Impact of Animal Waste Compost on Turf Soil Quality

Evaluating soil quality with multiple indicators.

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Introduction

Golf course management can affect soil quality. This study assessed the impact of swine and dairy compost on turf soil quality indicators. A suite of physical, chemical, and biological soil quality indicators was monitored and used to develop a composite soil quality rating. The addition of the organic amendments were expected to improve soil quality mainly by increasing the cation exchange capacity and exchangeable cations, particularly in the high sand golf green soil.

Objectives

- To examine the impact of swine and dairy compost applications on several turf soil quality indicators
- To use the status of these soil quality indicators to produce a composite soil quality rating.

Materials and Methods

Site Description

This study was conducted at Colbert Hills Golf Course (Manhattan, KS) from May to October, 2000. Soils on one golf green and three tee boxes were used as treatment areas. Five treatments were applied to the green and tee box soils: swine @ 1x, swine @ 2x, dairy @ 1x, dairy @ 2x, and untreated (x = 24 kg/100 m^2). The green soil was 100% sand planted to putter creeping bentgrass while the tee boxes were constructed from a native loam soil sodded with alliance perennial rye grass. The composts were provided by Bion Technologies (North Carolina).

Methods

Beginning in May 2000, the composts were applied once a month using a drop applicator. Soil samples were collected 15 days after application by removing a core 5 cm x 5 cm. The sample was divided into two 2.5 cm depths.

Physical properties analyzed were bulk density, porosity, and water content. **Chemical properties** analyzed were pH, electrical conductivity, cation exchange capacity, exchangeable cations (K, Na, Mg, Ca), total carbon, and total nitrogen. **Microbial properties** analyzed were microbial biomass carbon and nitrogen, mineralizable carbon and nitrogen, and microbial respiration.

All analyses were performed using standard methodology published in either the American Society of Agronomy Monograph No. 9. Methods for Assessing Soil Quality (1996), or USDA-NRCS Soil Survey Investigations Report No. 42, Version 3.0, Soil Survey Methods Laboratory Manual (1996).

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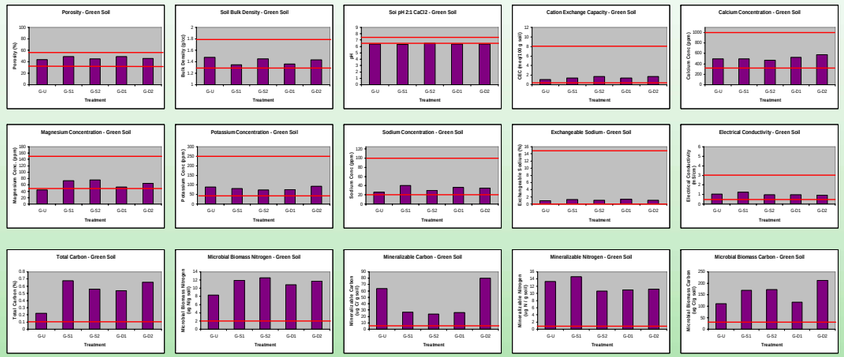
Soil Quality: Control charts for individual indicators

Control charts represent the August condition of various soil quality indicators. The red lines represent an upper and/or lower acceptability range.



Steps for converting individual indicators into a composite evaluation of soil quality.

- **Select appropriate indicators to evaluate soil quality.**
- **Measure indicator status.**
- **Establish control chart indices.**

Control charts compare an indicator value to ranges that delimit sustainable and degrading conditions. Setting appropriate target boundaries delineating sustainability and degradation is key. In some cases only minimum or maximum boundaries may be appropriate. Control limits can be established with the assistance of state extension services, literature surveys, management experience, model predictions, consultants, regulations, or other sources. In many cases more research is needed to establish appropriate boundaries.

- **Transform multiple indices into environmental quality evaluation graphs.**

In this step, indices from any number of quality control charts are normalized onto a "spider radar" graph. This format produces an easy-to-understand, visual representation of environmental quality. The cause of degradation (i.e. which indicator) and its severity (i.e. amount of skewing) are readily apparent based on irregularity in the diagram's form. Alternatively, a circular form could denote a severely degraded environment if all indicators lie outside the sustainable limits.

- **Select appropriate remedial management for degraded indicators.**
- **Monitor indicators over time.**

Soil Quality: Spider radar graphs for multiple indicators

These spider radar graphs give users a composite environmental quality evaluation by showing how well multiple indices conform to the limits of each indicator's sustainable range (as compared to scanning through many control charts). Indices (purple dots) that lie within their target range (zone between red lines) show soil indictors operating in a sustainable mode. Indices lying outside their target range represent an indictor in need of remediation.

A high quality ecosystem would show a nearly circular radar image (colored area outline by purple dots) within the sustainable range. Degraded functions lying outside the sustainable range skew the radar image and alert the superintendent or manager to begin remediation.

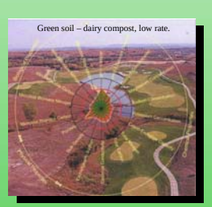
Outer arcs group indicators into various soil quality areas (physical, chemical, and biological).

Green soil – untreated.

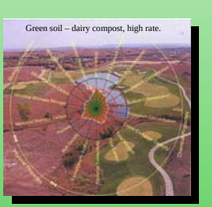
Green soil – swine compost, low rate.

Green soil – swine compost, high rate.

Green soil – dairy compost, low rate.



Green soil – dairy compost, high rate.



Conclusions

- Spider radar graph are effective in using multiple indicators to evaluate soil quality.
- High salt content of the compost increased exchangeable sodium and electrical conductivity, but these values still remained within the acceptable range.
- Bulk density, porosity, cation exchange capacity, microbial biomass carbon and nitrogen, mineralizable carbon and nitrogen, and microbial respiration showed the greatest improvement.
- The value of spider radar graphs will be enhanced as more knowledge of range limits is developed for turf soil quality indicators.