Nitrogen and Irrigation Interactions in Turf Grass

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ABSTRACT

Turfgrass irrigation for soils with high clay contents poses unique challenges due to very slow water infiltration and percolation. The objective of this research was to study the interaction between irrigation inputs and N fertilizer and also to identify minimal levels of soil profile moisture needed to maintain healthy turf grass. The study was conducted on a 2.2 acre linear gradient irrigation system (LGIS) at the Texas A&M University Research and Extension Center in Dallas. The LGIS delivered water quantities ranging from 0 to 120% Class A pan evaporation (Ep) from late spring to early fall when warm-season grasses were actively growing. A wilt line visually separated water stressed from healthy turf. Ammonium sulfate fertilizer labeled with ^{15}N was applied to microplots located within the LGIS at irrigation levels that replaced 120, 50, and 0% Ep. Access tubes were installed near each microplot and soil moisture was monitored to a depth of 100cm at 10cm intervals throughout the year. In both 2004 and 2005, the amount of ^{15}N remaining in the upper 15cm of the soil profile was greatest for the 50% Ep and least for the 0% Ep irrigation levels. Turf grass remained visually healthy at the 50% Ep irrigation level, yet there was 10cm less water in the upper 100cm of this soil profile compared to the 120% Ep irrigated soil profile. Significant savings in water and fertilizer use are possible by irrigating at 50 to 70% of Ep versus more liberal applications of water.

BACKGROUND

- Turfgrass is the most common plant in the urban landscape. Benefits include aesthetics, recreational activities, control of soil erosion, and enhancement of air quality by reducing the absorption and storage of solar radiation.
- The majority of irrigation used in urban landscapes is applied to turfgrass.
- It is important to use irrigation and fertilization practices that promote turfgrass vigor, but also conserve water and protect surface water quality.

RATIONALE

- Turfgrass irrigation for soils with high clay contents poses unique challenges due to very slow water infiltration and percolation rates.
- When the water application rate to high-clay soils exceeds the infiltration rate, water can runoff the landscape into streets where it quickly enters the stormwater drainage system.
- Surface runoff from urban landscapes can contain high levels of soluble fertilizer nutrients and pesticides. The overall result is a waste of potable city water and increased contamination of surface waters which supply a major portion of municipal water supplies in the Northern Blackland Prairies Resource Area.

OBJECTIVES

The objective of this research was to study the interaction between irrigation inputs and N fertilizer and also to identify minimal levels of soil profile moisture needed to maintain healthy turf grass.

MATERIALS AND METHODS

Study Area:

- A 2.2 acre Linear gradient irrigation system (LGIS) constructed to evaluate the water requirements for 20 warm-season turfgrass varieties.
- The LGIS delivers water quantities ranging from 0 to 120% Class A pan evaporation (Ep) **(Fig. 1)**.
- Irrigation is applied from late spring to early fall when warm-season grasses are actively growing. Note the wilt line in **Fig. 1** near the end of the growing season.

Soil Moisture Monitoring:

- PVC access tubes were installed at three irrigation levels that received sufficient water to replace 0, 50, or 120 percent of Class A pan evaporation (Ep) **(Fig. 1)**.
- Volumetric soil moisture under Tifway 419 bermudagrass was monitored at 10cm intervals to a depth of 100cm using the Diviner 2000® soil moisture probe from Sentek Pty. Ltd, Stepney, Australia **(Fig 2)**. Soil moisture was monitored from May to October.

^{15}N Microplots:

- Prilled ^{15}N-labeled ammonium sulfate fertilizer [$(^{15}NH_4)_2SO_4$, 5 at%] was applied to each microplot at a rate equivalent to 2 lbs N 1000 ft^{-2} (9.8 g m^{-2}) in late spring 2003 and again in 2004.
- Soil samples were extracted for ^{15}N determination from 0-7.5 and 7.5-15 cm depths in fall 2003 and from 0-7.5, 7.5-15, and 15-22.5 cm in fall 2004.

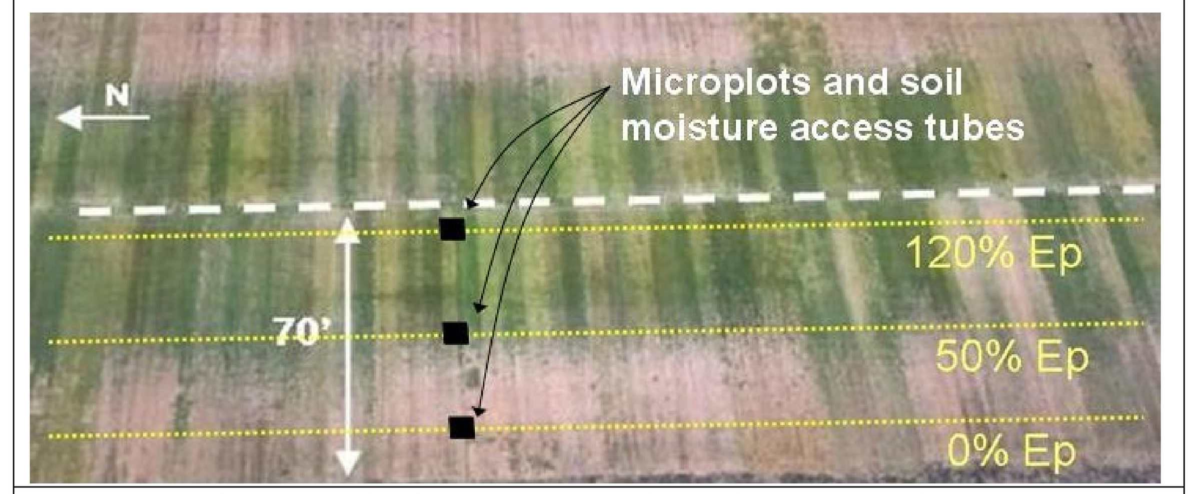

Fig. 1. Aerial view of the linear gradient irrigation system (LGIS) study area from October 2000. Grasses next to the center line (dashed line) received irrigation to replace 120% Class A pan evaporation. Irrigation levels decreased linearly with increasing distance away from the center line. Wilt lines are clearly visible as the transition from dark to light areas at approximately the 50% Ep irrigation level.

RESULTS AND DISCUSSION

- Tifway 419 turf quality remained at acceptable levels when irrigated to replenish only 40 to 60% Ep **(Fig. 1)**. From June to August of 2003 (8 weeks), the difference in amount of water applied to replace 120% Ep and 50% Ep was 6 inches.
- Throughout the growing season, the most dramatic changes in soil moisture occurred in the upper 10 cm of the soil profile, with changes becoming less dramatic with increasing depth in the soil profile **(Fig. 3)**.
- During the dry period from June to August, there was little difference in soil moisture between the 50% and 0% Ep irrigation levels in the upper 20 cm of the soil, but at depths greater than 20 cm, the 50% Ep irrigation level maintained a higher level of soil moisture than the 0% Ep irrigation level. The 120% Ep irrigation level maintained volumetric soil moisture content near field capacity at every depth throughout even the hottest, driest weather **(Fig. 3)**.
- Comparison of soil moisture profiles from late summer 2003 showed that the 50% Ep irrigation profile contained 7 inches less water in the upper 100 cm than the 120% Ep irrigation rate (shaded area in **Fig. 4**) while maintaining adequate turf quality.
- A greater quantity of fertilizer N was maintained in the soil under the 50% Ep irrigation rate compared to the 0% and 120% Ep irrigation levels **(Fig. 5)**.

Fig. 2. The Sentek Diviner 2000® (A) measures volumetric soil moisture content in 10 cm increments to a depth of 100 cm. Data is collected by inserting and then removing the Diviner 2000 probe into an access tube (B). Data collection time is about 1 minute per access tube.

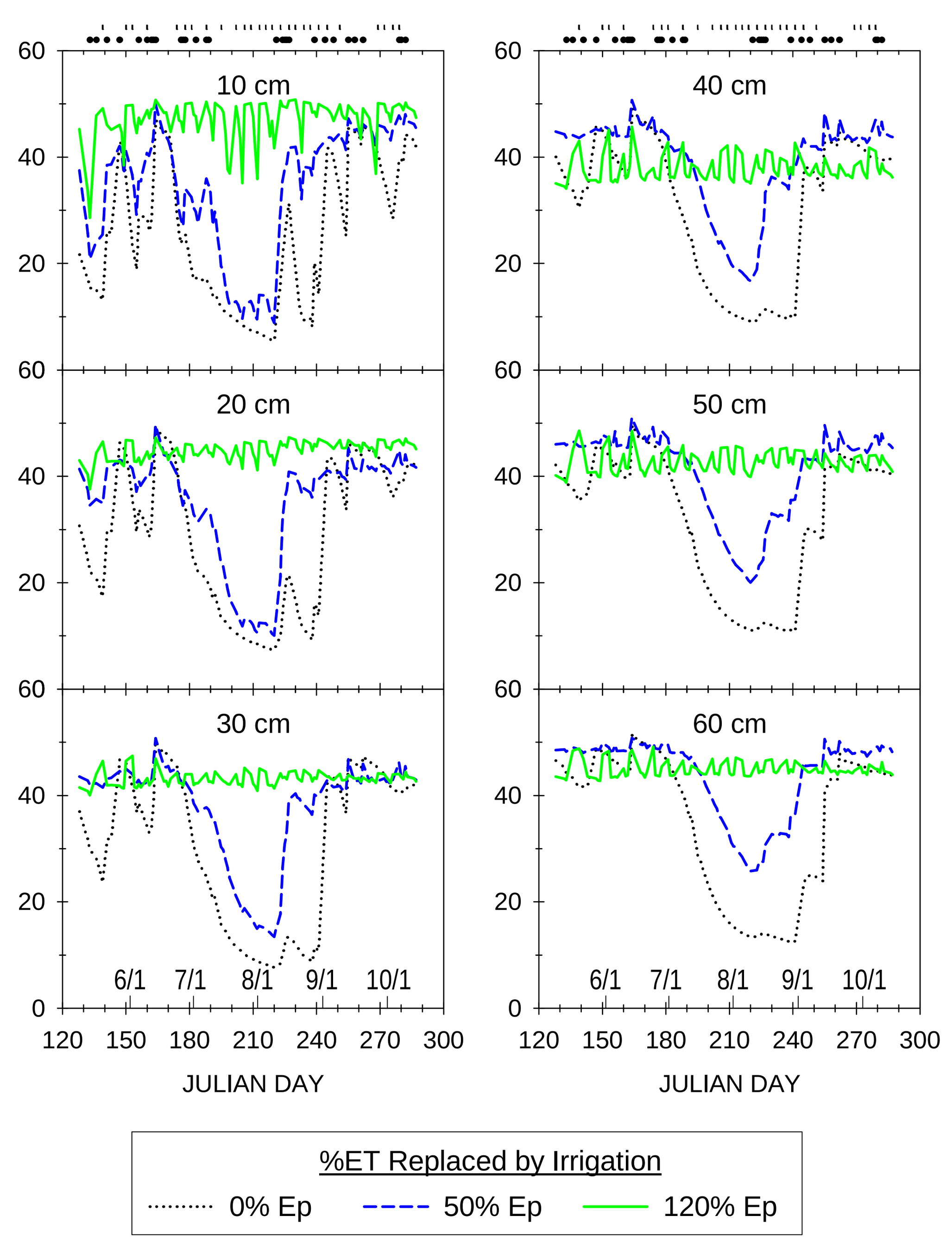

Fig. 3. Soil moisture levels in the 0 to 60 cm depth of a Bermudagrass landscape irrigated at approximately 0, 50, and 120% the rate of Class A pan evaporation from mid May to mid October. Vertical marks at the top of each column show days irrigation was applied (1.3 inches) for the 120% ET rate. Circles at the top of each column show days that rainfall was recorded.

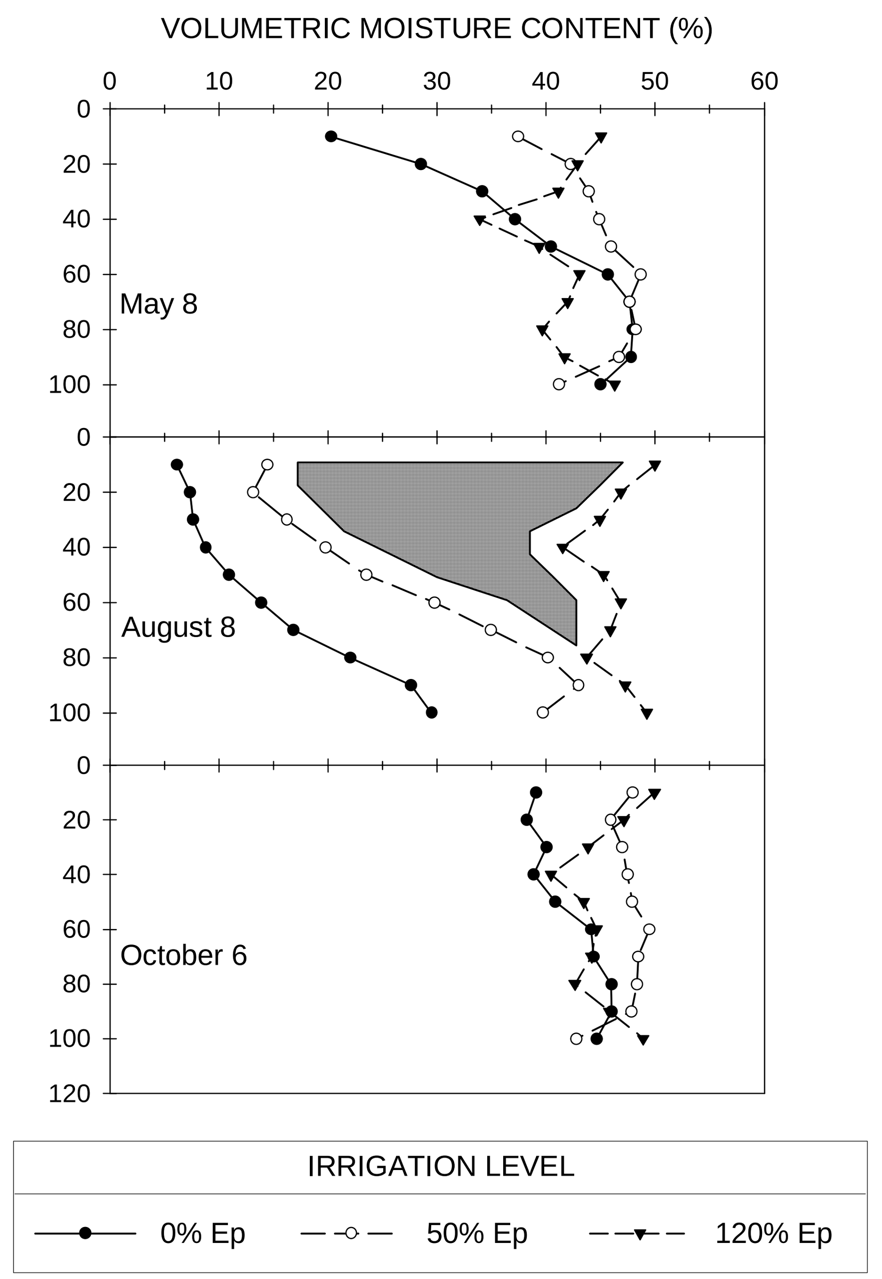

Fig. 4. Soil moisture levels on May 8, August 1, and October 6, 2003 in the upper 100 cm of a Bermudagrass landscape irrigated at approximately 0, 50, and 120% the rate of Class A pan evaporation. Dates correspond to the beginning of the irrigation season, the driest period of summer, and the post-irrigation season after several inches of rainfall. The shaded area in the August 8 plot represents potential water savings by maintaining soil moisture at the 50% Ep irrigation level.

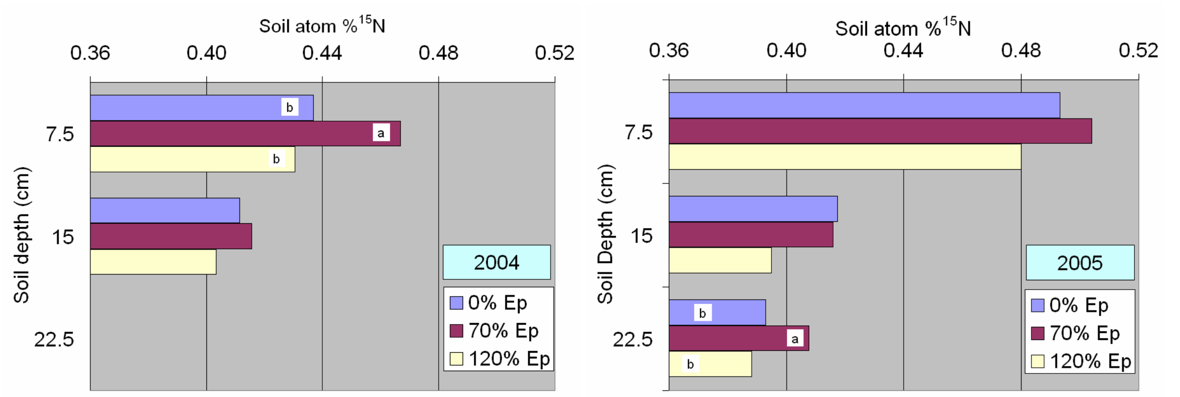

Fig.5. Soil atom %15N contents at different depths under Tifway Bermudagrass irrigated to replace 0, 50, and 120% Ep. For each year and depth, columns labeled with different letters are significantly different (LSD, p<0.05).

CONCLUSION

- Applying irrigation water at more than 50 to 70% Ep is excessive when the goal is to maintain healthy turf.
- Irrigation levels that support healthy turf growth without maintaining large quantities of soil water also sustain fertilizer N within the turf grass rooting zone.