Salinity Management in Turfgrass Systems Irrigated with Effluent Water

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Objectives:

1. Determine spatial and temporal salinity accumulation patterns in soil profiles on golf course fairways with effluent water irrigation.
2. Evaluate different management practices for reducing sodium and salt accumulation in the soil.

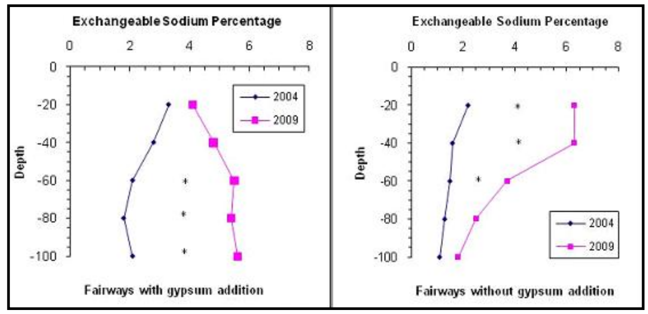
Start Date: 2008
Project Duration: 3 years
Total Funding: $82,459

The main constituents of effluent water include total dissolved salts, nutrient elements, and organic compounds. Salinity and sodicity issues associated with its use continue to be of great concern to the golf course industry. Real-time soil salinity and soil water content information would provide turf professionals with insight when trying to manage turf under effluent irrigation.

We have studied salinity accumulation patterns on four fairways of two effluent water irrigated golf courses using two different types of sensors: 5TE sensor (manufactured by Decagon Devices) and Toro Turf Guard Dual Level (TG2) sensor. Temporal and spatial accumulation patterns were measured using a network of *in situ* soil sensors located at two depths [15 and 30 cm for 5TE sensor and 8 and 19 cm for Turf Guard sensor (TG2)].

Sensors measured electrical conductivity (EC), volumetric soil water content (SWC), and soil temperature data were collected continuously during the 2008 and 2010 growing seasons. Correlation was observed between 5TE sensor-measured soil salinity vs. saturated paste extracted soil salinity ($r = 0.77$). A significant exponential relationship was observed between TG2 sensor-measured soil salinity vs. saturated paste extracted soil salinity.

In-ground measurements indicated that salinity can vary widely across a seemingly homogenous golf course fairway. Plots exhibiting low and high salinities presented opposite seasonal trends at Heritage Golf Course. Strong correlation was observed between average soil salinity and mean soil water content ($r = 0.76$), soil salinity and the percentage of sand in the soil texture composition ($r = -0.63$) for Heritage fairway 1. High salinity was found on fairway 19 at Common Ground Golf Course. However, the salinity level as high as 10.6 dS/m is not a result of water reuse, but a historical geological contribution. Drainage appears to be vital in maintaining low soil salinity levels under effluent irrigation in clay soils. Slow to infiltrate, percolate and difficult to leach, predominately clay soils irrigated with effluent water can accumulate soil salinity over time.



Exchangeable sodium percentage at five soil depths at the initiation (2004) and 5 years after effluent water irrigation (2009). Each data point is the mean of four replications. Asterisks denote a significant difference between 2004 and 2009 samples at P < 0.05.

We collected soil baseline information in 2004 from three golf courses that had just started to use effluent water. In 2009, 5 years after the initiation of effluent water irrigation, soil samples were collected 30 cm from the original sampling spots and analyzed for soil characteristics. Samples were taken at 0 to 20, 20 to 40, 40 to 60, 60 to 80, and 80 to 100-cm depths.

Results from this study suggest that soil salinity and soil organic matter content did not increase at most of the sample sites over the 5-year period. The average soil exchangeable sodium percentage (ESP) increased from 2.65% in 2004 to 5.35% in 2009. Samples collected from all sites showed a significant increase in soil pH (~0.3 units). Our results suggested that sodicity is the primary concern on these landscape soils when effluent water is used for irrigation.

Four golf course fairways were subjected to gypsum application following aerification (aerify once or twice per year and apply gypsum at 50 lb/1,000 ft^2/year). Another four fairways were control with no gypsum addition. For gypsum treated fairways, the increase in ESP from 2004 to 2009 at 0-20 cm and 20-40 cm depths were not statistically significant. The increase became significant from 40-60 cm, 60-80 cm, and 80-100 cm. The changes along the soil profile reflect sodium leaching that effectively prevented a significant increase in soil ESP at the shallow soil depths (0-40 cm) where most of the turfgrass roots are.

For control sites, the increases in ESP from 2004 to 2009 were significant at 0-60 cm depths, demonstrated by an ESP at the 0-20 and 20-40 cm depths that had approximately tripled. The ESP increase became nonsignificant at 60-80 cm and 80-100 cm. High levels of sodium relative to calcium and magnesium in effluent water resulted in increased soil ESP, especially at the shallow soil depths .

Summary Points

- At the experiment conditions, sodicity is the primary concern when effluent water is used for irrigation. The average soil ESP and SAR values approximately doubled over the 5-year period.
- Fairways irrigated with effluent water exhibited an increased soil pH.
- Significant linear correlation was observed between 5TE salinity sensor-measured soil salinity and Turf Guard measured soil salinity vs. saturated paste extracted soil salinity.
- Accumulation of salts appears to relate to soil water content (drainage effectiveness), soil texture, and soil compaction level.
- Soil aerification and gypsum addition effectively prevented a significant increase in soil ESP at the shallow soil depths (0-40 cm).