resulted in similar total inorganic N compared with PCHCU.

A significant year by treatment interaction occurred for the percent N release for PCHCU, but not for XCU. XCU percent N release was combined over years. PCHCU had a slower N release rate compared with XCU (Figure 1). The PCHCU percent nitrogen release (NR) curve in 2019 was fit using the gompertz function, NR = A*EXP(-B*EXP(-C*day)), with A = 73.32, B = 11.65, and C = 0.06. The PCHCU NR curve in 2020 was fit using the logistic function, NR = A/(1 + B*EXP(-C*day)), with A = 101.7, B = 9.99, and C = 0.07. The XCU NR curve (XCU-Mono) was fit using the monomolecular function NR = A*(1 — B*EXP(-C*day)), with A = 100.8, B = 1.01, and C = 0.06. Both PCHCU and XCU show an extended release curve with PCHCU having a greater release period (Table 3).

Acknowledgements

The authors would like to thank Anthony "Tony" Goldsby (The Andersons, Inc., Maumee, OH) for his assistance and for providing the products used in this research. Appreciation is extended to Simon Mitbo, Colin Laswell, Nathan Underwood, and Ethan DenBeste for their help with experimental setup, data collection, and plot maintenance.

Table 1. List of fertilizer treatments and fertilizer application rates for the ion strip experiment, Ames, Iowa.

Treatment	Application rate[1]
Humic coated urea (HCU)	1 lb N 1,000 sq. ft.$^{-1}$
Poly-coated humic-coated urea (PCHCU)	1 lb N 1,000 sq. ft.$^{-1}$
Urea + humic dispersing granules (HDG)	1 lb N 1,000 sq. ft.$^{-1}$ + 0.92 lb HDG 1,000 sq. ft.$^{-1}$
XCU	1 lb N 1,000 sq. ft.$^{-1}$
Uflexx	1 lb N 1,000 sq. ft.$^{-1}$
Urea	1 lb N 1,000 sq. ft.$^{-1}$
Nontreated	-

[1]Treatments applied April 29 and May 27, 2019 and 2020.

Table 2. Effect of various fertilizers on Kentucky bluegrass percent green cover and cumulative means of resin membrane NO_3-N, NH_4-N, and total inorganic N in 2019 and 2020, Ames, IA.

Treatment	Green cover[1]	Resin NO_3-N[2]	Resin NH_4-N	Total inorganic resin N
	%	μg NO_3^--N cm^{-2}	μg NH_4^+-N cm^{-2}	μg $(NO_3^- + NH_4^+)$-N cm^{-2}
Humic coated urea (HCU)	89.2	0.31	1.29	1.60
Poly-coated humic-coated urea (PCHCU)	90.6	0.94	1.23	2.17
Urea + humic dispersing granules (HDG)	89.9	0.57	1.24	1.81
XCU	90.0	0.43	1.35	1.79
Uflexx	88.7	0.59	1.34	1.93
Urea	88.8	0.42	1.27	1.69
Nontreated	87.1	0.36	1.26	1.63
$LSD_{0.05}$	1.1	0.21	NS[3]	0.31

[1]Percent green cover was determined with digital image analysis.
[2]Ammonium and nitrate concentrations were measured using colorimetric analysis on a microplate reader.
[3]NS, nonsignificant.

Table 3. Non-linear equation parameters for PCHCU and XCU percent nitrogen release (NR) curves.

Treatment	A	B	C
Poly-coated humic-coated urea (PCHCU), 2019[1]	73.32	11.65	0.06
PCHCU, 2020[2]	101.70	9.99	0.07
XCU[3]	100.80	1.01	0.06

[1]Gompertz function, NR = A*EXP(-B*EXP(-C*day)).
[2]Logistic function, NR = A/(1 + B*EXP(-C*day)).
[3]Monomolecular function, NR = A*(1 - B*EXP(-C*day)).

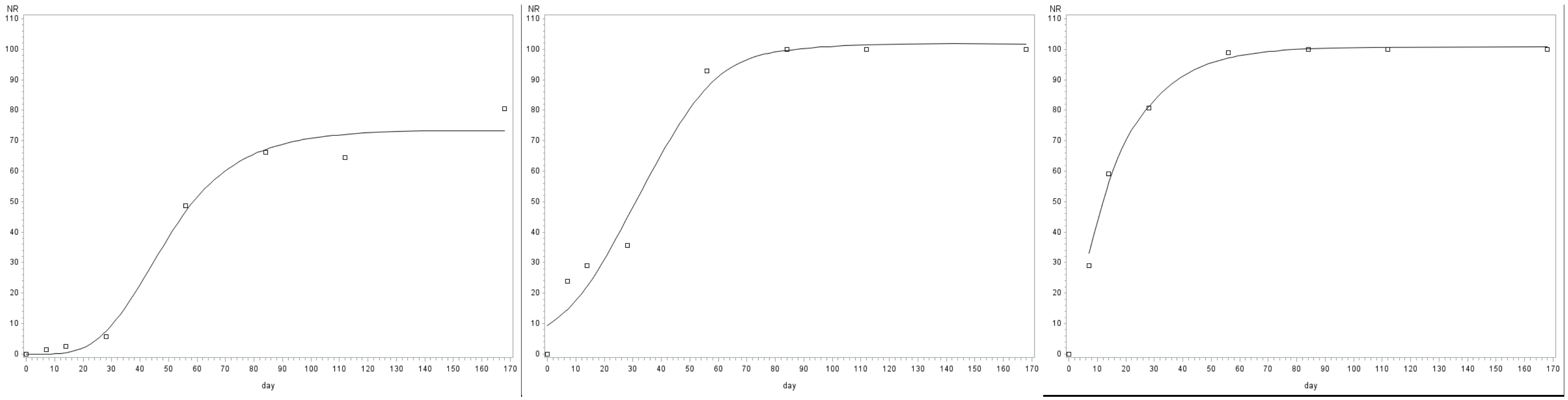

Figure 1. (Left) Nitrogen (N)-release curve for poly-coated humic-coated urea (PCHCU) in 2019. (Middle) N-release curve for PCHCU in 2020. (Right). N-release curve for XCU combined across years. Percent N release determined by using the mesh bag weight loss technique.