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Nature of the Problem

The integration of nutrient management among the turf industry, municipalities, and animal agriculture can reduce nutrient loading and protect water quality on a watershed scale. Cycling of biosolids from waste-treatment plants and animal feeding operations exemplifies a strategy for using waste sources of nutrients and organic matter as resources for turfgrass culture on urban landscapes, golf courses, and commercial sod. Biosolids can enhance turfgrass establishment and quality, replace fertilizer inputs, and improve soil physical properties, including soil water holding capacity (Angle, 1994). In addition, slow release of nutrients and increased cation exchange capacity for biosolids-amended soil can prevent nutrient leaching. Yet, the benefits of biosolids as soil amendments are tempered by concerns about P and N losses and loading of surface and groundwaters. Benefits related to physical, chemical, and microbiological properties of soil and to turfgrass establishment and quality need to be evaluated in relation to regulatory limits that protect the quality of surface waters (Sharpley and Tunney, 2000).

Recent evaluations of leaching losses from animal sources of biosolids are inconsistent with the assumption that nutrient release from biosolids will be slow compared to inorganic fertilizers. The P forms in biosolids can be largely inorganic (63 to 92%) and contribute to large dissolved inorganic P concentrations in leachates (34 to 75 mg P L⁻¹) (Sharpley and Moyer, 2000). In addition, dissolved organic P in manure biosolids is even more mobile in soil than inorganic P (Chardon et al., 1997). If leaching losses of P are directly correlated to water-extractable P in biosolids, extractable concentrations in biosolids-amended soil could similarly predict losses (Sharpley and Moyer, 2000). Research is needed to quantify P amounts and forms in biosolids-amended soil in relation to leaching losses during turfgrass establishment. Leaching and drainage losses of both inorganic and organic P from establishing turfgrass on urban landscapes and golf courses could contribute to nonpoint source pollution of surface waters (Linde and Watschke, 1997, Mallin and Wheeler, 2000).

Research Objectives

Evaluate biosolids as a soil amendment and nutrient resource for turfgrass establishment.

Relate physical and chemical properties of biosolids-amended soil to leaching losses of P and N during turfgrass establishment and maintenance.

Soil physical, chemical, and microbiological properties and leaching losses of P, N, and organic C will be evaluated in relation to imports of composted biosolids in column lysimeters. The rates of biosolids imported for turfgrass establishment will be constrained by upper limits specified in state and national standards for environmental thresholds of soil P.

Column lysimeters. Four replications of a factorial design comprising three treatments and three soil textures will evaluate responses of turf, soil physical and chemical properties, and leaching losses to composted biosolids during turfgrass establishment. The treatments will comprise a control (no manure) and two rates of P applied in biosolids (200 and 400 kg P ha⁻¹) incorporated within a firmed surface layer (10-cm depth) of each soil. A coarse (USGS Greens Specification), medium (Windthorst fine sandy loam), and fine (Houston black clay) soil texture will each be used in the surface layer and within a 40-cm depth of subsurface soil within 10-cm-diameter PVC columns. The surface layer and 10-cm increments of subsurface layers will be weighed and uniformly firmed within columns using a piston and weighted hammer. Turfgrass will be sprigged after the surface layer is firmed. A drainage cavity and port at the base of columns will be used to deliver hydraulic pressure for initial hydration of columns and for collection of leachates after irrigation events. The turf surface will be watered daily to balance evapotranspiration. A 9-cm depth of distilled water will be applied 4, 8, and 12 weeks after sprigging to achieve water flow through columns and to measure water infiltration rates. Columns will be weighed before and after each leaching event to quantify soil water content. Turfgrass will be clipped at the 5-cm height, dried, weighed, and sampled throughout the experiment to quantify growth rates and nutrient uptake. After the third leaching event, soil columns will be sawed into depth increments starting at the base of the surface or treatment layer (10-cm depth) and sampled. The surface layer will be longitudinally split to quantify soil physical, chemical, and microbiological properties with and without turfgrass roots.

Sampling and analysis of leachate, runoff, and soil. Physical properties and total and extractable nutrient concentrations in surface and subsurface layers of soil will be quantified before sprigging of turfgrass and after the final leaching or runoff event. Treatment effects on bulk density, water infiltration rate, water holding capacity, and aggregation of the surface layer of soil will be evaluated. Concentrations of total and extractable P, N, and organic C forms in the surface layer and subtending soil depths within columns will be analyzed. Total microbial biomass, CO₂ evolution, microbial metabolism of diverse substrates, and fatty acid methyl ester profiles will be used to quantify microbial responses to treatment variables within the surface layer of establishing turf.

Volumes and dissolved concentrations of total P and molybdate reactive P, total N and NO₃-N, and organic C will be quantified for leachates from column lysimeters. The sediment fraction of P and N in leachate will be removed through filtration (< 0.4 m), dried, and weighed. Concentrations of nutrient forms in the surface layer of column lysimeters will be related to quantities measured in leachates. Variation within the surface layer will be used to predict potential leaching or runoff losses of P, N, and organic C applied in biosolids on golf courses.

Soil, sediment, and nutrient data from these leaching experiments will contribute to collaborative development of input files and calibration of a watershed-scale model of water, sediment, P, and N transport and losses from turfgrass. The turfgrass data will be

combined with soil, land cover, weather, and land management data of ongoing calibrations (Vietor et al., 2002, Gaudreau et al., 2002) of the GIS version of the Soil Water Assessment Tool (SWAT) in BASINS 3.0.

References

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Intended Career Path Statement

A research and teaching career in turfgrass science, including soil, water, and pathology of turfgrass.