Evaluation of Humic Fertilizers on Soil Health with Creeping Bentgrass on a USGA Root Zone

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Introduction

Improving soil health has gained popularity in recent years. 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 a better-developed root system, improved stress tolerances, increased nutrient uptake and efficiency, improved soil structure, and increased effectiveness of fertilizers. However, minimal research has been conducted to substantiate these claims. The objective of this study is to evaluate soil health parameters of a sand-based turfgrass fertilized with humic substances.

Materials and Methods

Research was conducted at the Iowa State University Horticulture Research Station, Ames, Iowa, on a Penncross creeping bentgrass (*Agrostis stolonifera* L.) putting green established over a root zone meeting United States Golf Association (USGA) specifications. Turf was maintained at a 0.140 in. mowing height (mowed six times/week) and received irrigation as needed to minimize turfgrass stress. Preventive fungicides were applied for dollar spot and Pythium blight.

The experimental design was a randomized complete block with three replications. Fertilizer treatments included humic-coated urea (HCU at two rates), HCU + humic dispersing granules (HDG), HCU + black gypsum (BG), urea, HDG, and a nontreated control (Table 1).

Soil parameters measured included microbial biomass carbon (C) and nitrogen (N), potential net N mineralization, nutrient concentrations, pH, cation exchange capacity (CEC), percent organic matter, volumetric water content, soil compaction, and potential C mineralization. Microbial biomass was determined using the fumigation-extraction method. Microbial biomass carbon and microbial biomass nitrogen were measured using a Shimadzu TOC analyzer. Potential net N mineralization was determined by obtaining inorganic N concentrations before and after a two-week soil incubation. Ammonium and nitrate concentrations were measured using colorimetric analysis on a microplate reader. Turfgrass visual quality (1-9, 6 minimally acceptable) was collected biweekly from April-October 2019 and 2020. Nutrient concentrations, pH, CEC, and organic matter was determined by sending soil samples to Solum, Inc. (Ames, IA) and SureTech Laboratories (Indianapolis, IN). Soil volumetric water content was measured using a FieldScout TDR Meter with 3-in. probes. Soil compaction was measured using a Turf-Tec Penetrometer. Potential C mineralization was determined by measuring the CO_2 produced through a soil incubation. The CO_2 concentration was determined using a LiCor-830 CO_2 analyzer (Lincoln, NE). All data was analyzed using SAS at the 0.05 level of significance and means separated with Fisher's LSD (least significant difference).

Results and Discussion

No differences between treatments were found for volumetric water content and soil compaction (data not shown). There was no treatment effect on microbial biomass C, phosphorus and potassium concentrations, pH, CEC, and potential net N mineralization (Table 2). However, there was a treatment effect on microbial biomass N and soil organic matter. The treatments resulting in the highest microbial biomass N were HCU + HDG and HCU + BG. HCU (low rate) provided the greatest soil organic matter relative to all other treatments other than HCU + HDG. Lab work is currently being conducted to determine the potential C mineralization between treatments.

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Table 1. List of fertilizer treatments, application rates, and application timing in 2019 and 2020, Ames, Iowa.

Treatment	Application rate	Application timing
Humic-coated urea (HCU)	0.15 lb N 1,000 sq. ft.$^{-1}$	April-October (2-wk intervals)
HCU	0.10 lb N 1,000 sq. ft.$^{-1}$	April-October (- wk intervals)
HCU + humic dispersing granules (HDG)	0.15 lb N 1,000 sq. ft.$^{-1}$ + 1.14 lb HDG 1,000 sq. ft.$^{-1}$	HCU: April-October (2-wk intervals) HDG: April, May, Sept., Oct.
HCU + black gypsum (BG)	0.15 lb N 1,000 sq. ft.$^{-1}$ + 3 lb BG 1,000 sq. ft.$^{-1}$	HCU: April-October (2-wk intervals) BG: April, July, Oct.
Urea	0.15 lb N 1,000 sq. ft.$^{-1}$	April-October (2-wk intervals)
HDG	1.14 lb HDG 1,000 sq. ft.$^{-1}$	April, May, Sept., Oct.
Nontreated	-	-

Table 2. Effect of various fertilizers on soil parameters of creeping bentgrass putting green established on a United States Golf Association (USGA) specification root zone in 2019 and 2020, Ames, Iowa.

Treatment	Microbial biomass carbon[1]	Microbial biomass nitrogen (N)	Phosphorus[2]	Potassium	pH	CEC	Organic matter	Potential net N mineralization[3]
	mg kg^{-1}	mg kg^{-1}	ppm	ppm		cmol$_c$ kg^{-1}	%	mg N kg^{-1}
Humic-coated urea (HCU)	357[4]	49	11	53	7.3	12	2.6	6.5
HCU	393	52	11	49	7.4	11	3.1	5.2
HCU + humic dispersing granules (HDG)	372	59	11	53	7.4	11	2.8	6.0
HCU + black gypsum (BG)	389	57	11	46	7.4	12	2.7	5.8
Urea	376	49	12	57	7.3	11	2.7	5.5
HDG	337	44	10	47	7.4	11	2.5	4.6
Nontreated	348	47	11	51	7.4	12	2.4	4.9
LSD$_{0.05}$	NS[5]	11	NS	NS	NS	NS	0.3	NS

[1]Microbial biomass carbon and nitrogen were determined using the fumigation-extraction method.
[2]Soil samples collected May 13, 2019 and 2020 (after one fertilizer application) and October 31, 2019 and 2020 (end of field season). Phosphorus and potassium concentrations, pH, cation exchange capacity (CEC), and organic matter values determined by Solum, Inc. (Ames, IA) and SureTech Laboratories (Indianapolis, IN).
[3]Potential net N mineralization was measured by inorganic N extraction before and after a 2-week incubation.
[4]No interaction between year, sampling date, and treatment effect, means are pooled across years and dates.
[5]NS = nonsignificant.