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# THE EFFECTS OF IRRIGATION AND NITROGEN ON ST. AUGUSTINEGRASS COLOR, QUALITY AND GROWTH

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## ABSTRACT

St. Augustinegrass [(*Stenotaphrum secundatum* (Walt.) Kuntz.] is the predominate grass for lawns in Florida with an estimated 0.7 million ha. However, limited information is available on St. Augustinegrass response to irrigation regimes and nitrogen (N) levels in subtropical south Florida. A study was implemented to monitor St. Augustinegrass quality, color and cumulative turfgrass clippings in response to irrigation regimes and N inputs over six bi-monthly application cycles encompassing wet and dry seasons. Treatments were arranged in a randomized complete block, split-plot design with four replications, and consisted of two irrigation regimes: 2.5 mm daily ("low") except when daily precipitation > 6.4 mm (irrigation turned off) and 13.0 mm three times weekly ("high") with no voiding of irrigation after rain events. Subplots consisted of four N rates (98, 196, 294, and 588 N kg $ha^{-1}$ $yr^{-1}$). Irrigation regime had no effect on turfgrass color, quality or clippings throughout the duration of the experiment. However, N rate significantly affected turfgrass color, quality and cumulative turfgrass clippings. Highest visual ratings for turfgrass quality and color as well as total aboveground biomass were obtained at the 588 kg N rate. Furthermore, the lowest visual ratings for turfgrass quality and color were observed at the 98 kg N rate. All N rates provided minimum acceptable turfgrass quality of 6.0 throughout the duration of the experiment.

**Abbreviations:** C, cycle; ET, evapotranspiration; K, potassium; N, nitrogen; P, phosphorous.

**Keywords:** irrigation, nitrogen, St Augustinegrass, turfgrass, *Stenotaphrum secundatum*

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## INTRODUCTION

St. Augustinegrass, (*Stenotaphum secun-datum* [Walt.] Kuntz) is one of the most predominately used grass species for home lawns in the Southeastern United States. In Florida alone, St. Augustinegrass is grown on approximately 70% of the lawns with an additional 24,164 ha grown for sod production (Busey, 2003; Haydu et al., 2005). 'Floratam' is the most extensively used cultivar, due mainly to its resistance to chinch bugs (*Blissus insularis* Barber). Chinch bug populations have overcome the resistance of Floratam, although these populations are isolated (McCarty and Cisar, 1995). St. Augustinegrass is adapted for moderate cultural practices (Cisar et al., 1982), which include judicious inputs of both N and irrigation (Trenholm et al., 2000).

Irrigation and N are essential components of producing quality turfgrass (Beard, 1973). At the appropriate rates, N and irrigation have shown to improve turfgrass color, quality, and root growth along with many additional benefits. However, excess N and irrigation rates to turfgrass can potentially increase $NO_3$-N leaching and degrade water quality (Hull and Liu, 2005; Owen and Barraclough, 1983; Snyder et al., 1984).

With water becoming a limiting resource due to increasing population in south Florida, great efforts are being made to preserve water quality. One identified source of ground water and surface contamination is from fertilizers applied to home lawns (Petrovic and Easton, 2005). Thus, homeowners are under increasing scrutiny to ensure that management practices such as fertilization and irrigation do not impact water quality. Great measures must be taken to reduce the environmental impact of these practices without forfeiting the quality of the homeowner's lawn. One possible solution would be to reduce N and irrigation inputs. This however, could subsequently lead to a decline in turfgrass root density, thus leading to even greater quantities of $NO_3$-N contaminating ground water (Bowman et al 1998). Currently, there is very little published literature available on the quantity of nitrogen or irrigation needed to produce acceptable turfgrass quality for home yards in south Florida (Busey, 2003). Therefore, research must be conducted to provide accurate fertilizer recommendations and irrigation regimes so acceptable turfgrass quality can be maintained with minimum impact on the environment. Thus, the objective of this research is to determine the effects of irrigation regimes and nitrogen rates on turf growth, quality and color of St. Augustinegrass in south Florida.

## MATERIALS AND METHODS

In Oct 2006, a study was initiated at the Ft. Lauderdale Research and Education Center at the University of Florida on a mature stand of St Augustinegrass cv. 'Floratam' grown on mined sand (Rymatt Golf, Collier County, Florida). The field plot design was a randomized complete block, split-plot design with four replications. Main blocks (8 x 4 m) consisted of one of two irrigation regimes: 2.5 mm daily (Low) except when daily precipitation > 6.4 mm (irrigation turned off), and 13.0 mm three times weekly (High). Subplots (2 x 4 m) consisted of four N rates (98, 196, 294, and 588 N kg $ha^{-1}$ $yr^{-1}$). Nitrogen rates were split over 6 application dates: 12 Oct, 12 Dec 2006 and 15 Mar, 17 Apr, 18 Jun, and 16 Aug 2007 providing 3 application cycles (C) for each of Florida's wet and dry season. Each application date represented the start of a new fertilizer C. Spray grade granular urea (46-0-0) was used as the source of N and applied with a backpack $CO_2$-pressurized (30 psi) sprayer equipped with two flat-fan TeeJet 8010 nozzles on 51 cm spacing. Immediately following urea applications plots received 10 mm of irrigation to reduced loss to volatilization (Bowman et al., 1987). In addition, to N fertilization, P and K from triple superphosphate and muriate of potash was applied to maintain acceptable soil test values at the rate 196 and 392 kg $ha^{-1}$ $yr^{-1}$, split equally every 3 months, respectively. Throughout the duration of the experiment plots were maintained using a rotary mower and clippings were removed. Pesticides were applied according to their label when required.

Evaluations included visual ratings of quality and color based on a scale of 1-10, where 1 was brown or dead grass and 10 represented dark green uniform grass. A rating of 6 was considered minimally acceptable. Visual evaluations were made bi-weekly. Turfgrass clippings were sampled bi-weekly using a rotary mower set at a height of 75 mm and dry weights measured by drying at 60°C. Evapotranspiration (ET) was calculated using Penman model from data collected from a weather station on site (Penman, 1948).

All observations (turfgrass color, quality and clippings) were averaged on plot to plot bases over each cycle to condense and simplify data presentation. Cycle averages were subjected to analysis of variance with PROC GLM (SAS Institute, 1999) and means were separated using the Waller-Duncan's K-ratio Test ($P < 0.05$).

## RESULTS and DISCUSSION

**Hydrology.** The relative contribution of irrigation and rainfall differed depending upon the time of year and irrigation regime (Table 1). For the dry

Table 1. Total inputs of irrigation regime and precipitation per cycle (C) to St. Augustinegrass,

| †Irrigation regime | Cycle | Precipitation | Irrigation | Precipitation + Irrigation | ET |
|---|---|---|---|---|---|
| | | -----------mm----------- | | | |
| Low | C1 | 97.3 | 142.2 | 239.5 | 135.1 |
| Low | C2 | 215.9 | 221.0 | 436.9 | 201.7 |
| Low | C3 | 86.4 | 78.7 | 165.1 | 121.2 |
| Low | C4 | 411.7 | 129.5 | 541.3 | 257.6 |
| Low | C5 | 248.4 | 129.5 | 378.0 | 262.1 |
| Low | C6 | 452.9 | 104.1 | 557.0 | 210.6 |
| High | C1 | 97.3 | 330.2 | 427.5 | 135.1 |
| High | C2 | 215.9 | 508.0 | 723.9 | 210.7 |
| High | C3 | 86.4 | 177.8 | 264.2 | 121.2 |
| High | C4 | 411.7 | 330.2 | 741.9 | 257.6 |
| High | C5 | 248.4 | 330.2 | 578.6 | 262.1 |
| High | C6 | 452.9 | 292.1 | 745.0 | 210.6 |

†Low Irrigation = 2.5 mm daily except when daily precipitation > 6.4 mm (irrigation turned off), and High Irrigation = 13.0 mm three times weekly

season cycles (i.e., C1, C2, and C3) low and high irrigation regimes accounted for up to 59 and 77% of the water received by plots, respectively (Table 1). However, for the wet cycles (i.e., C4, C5, and C6) low and high irrigation regimes account for up to 34% and 57% of the water received by plots, respectively (Table 1). Furthermore, for the dry season cycles low and high irrigation regimes alone accounted for up to 110 and 251% of evapotranspiration rates. However, for the wet cycles low and high irrigation regimes account for up to 50 and 138% of ET, respectively (Table 1).

**Turfgrass Quality, color and clipping growth.** Irrigation regime had no significant effect ($P > 0.05$) on turfgrass color, quality or clippings throughout the duration of this experiment (Table 2). This may be explained by the total amounts of water (Irrigation + rain) exceeding growing season ET rates (Table 1). Under low and high irrigation regimes the total amount of water for the dry season exceeded ET by up to 216 and 359%, respectively. For the wet season total amount of water for low and high irrigation regimes exceeded ET by up to 264 and 354% (Table 1).

Table 2. Effect of irrigation regime and N fertilization on color ratings of St. Augustinegrass, average by cycle (C) for 1 yr.

| Factor | C1 | C2 | C3 | C4 | C5 | C6 |
|---|---|---|---|---|---|---|
| †Irrigation Regime | ----------------Color (1-10)‡------------- | | | | | |
| Low | 7.1 | 7.2 | 7.2 | 7.3 | 7.3 | 7.3 |
| High | 7.1 | 7.1 | 7.1 | 7.2 | 7.3 | 7.2 |
| Sig. | NS | NS | NS | NS | NS | NS |
| N Rate ($kg\ ha^{-1}\ yr^{-1}$) | | | | | | |
| 98 | 6.5 | 6.3 | 6.4 | 6.2 | 6.6 | 6.7 |
| 196 | 7.0 | 6.8 | 6.7 | 7.0 | 7.1 | 7.0 |
| 294 | 7.2 | 7.4 | 7.2 | 7.4 | 7.4 | 7.3 |
| 588 | 7.7 | 8.2 | 8.4 | 8.5 | 8.0 | 7.9 |
| Sig. | ** | ** | ** | ** | ** | ** |
| Irr. X N Interaction Sig. | NS | NS | NS | NS | NS | NS |

** and NS refer to $P < 0.01$ and $P > 0.05$, respectively.
†Low Irrigation = 2.5 mm daily except when daily precipitation > 6.4 mm (irrigation turned off), and High Irrigation = 13.0 mm three times weekly
‡ Turfgrass color ratings based on a 1-10 scale with 10=dark green turf, 1 = dead/brown turf and 6= minimally acceptable turf.

Table 3. Effect of irrigation regime and N fertilization on quality ratings of St. Augustinegrass, average by cycle (C) for 1yr.

| Factor | C1 | C2 | C3 | C4 | C5 | C6 |
|---|---|---|---|---|---|---|
| †Irrigation Regime | ---------------Quality (1-10) ‡----------- | | | | | |
| Low | 6.9 | 7.0 | 7.0 | 7.1 | 7.1 | 7.1 |
| High | 6.9 | 6.9 | 6.8 | 7.1 | 7.1 | 7.0 |
| Sig. | NS | NS | NS | NS | NS | NS |
| N rate ($kg\ ha^{-1}\ yr^{-1}$) | | | | | | |
| 98 | 6.2 | 6.0 | 6.2 | 6.1 | 6.4 | 6.5 |
| 196 | 6.8 | 6.6 | 6.4 | 6.7 | 6.8 | 6.8 |
| 294 | 7.0 | 7.2 | 7.1 | 7.4 | 7.3 | 7.2 |
| 588 | 7.5 | 7.9 | 8.0 | 8.3 | 7.9 | 7.8 |
| Sig. | ** | ** | ** | ** | ** | ** |
| Irr. X N Interaction Sig. | NS | NS | NS | NS | NS | NS |

** and NS refer to $P < 0.01$ and $P > 0.05$, respectively.
†Low Irrigation = 2.5 mm daily except when daily precipitation > 6.4 mm (irrigation turned off), and High Irrigation = 13.0 mm three times weekly
‡ Turfgrass color ratings based on a 1-10 scale with 10=dark green turf, 1 = dead/brown turf and 6= minimally acceptable turf.

Nitrogen rates significantly ($P < 0.05$) affected turfgrass color, and quality (Table 2 and 3) in all cycles. Furthermore, all N rates provide minimum acceptable turfgrass quality of 6.0 throughout the duration of the experiment. Plots receiving the highest (588 $kg\ N\ ha^{-1}\ yr^{-1}$) and lowest N rate (98 $kg\ N\ ha^{-1}\ yr^{-1}$) continuously ranked highest and lowest in turfgrass quality and color with average scores of 7.9, 8.1, and 6.2, 6.4 over the duration of the experiment (Table 2 and 3).

Plots receiving 196 and 294 kg N $ha^{-1}\ yr^{-1}$ average scores of 6.7, 7.2 and 7.0, 7.3 for turfgrass quality and color, respectively. In addition, N rates significantly ($P < 0.05$) affected turfgrass cumulative clipping weights (Table 4). In C2, C4, C5, and C6 cumulative clipping weights were always greatest and lowest in the highest and the lowest N rates with means of 36 g and 8 g when averaged for the year, respectively. Furthermore, cumulative clipping yields were higher during the wet (7 g) than dry cycles (33 g) (Table 4). The differences in clipping yields may be explained by the more conducive climate (warmer temperatures and longer photoperiod) for turfgrass growth during the wet cycles.

## CONCLUSION

The high irrigation regime applied up to 88 and 140% more water over the wet and dry cycles than the low irrigation regime without improving turfgrass color or quality. This suggests that the low irrigation regime may be a more appropriate regime out of the low and high regimes for conserving water while maintaining acceptable turfgrass quality and color. However, further research is needed to investigate rates lower than the low irrigation regime during the dry season.

Furthermore, 588 kg N ha$^{-1}$ yr$^{-1}$ produced the highest turfgrass quality and color. However, with this nitrogen rate elevated clippings yields were produced which could lead to scalping or more frequent mowing, especially during the wet season when the climate in south Florida is more conducive for excessive turfgrass growth. A rate of 98 kg N ha$^{-1}$ yr$^{-1}$maybe more appropriate for home-owners in south Florida, as fewer clippings are produced without sacrificing the quality of color of the turfgrass below unacceptable levels. Therefore, this rate may reduce the frequency of mowing and the likelihood of scalping without compromising turfgrass quality or color.

Table 4. Effect of irrigation regime and N fertilization on clipping weights of St. Augustinegrass, average by cycle (C) for 1yr.

| Factor | C1 | C2 | C3 | C4 | C5 | C6 |
|---|---|---|---|---|---|---|
| | | | g m$^{-2}$ | | | |
| †Irrigation Regime | | | | | | |
| Low | 4.2 | 3.4 | 14.3 | 20.3 | 41.4 | 41.6 |
| High | 3.7 | 3.6 | 12.1 | 19.5 | 38.2 | 37.2 |
| Sig. | NS | NS | NS | NS | NS | NS |
| N rate (kg ha$^{-1}$yr$^{-1}$) | | | | | | |
| 98 | 2.0 | 2.0 | 8.4 | 6.8 | 14.0 | 16.1 |
| 196 | 5.8 | 3.5 | 11.7 | 18.5 | 32.3 | 36.2 |
| 294 | 3.2 | 3.3 | 10.7 | 16.6 | 35.0 | 36.5 |
| 588 | 5.1 | 5.3 | 22.1 | 37.7 | 78.0 | 68.7 |
| Sig. | NS | ** | NS | ** | ** | ** |
| Sig. | NS | NS | NS | NS | NS | NS |

** and NS refer to $P < 0.01$ and $P > 0.05$, respectively.

†Low Irrigation = 2.5 mm daily except when daily precipitation > 6.4 mm (irrigation turned off), and High Irrigation = 13.0 mm three times weekly

## REFERENCES


Beard, J.B. 1973. Turfgrass science and culture. Prentice Hall, Inc. Englewood Cliffs, N.J.

Bowman, D.C., J.L. Paul, W.B. Davis, and S.H. Nelson. 1987. Reducing ammonia volatilization from Kentucky bluegrass turf by irrigation. Hort. Sci. 22:84–87.

Bowman, D.C.,D.A. Devitt, M.C. Engelke, and T.W. Rufty Jr. 1998. Root architecture affects nitrate leaching from bentgrass turf. Crop. Sci. 38:1633–1639.

Busey, P. 2003. St. Augustinegrass. pp. 309-330. *In* Casler, M. D., and Duncan, R. R. (eds.) Biology, breeding, and genetics of turfgrasses. John Wiley & Sons, Inc, Hoboken, NJ.

Cisar, J. L., G .H. Synder, and G. S. Swansoin. 1982. Nitrogen, phosphorous, and potassium fertilization for histosol-grown St. Augustine grass sod. Agron. J. 84:475-479

Haydu, J. J., J.Cisar, and L.Satterthwaite. 2005. Florida's Sod Production Industry: A 2003 Survey. International Turfgrass Society Research Journal 10 (2):700-704.

Hull, R.J. and Liu, H. 2005. Turfgrass nitrogen: physiology and environmental impacts. International Turfgrass Society Research Journal 10:962-975.

McCarty L.B. and J.L Cisar. 1995. St. Augustinegrass for Florida lawns. pp. 12-13. *In* Florida Lawn Handbook. McCarty, L.B., Black, R.J., and Ruppert, K.C. (ed.). Univ. of Florida, Institute of Florida and Agricultural Science. Gainesville, FL, USA.

Owen, T.R. and D. Barraclough. 1983. The leaching of nitrates from intensively fertilized grassland fertilizers and agriculture, N. 85, September

Penman, H.L. 1948. Natural evaporation from open water, bare soil and grass. P. Soc. Roy. A Mat. 193:120-146.

Petrovic, A. M. and Z. M. Easton. 2005. The role of turfgrass management in the water quality of urban environments. International Turfgrass Society Research Journal 10:55-69.

Trenholm, L. E., J. L. Cisar, and J. Bryan Unruh, 2000. St Augustinegrass for Florida Lawns. Electronic Data information Source (EDIS) Cooperative Extension Service Fact Sheet ENH5.University of Florida Institute of Food and Agriculture Sciences, Gainesville, FL.

SAS Institute. 1999. SAS/STAT user's guide. Version 8.02. SAS Institute, Cary, NC.

Snyder, G. H., B. J. Augustin, and J. M. Davidson. 1984. Moisture sensor controlled irrigation for reducing nitrogen leaching in bermudagrass turf. Agron. J. 76:964-969.