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BRIEF

Organic Matter Concentration of Creeping Bentgrass Putting Greens in the Continental U.S. and Resident Management Impact

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SOIL ORGANIC MATTER (SOM) accumulation in creeping bentgrass (*Agrostis stolonifera* L.; CB) putting greens has been a concern for decades. Gaussoin et al. (2013) summarized the negative effects associated with excessive SOM (thatch-mat), including decreased water infiltration, localized dry spots, reduced high and low temperature tolerances, increased pest problems, and reduced pesticide effectiveness. The objective of this study was to survey SOM concentrations in CB greens throughout the continental U.S. to determine management practices, and/or their interactions, that significantly affect green OM content. Regression techniques were used to determine the significance of various management practices and site-specific characteristics on green OM content.

Three hundred and eight putting greens on 104 golf courses in 15 states (AR-4, CA-3, CO-4, CO-8, IL-6, IA-6, MN-4, MT-9, NE-13, NJ-3, NM-6, SD-22, WA-5, WI-3, WY-8) were surveyed for management practices and SOM concentration from June 2006 thru June 2008. All golf greens surveyed were CB with varied levels of annual bluegrass (*Poa annua* L.). Three 0.75-inch diameter samples were collected per putting green to determine SOM concentration (three putting greens per golf course). Verdure was removed from the sample and discarded. Samples were cut to 3.0 inches below the verdure and the excess soil discarded. Samples were analyzed for SOM concentration (gravimetric concentration) using the loss-on-ignition method (Nelson and Sommers, 1996) at 750°F ± 5°F for 12 h.

Survey data included: green age, annual precipitation, latitude, longitude, altitude, mean annual relative humidity, topdressing rate, material and frequency, course category (private vs. public), green construction method, CB cultivar, annual bluegrass (%, visual), mowing height, cultivation type and frequency, verticutting frequency, total nitrogen applied (yr^{-1}), and plant growth regulator use. Golf courses that did not return surveys were eliminated from the regression analysis.

Data analysis was performed using SAS version 9.2 (SAS Institute, 2008). Models were fitted by first examining bivariate

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relationships between SOM concentration and each variable of interest (survey data). Variables that were significantly related to the SOM ($P \leq 0.1$) in bivariate analyses were then entered into a multivariate linear regression analysis that utilized backward, forward, and stepwise selection procedure to construct the final model. Contrasts were used on categorical data to determine differences within a parameter. There were no statistical differences between courses that returned the survey and those that did not on the variables that were collected at all courses (SOM, annual rainfall, latitude, longitude, altitude, and relative humidity). The Cate-Nelson graphical procedure (Cate and Nelson, 1971) for determining soil test critical levels was adapted to relate annual sand topdressing rates to SOM concentration.

The average SOM concentration for the 308 putting greens sampled was 3.1% and ranged from 1.23 to 8.43%. Variables that correlated to SOM concentration in the bivariate analysis and the multivariate regression analysis were: bentgrass cultivar, topdressing frequency, cultivation frequency, and putting green age. Annual rainfall, longitude, annual bluegrass percent, and construction method were correlated to SOM in the bivariate analysis, but were not significant in the multivariate regression analysis.

As previously reported, SOM concentration increased with green age. Greens with unknown CB cultivars had higher SOM concentrations than greens with Penncross, Providence, Dominant, Pennlinks, L93, and Penn A or G series. Courses with unknown cultivars were older with native soil-based greens. In these cases, age and soil type may have had more of an effect on SOM concentrations than CB cultivar. Topdressing and cultivation frequencies also influenced SOM concentration. Greens that were sand topdressed every 7 to 14 days had lower SOM concentrations then those topdressed monthly or once or twice per year. Sand topdressing is considered the most effective cultural management practice for controlling thatch accumulation (Beard, 1973). Further analysis of topdressing data, using the Cate-Nelson procedure on putting greens between the ages of 6 and 108, indicates that greens receiving an annual sand topdressing rate of 20.3 $ft^3/1000\ ft^2$ were consistently $\leq$3.3% SOM. Increasing cultivation frequency also reduced organic matter concentration. Cultivation strictly in the fall resulted in higher SOM concentration than monthly cultivation; however, our data suggests monthly cultivation was not more effective at controlling SOM accumulation than two cultivations per year. The survey was limited in that it did not account for cultivation tine size (i.e., diameter) or the frequency of each cultivation type. This information would allow us to estimate the percent area impacted by cultivation, which may be more informative than cultivation frequency.

The final regression model demonstrated an R^2 of 0.572, which is indicative of the complex parameters involved. However, from this research we were able to identify several management practices—including sand topdressing and soil cultivation—that significantly impacted SOM. Increasing sand topdressing frequency to every 7 to 14 days and applying at least 20.3 $ft^3/1000\ ft^2$ topdressing sand annually, combined with routine soil cultivation to ensure sand incorporation, are practices that can be utilized to manage SOM.

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