Turfgrass Irrigation with Municipal Effluent: Nitrogen Fate, Turf K_c Values and Water Requirements

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Goals:

- *Determine the potential movement of nitrogen contained in municipal secondarily treated wastewater used to irrigate turf.*
- *Determine how effluent irrigation influences the water and nitrogen requirements of turf.*
- *Evaluate five evapotranspiration equations currently used in the United States to predict actual turfgrass water use.*
- *Accumulate an atmospheric database and turfgrass water use database that can be used by the public and private sector to develop and test the accuracy of evapotranspiration equations.*

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The fate of applied nitrogen (N) and turfgrass water use in high maintenance turfgrass systems irrigated with potable (well) water and effluent (wastewater) are being studied using two large weighing lysimeters located at the University of Arizona Karsten Turfgrass Research Center. Each water source is applied to a single lysimeter at rates sufficient to prevent water stress of TIFWAY bermudagrass (summer) and FROGHAIR intermediate ryegrass (winter).

The lysimeters, 13 ft deep and 8 ft in diameter, weigh approximately 100,000 pounds each and employ truck scales to measure changes in lysimeter mass due to evaporation. Sampling ports, located at a depth of 3.3' and then every additional 1.6' to a depth of 11.6', provide access to the lysimeter soil for extraction of soil water and measurement of soil water status.

Nitrogen, applied as labeled (N^{15}) ammonium sulfate, is applied to both lysimeters every two weeks. The rate of N applied to the lysimeter receiving wastewater is adjusted downward to ensure both lysimeters receive similar levels of N. A complete meteorological station is located at the lysimeter facility to provide environmental data required for estimating reference evapotranspiration (ET_o).

Turf responded positively to irrigation with wastewater, and generated more biomass than turf irrigated with potable water. The first 14 months of the study revealed nitrogen uptake of 223 lbs N/A and overall N use efficiency of 61 % for turf irrigated with wastewater. This compares

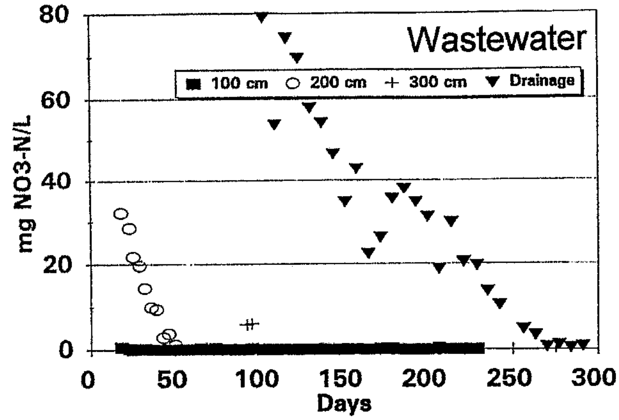

Figure 5. Nitrate nitrogen measured in soil solution samples and drainage water from the lysimeter irrigated with wastewater for the period April 10, 1995 through February 29, 1996.

positively with a N uptake rate of 173 lbs N/A and a N use efficiency of 42% for turf irrigated with potable water during the same period.

The uptake of fertilizer N in aboveground biomass was lower than for total N uptake. Fertilizer uptake efficiency totaled 26% and 22% for turf irrigated with wastewater and potable water, respectively. The low uptake efficiency of fertilizer N is not fully understood, though analysis of soil solution samples and drainage water indicate the losses are not due to leaching. Possible causes may be immobilization in the below-ground plant and microbial biomass or loss through denitrification.

Turf water use is determined from daily changes in lysimeter mass with appropriate compensation for irrigation and rainfall. The ratio of actual turf water use to ET_o, referred to as the crop coefficient (K_c), is required to convert ET_o to turf water use for irrigation purposes. Five popular methods of estimating ET_o are presently under evaluation -- the Penman Equations used by the four regional public weather networks (Arizona, California, New Mexico and Southern Nevada) and the Penman Montieth Equation.

Results from the second year of study show the five methods of estimating ET_o differ by as much as 30%, showing a clear need to match K_c with the method of ET_o estimation. Appropriate bermudagrass K_{cs} for the five methods of estimating ET_o varied from 0.64 to 0.85 for turf irrigated with potable water and 0.66 to 0.86 for turf irrigated with wastewater. Ryegrass K_c values ranged from 0.57 to 0.80 for turf irrigated with potable water and 0.57 to 0.84 for turf irrigated with wastewater. The higher water use (K_{cs}) observed with wastewater irrigation was associated with higher biomass production. Comparison of seasonal K_{cs} for 1995 and 1996 revealed slightly lower Kcs in 1996, regardless of ET_o procedure.

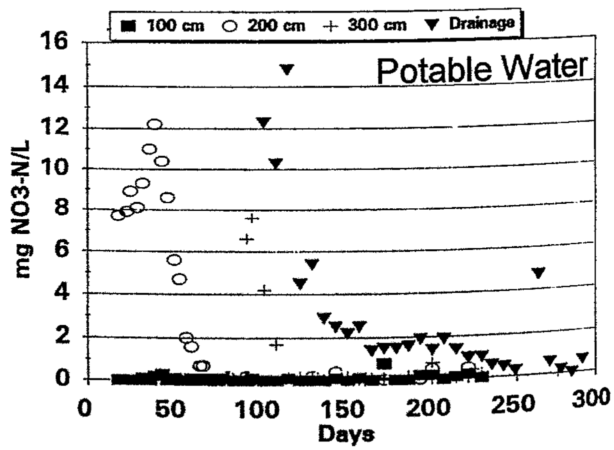

Figure 6. Nitrate nitrogen measured in soil solution samples and drainage water from the lysimeter irrigated with potable water for the period April 10, 1995 through February 29, 1996.