Turfgrass Fertigation: An Investigation into Sustainable Backyard Irrigation

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Turfgrass's water consumption may often be overlooked simply because a green plot behind a picket fence is difficult to conceive as a contribution to water scarcity. However, collectively turfgrass is the number one irrigated crop, with triple the water consumption as the next leading crop (Leinauer and Devitt, 2013). Considering turfgrass's capability to provide dust and erosion control, mitigate the urban heat island effect, create revenue through recreational value and an established societal value on the aesthetics of a sprawling green lawn, it is clear that the elimination of water usage on turfgrass is unrealistic. Thus a reinvention of the present turfgrass maintenance process is necessary.

Current turfgrass maintenance relies on two key inputs: water and nitrogen. These necessary components for growth and physical appeal are provided through irrigation with potable water and an applied nitrogen fertilizer. The application of such fertilizers have some associated risk when excess fertilizer is not taken up by the grass and is lost to the environment. This excess nitrogen may undergo denitrification resulting in the emission of the leading ozone depleting greenhouse-gas: nitrous oxide, and it can cause potential human and ecosystem health risks due to watershed contamination from nitrate-rich runoff (Rapson and Dacres, 2013).

The research performed investigates the feasibility of transitioning to fertigating turfgrass with a tailored water. Fertigation describes the process of encompassing both the irrigation and fertilization processes into a single distribution of both water and nitrogen. Fertigation would ideally use tertiary treated water from a decentralized wastewater treatment facility, tailored to retain a higher concentration of nitrate. This tailored water would then be distributing this essential nitrate during every watering event at a consistent concentration, thus meeting the nitrogen requirements of the grass without the application of a nitrogen fertilizer.

Analysis was performed to determine whether the fertigation process, when applied in the establishment of turfgrass, could in fact supply sufficient nitrogen for grass to reach its growth potential, while also minimizing harmful side effects of nitrogen application. The effects focused on were the loss of nitrogen via nitrous oxide and as nitrate in leachate. The aforementioned parameters were tested on three turfgrass types, two native species: Buffalograss and Inland Saltgrass, and on the reference grass Bermudagrass, These grasses, and a control plot had six repetitions each. Half of the repetitions were traditionally maintained using potable water and nitrate fertilizer, calcium nitrate tetrahydrate, and the remaining three replications were fertigated. The treated water used to fertigate was tailored to a nitrate concentration of 15ppm, a value calculated for Las Cruces, New Mexico. All grasses were grown in soil taken from the Chihuahua Desert and potted in columns with an inner diameter of 24.5cm and depth of 45cm, these columns were maintained in a greenhouse.

The health and establishment rate of the grass were measured with monthly root sampling as well as photo analytics, and comparisons of masses of dried grass clippings both performed weekly. Root samples were taken with common coring methods to indicate the maturity of the grass, photo analysis was done with use a Sigma Scan Pro 5.0 software to compare the amount of green coloring in a set area, and masses of clippings show variation in density and establishment success. In the establishment phase, these traits were highly variable due to the varying germination rates between the grasses, but they will continue to be monitored as the grasses mature.

Gas samples were collected weekly, during the peak emission time of established grass, 48 hours after a fertilization event. Samples were collected using chamber methods (Rapson and Dacres, 2013). Nitrous oxide concentrations were found using a gas chromatograph with an electron capture detector (GC- ECD). Results are shown in Figure 1 which compares the measured emissions to the nitrous oxide concentration of ambient air – a value that can fluctuate between 0.25 and 0.31 ppm and is plotted at 0.28ppm (EPA). The slight variation in nitrous oxide emissions falls within the bounds of instrumental error of the GC-ECD and it can be concluded that in the first 5 weeks of establishment neither Buffalograss nor Bermudagrass emit any significant amounts of nitrous oxide, regardless of treatment method (Figure 1).

To study nitrate in leachate, weekly water samples were taken from two points per container, a mid-level leachate sample withdrawn from about 12 cm below the soil surface with a lysimeter, and a drainage sample collected from a pan resting below the elevated container. These water samples were analyzed with colorimetric methods, dying an assay of reduced samples to find a combined nitrite and nitrate concentration, from which nitrite concentrations were subtracted **(**Hernández-López, and Vargas-Albores, 2003). It was found that the highest concentrations of nitrate existed in the earliest water samples (Figure 2). Over time, it is expected that nitrate levels will decrease with the establishment of root structure, which will absorb nitrates to be used by the grasses. Continued monitoring of nitrate concentrations will be conducted past these initial 5 week results.

During the establishment period of the turfgrasses, maintenance with the more sustainable tailored water proved sufficient for the grasses, as there was comparable growth and spread to the traditionally maintained grasses. Neither traditional nor fertigated treatment method resulted in any nitrous oxide emission from grasses in the first 5 weeks of establishment. Nitrate concentrations in leachate and drained water had little variance between treatments within the first five weeks of establishments, an expected result due to the lack of developed root system.

It is acknowledged that further research is necessary to monitor other nutrients in tailored water application, but the preliminary results of this study show that tailored water is suitable for establishing grass at least within the first five weeks of growth, without added nitrogen loss to the environment. With continued monitoring of nitrogen pathways and grass growth and development, the research team hopes to prove that application of nitrogen via a tailored water allows for the necessary nitrogen needs of the grasses to be met but limits the loss of excess nitrogen, thus limiting both greenhouse gas emissions, and nitrate accumulation in watersheds.

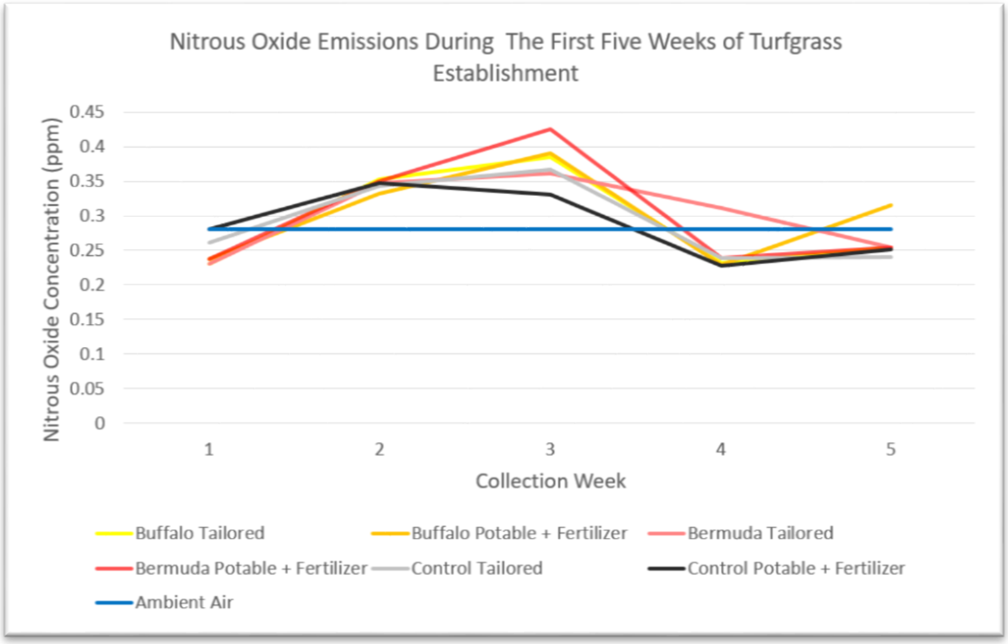

Figure 1: *Nitrous Oxide Emissions from Turfgrasses Maintained with Traditional Methods (Potable Water + Fertilizer) and Fertigation (Tailored Water).*

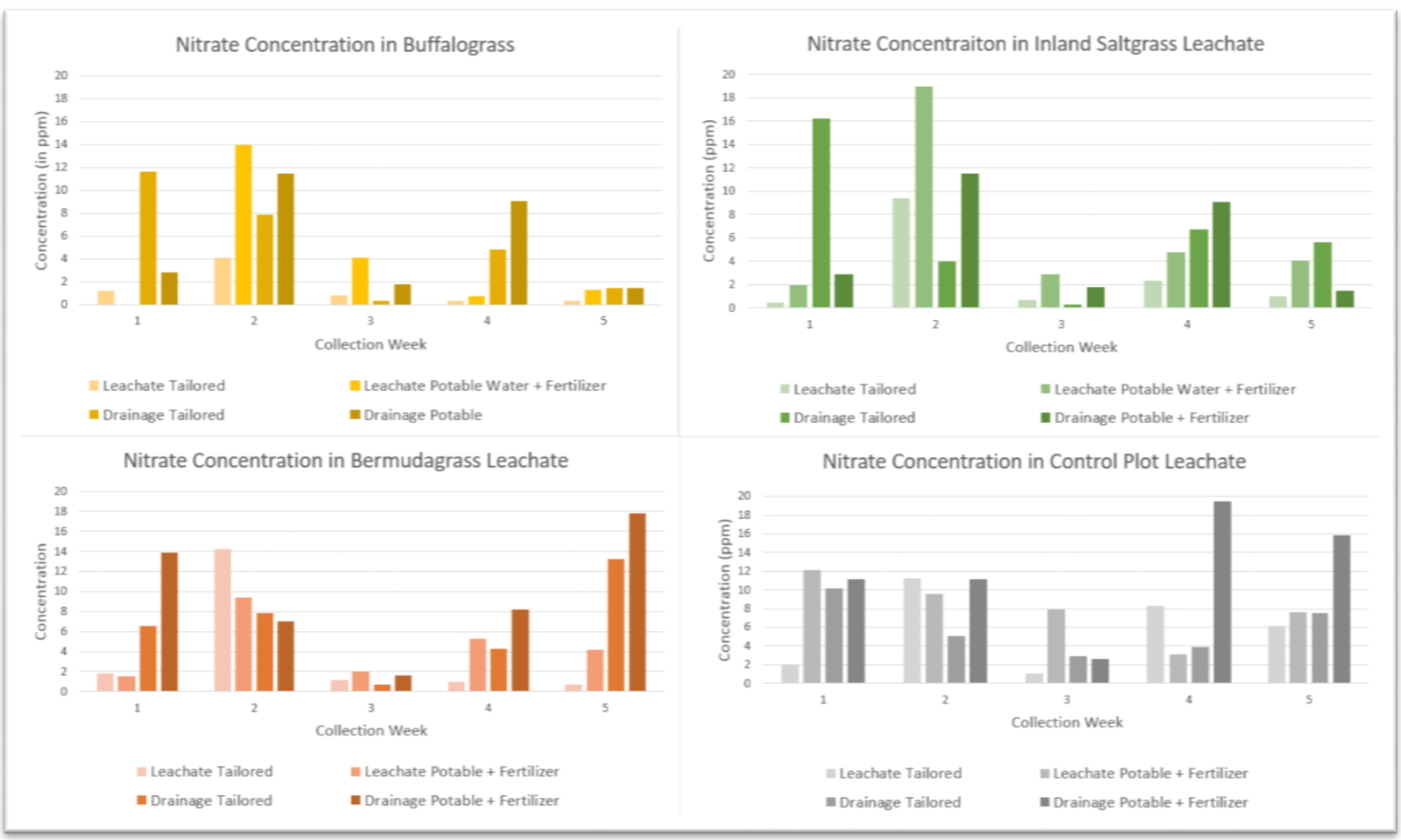

Figure 1: *Nitrate Concentrations in Leachate and Drainage Water*

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