Spatial Distribution of Organic Matter and Soil Properties in the Rootzones of Aging Putting Greens

Deying Li
North Dakota State University

Roch Gaussoin
University of Nebraska

Objectives:

1. Evaluate the soil chemical properties such as cation exchange capacity (CEC), mineralizable N, and pH as affected by treatments during the grow-in period and age of the putting green.
2. Analyze the decomposition of soil organic matter (lignin and cellulose) and to understand its spatial distribution and the effects on soil chemical properties.

Start Date: 2008
Project Duration: 2 years
Total Funding: $6,000

The chemical and physical properties of a putting green rootzone can be largely altered by the changes of organic matter over time. Meanwhile, spatial distribution and decomposition of organic matter, both quantity and quality, may be reflected from the soil fertility. Not only the turf quality, but also the fate of chemicals is affected by the status of soil properties. Environment and cultural practices influences the dynamics of soil properties. However, little information is available for the soil organic matter with depth-based analysis of putting green rootzone mixtures.

The first part of this study was aimed at investigating space variations of selected soil properties which are used as measures (indicators) of soil organic matter. The second part focused on testing the potential of using Fourier transorm infrared spectroscopy (FTIR) in predicting soil properties.

Soil samples in this study were collected in 2006 from four experimental putting greens that were constructed in sequential years from 1997 to 2000 in University of Nebraska. Putting green age was 6, 7, 8 and 9 years old. Treatments are consisted of two rootzone mixtures: a sand:sphagnum peat mixture at 80:20 (v/v) and a sand:sphagnum peat:soil mixture at 80:15:5 (v/v/v). Two nutritional programs during the year of establishment were also included.

Four-inch deep cores of soil samples were collected from each plot and subdivided evenly into 12 layers. Soil pH, cation exchange capacity (CEC), total C, total N, and mineralizable N were measured for each layer.

The rootzone mixtures and establishment fertilization regimes had no effect on soil chemical properties investigated except for EC which was higher in sand/peat/soil rootzones. Total organic C, total N, CEC, and EC decreased with soil depth, whereas soil pH increased with soil depth. The interaction between putting green age and soil depth was significant for total N, CEC, and EC. The initial differences of soil chemical properties disappeared due to topdressing over a period of 6 years at the top of the rootzones. This was especially apparent in the 0- to 2-cm layer.

The rootzone mixtures and establishment fertilization regimes had no effect on soil chemical properties investigated except for EC which was higher in sand:peat:soil rootzones.

Diffuse reflectance Fourier transform infrared (DRIFT) spectroscopy in the near-infrared (NIR) (4,000-10,000/cm) and mid-infrared (MIR) (600-4,000/cm) region in conjunction with partial least square regression (PLSR) is able to rapidly predict multiple soil properties from a single spectral scanning and is deemed as a promising surrogate for conventional analytical methods.

In the second study, by using samples collected in the first study, calibration models were developed for total organic C, total N, CEC, EC, and pH by regressing spectral results of DRIFT-NIR and DRIFT-MIR with values determined by conventional methods.

Results for total organic C, total N, CEC, and EC achieved $R^2 > 0.80$. MIR and NIR spectroscopy gave similar calibration accuracy for soil properties investigated. Satisfactory accuracy of MIR calibrations and mutual predictions was achieved with subsets of different rootzone mixtures and putting green ages.

However, subsets separated by soil depth failed to be predictive with sufficient accuracy within the group. Results of the study verified the potential of using DRIFT-NIR and DRIFT-MIR to predict soil chemical properties of sand-based turf soil, however, model robustness may be affected by sampling depth.

Summary Points

- Generally, soil pH increases and soil CEC and mineralizable N decreases from the top to the bottom of the soil profile across years and treatments.
- By the end of six years, sand mixtures and establishment fertilization regime had no effect on soil chemical properties investigated except EC, which was higher in sand/peat/soil rootzones.
- The initial differences of soil chemical properties disappeared due to topdressing practice over a period of 6 years at the top of the rootzones especially in the 0- to 2-cm layer.
- MIR and NIR calibration models for total organic C, total N, CEC and EC resulted in prediction with $R^2 > 0.80$.
- MIR outperformed NIR for total organic C, total N and pH. EC was better calibrated by NIRS.
- MIR and NIR had equal accuracy for CEC.
- Subsets separated by depth failed in calibration and mutual prediction, suggesting that calibration robustness could be largely affected by OM.