Dissolved Organic Carbon and Nutrients in Native Soil Under Three Turfgrasses and Two Sand-Based Sports Fields.

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INTRODUCTION

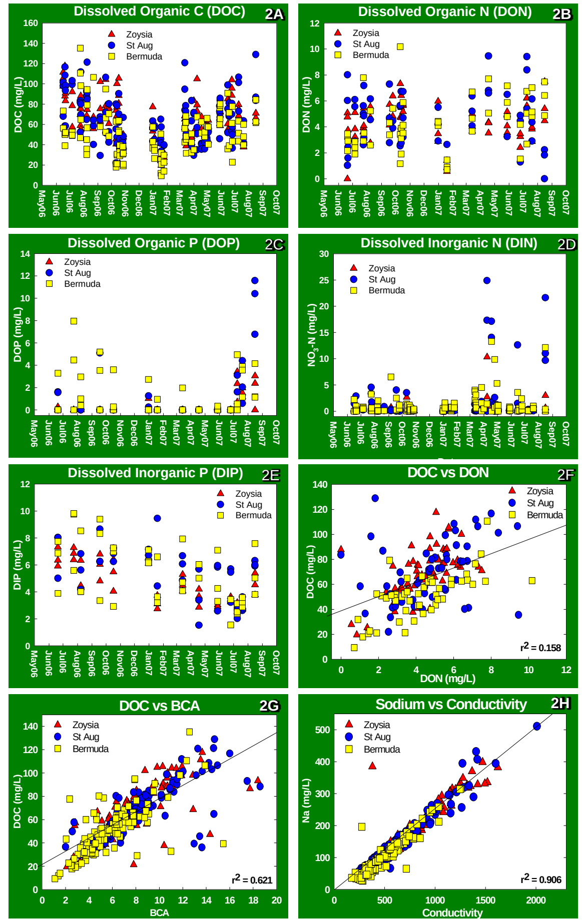
Turf grasses have the potential to prevent erosion, improve soil aggregation, provide small-wildlife habitats, and improve the aesthetic qualities of the urban environment. Typical urban settings, such as home lawns and sports fields, are generally small to large in size and may be subject to extreme variability in fertilization rates and irrigation practices within only a few feet of each other (e.g., neighbors in a residential district may fertilize and irrigate at different rates). Sports fields, another component of the urban landscape, also present the difficulty of varying types of management practices, depending on the location (i.e., infield versus outfield). The goal of this project was to characterize organic as well as inorganic constituents in soil solutions under three turf grasses and in drainage water from two sports fields with engineered sand-based root zones.

MATERIALS AND METHODS

- Samples were collected from three turfgrass areas on a native soil (Booneville fine sandy loam), consisting of Bermuda (*Cynodon dactylon* (L.) Pers), Zoysia (*Zoysia japonica* Steud.), and St. Augustine (*Stenotaphrum secundatum* (Walt.) Kuntze) grasses; and two sports fields with sand-based root zones; the Texas A&M University soccer (*TifSport* Bermuda grass) and softball (*TifWay 419* Bermuda grass) fields.
- Soil solutions were collected from shallow wells (30 cm) placed in plots of the three turfgrasses (Figure 1). Water samples were obtained from the main drainage outlets of the sports fields. Nutrients were analyzed as described below.
- Dissolved organic carbon (DOC) was analyzed using a TOC analyzer (UV-catalyzed persulfate oxidation method; Model 700, O.I. Corp., College Station, TX). A standard absorption measurement of color (440nm) of randomly selected samples was also made to compare results with DOC values. Water samples were also analyzed with a bicinchoninic acid reagent (BCA) to detect low-molecular weight DOC.
- Dissolved organic nitrogen (DON) was quantified using the difference method, with total dissolved nitrogen (TDN) determined by a persulfate oxidation method and dissolved inorganic nitrogen (DIN) measured by colorimetric determination of nitrate-N (NO_3-N) after Cd reduction.
- Dissolved organic phosphorus (DOP) was determined using the difference method, with total dissolved P (TDP) determined by ICP analysis and dissolved inorganic P (DIP) determined colorimetrically.
- Water chemistry (i.e., EC, pH, and other nutrients) were analyzed by the Texas Cooperative Extension Soil, Water, and Forage Testing Lab, College Station, Texas.

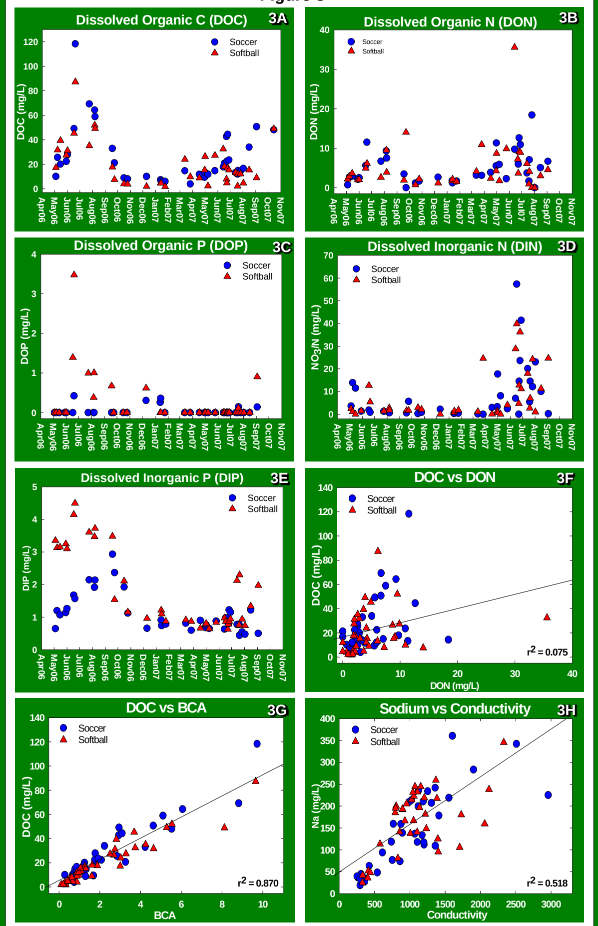
Characterization of Dissolved Constituents in Turf Plot Soil Solutions

Figure 2



Characterization of Dissolved Constituents in Sand-Based Drainage Water

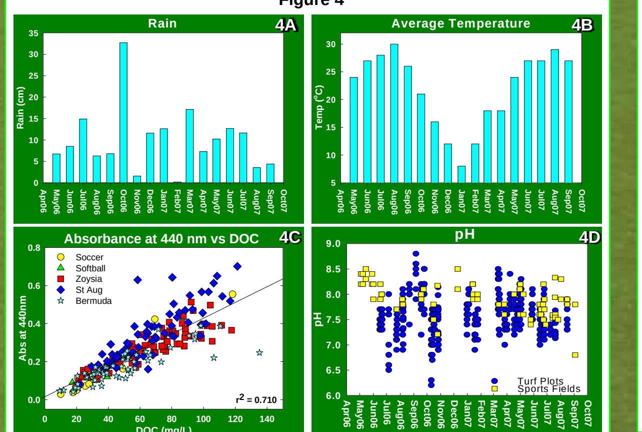
Figure 3



Stand Pipe Well Screens, 0.040 Well Screen Slot, 1-1/2"

Figure 1. Standpipe well screens were installed to a depth of 30 cm into the soil profile such that open slits were immediately below the soil surface. Above ground slits were filled with polyester resin and PVC caps had 0.1 mm holes to allow equalization of pressure in the tubes.

Figure 4



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RESULTS

- Turf plots and sports fields both showed seasonal changes in DOC and DON levels with peak values observed during July and August (Figures 2A, 2B, 3A, 3B).
- Levels of DOP were higher in the soil solutions than the drainage from the sand-based root zones with little to no seasonal fluctuations, except during July and August (Figures 2C, 3C).
- Trends in DIN were similar regardless of soil type (Figures 2D, 3D), while DIP remained constant in native soils, but demonstrated a seasonal change in the sand-based root zones (Figures 2E, 3E). High DIN values reflect recent fertilizer applications to the sports fields.
- DOC and DON were not highly correlated, but a positive linear relationship was observed in both the sports fields and turf plots (Figures 2F, 3F), with an average C:N ratio ranging from about 6:1 (sports fields) to 16:1 (turf plots).
- DOC and BCA were highly correlated (Figures 2G, 3G), as were sodium and conductivity (Figures 2H, 3H) in both native and sand-based soils.
- Absorbance (440nm) readings were highly correlated with DOC regardless of soil type (Figure 4C).

DISCUSSION

- In this study, soil solutions from native soils showed a marked difference in quantities of nutrients versus drainage from sand-based fields. This may be due in part to the collection from drain pipes vs. in-soil wells. Drainage water was sampled because the sports fields were designed to drain uniformly through a central drain pipe, in effect making them the equivalents of very large lysimeters. Regardless of the soil and turf type, there was a seasonal effect on DOC and DON, while DOP remained fairly consistent. It should be noted, that the sports fields were over-seeded during the winter months with a cool season ryegrass. This switch from a C4 to C3 grass could also have influenced the organic nutrient levels.
- Rainfall (Figure 4A) was not uniform from year to year, with higher levels in June and July 2007. Average temperatures for 2007 were similar to 2006 (Figure 4B). pH was uniform throughout the year, with higher alkalinity in the sports fields (Figure 4D). The lower concentrations of organic nutrients in 2007 may therefore be due to a "flushing" of the root zones from the greater amounts of rainfall. This suggests that irrigation should be carefully monitored, as excessive irrigation will likely increase the transport of nutrients through the soil profile and into local drainage systems.
- The correlation of BCA with DOC may represent the detection of humic acids in the water samples. Average BCA-reactive C ranged from 9.8% in the sports fields to 12.1% of DOC in the turf plots. BCA is known to react with low-molecular weight phenolic compounds and carbohydrates and has also been used to detect proteins in beer. The higher percentage of BCA in the turf plots may reflect the higher concentrations of organic matter typically found in clayey soils.
- We suggest that native soil solution represents a larger pool of organics than sand-based drainage water, and should be monitored closely because there may be greater potential for negative offsite consequences. We also suggest that the lower levels of organic nutrients and C:N ratio in sand-based drainage water may be due to lower adsorption of nutrients to the sand-based root zone. It appears prudent to carefully monitor fertilization rates and irrigation applied to sand-based turf grasses to minimize their off-site impacts on the environment.