Impact of Surfactant Application on Turfgrass Irrigated with Diminishing Amounts of Water Based Upon Reference Evapotranspiration (ETo)

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Objectives: Crop coefficients have been developed for warm- and cool-season turfgrasses under a variety of stress levels. Data which quantify turf performance under varying crop coefficient stress levels are not readily known. Crop coefficient-based irrigation programs can be difficult for residential lawn managers because of the need for real-time meteorological data. The objectives of this study were as follows: 1) quantify St. Augustinegrass turf performance under deficit irrigation using historical average ETo, 2) evaluate interactions between deficit irrigation and fertility, and 3) identify potential benefits of wetting agent products for residential lawns.

Impact: Information will lead to a simpler message for water conservation BMP's which can provide AgriLife Extension and water supply organizations tools to better implement conservation programs. Results will offer science-based but practical recommendations for management of St. Augustinegrass in Texas. Specifically, managers and policy makers can better understand the minimal irrigation needs for viability of St. Augustinegrass turfs.

Summary: The study was conducted at the future site of the Texas A&M Urban Ecology Center on 'Raleigh' St. Augustinegrass plots maintained as residential lawns. The experimental design was a randomized complete block split-split-plot arrangement. Whole main plots were sixteen individually irrigated zones allowing for up to four replications of four irrigation treatments. Split-plot treatments were fertilizer rate and wetting agent application. An audit revealed irrigation application rates to be approximately 1.5" per hour. Irrigation scheduling was initiated on July 1, 2011, to apply the following irrigation treatments three days per week (MWF): 'overwatering' (100% ETo), 'turf coefficient' or 'Tc' (60% ETo), 'normal stress' (60% Tc), 'severe stress' (40% Tc). Baseline ETo volumes were selected from historical monthly averages for College Station. Three fertilizer rates were evaluated within each irrigation treatment: 0.0, 0.4, and 0.8 lb N 1000 ft^{-2}. Within each fertilizer rate, three wetting agent treatments were evaluated: none, Primer Select (Aquatrols), and Revolution (Aquatrols). Each wetting agent was applied monthly at label rates. Visual quality, digital image analysis (DIA), and volumetric water content were measured weekly through Sept.

Clipping yield was measured monthly, and soil chemistry was analyzed once at the conclusion of the growing season.

Irrigation main effects: Historical ETo was approximately 80% of measured ETo from July 1 to Aug 31, 2011. In general, the Tc and ETo treatments provided good quality turf throughout the growing season. Interestingly, overwatering resulted in similar moisture content as the turf coefficient despite applying 40% more water. These results are likely due to greater runoff, luxury consumption by the grass, and higher ET rates within ETo treatment plots.

Upon treatment initiation, normal stress (NS) and severe stress (SS) treatments began immediate declines in quality and percent cover until equilibrium was reached between plant density and available moisture. Despite receiving only 28% and 19% of ETo respectively, NS and SS maintained some green cover for future recovery. Generally, deficit irrigated turf recovery during fall and spring was good. During Feb and Mar evaluations, percent green cover was nearly the same for each irrigation treatment. Interestingly, DIA green cover found greater percent green cover on severe stress plots. Ultimately, for residences capable of tolerating temporary density loss, both normal and severe stress volumes appear to be effective at maintaining adequate ground cover for recovery.

The use of a crop coefficient of 0.6 for warm-season turfgrasses has been generally accepted for ‘normal’ conditions. The severity of the 2011 drought in comparison to the historical averages used for irrigation application in this study provided a unique test to our simplified model. Most importantly, it illustrated the robustness of the 0.6 Tc – Historical ETo method for irrigation scheduling. Furthermore, it points to the possibility of overwatering if occasional rainfall had occurred. Specifically, irrigation to replace 50% of ETo appears to provide acceptable turf quality. Turf performance under more ‘normal’ weather conditions is required for better evaluation of irrigation treatments.

Fertilizer main effects: Fertilizer response was slow and not evident until late summer or fall when recovery was hastened by fertilizer applications. Interactions between fertility level and irrigation volume were not evident in 2011. Spring recovery and cumulative growing season effects could produce such interactions. Fertility main effects demonstrated greater dark green color index (DGCI) on several dates, but differences between high and medium N levels were negligible suggesting 0.4 lb N per month is adequate for St. Augustinegrass turfs.

Surfactant effects: Soil surfactant effects were minimal and not affected by irrigation volume. Color enhancement was evident using either product, but soil moisture content appeared unaffected by surfactant use. Wetting agent effects should not be ignored completely as irrigation volume, slope, soil heterogeneity, or irrigation uniformity would be expected to have disproportionately greater effects.

Soil chemical analysis: Irrigation significantly affected N, P, K, Na, and pH levels. Specifically, SS treatments resulted in higher N, P, and K, and reduced Na compared to other treatments. Overwatering increased leaching of major nutrients as well as Na. Fertilizer application did not affect year end nutrient levels indicating most of the applied N had moved from the soil. Long term effects of salt loading and nutrient loss could be significant and requires further evaluation.

Conclusion

Deficit irrigation successfully reduced water consumption while maintaining adequate plant material for fall and spring turf recovery. Additionally, turf coefficient volumes maintained acceptable cover despite the extreme conditions witnessed during 2011. The unique nature of the 2011 drought has created an equally unique irrigation trial, but these data are limited. In order to evaluate long term effects of these treatments and potential cumulative effects, more data are needed. Data collected in 2011 can serve as a benchmark for the 'worst case scenario', but further data are needed for evaluation under more 'normal' weather conditions.

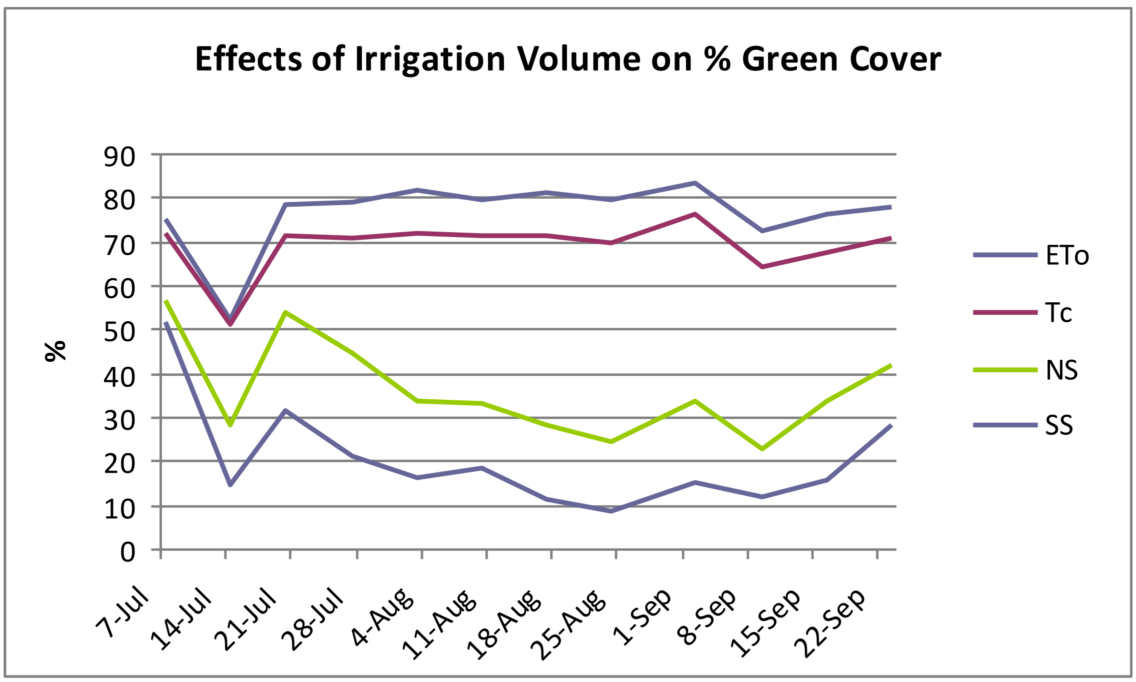

Figure 1. Effects of irrigation volume on percent green cover (DIA) recorded weekly from 7 Jul to 22 Sep 2011, College Station, TX. (ETo = 100% Historical ETo, Tc = 60% ETo, NS = 60% Tc, SS = 40% Tc).

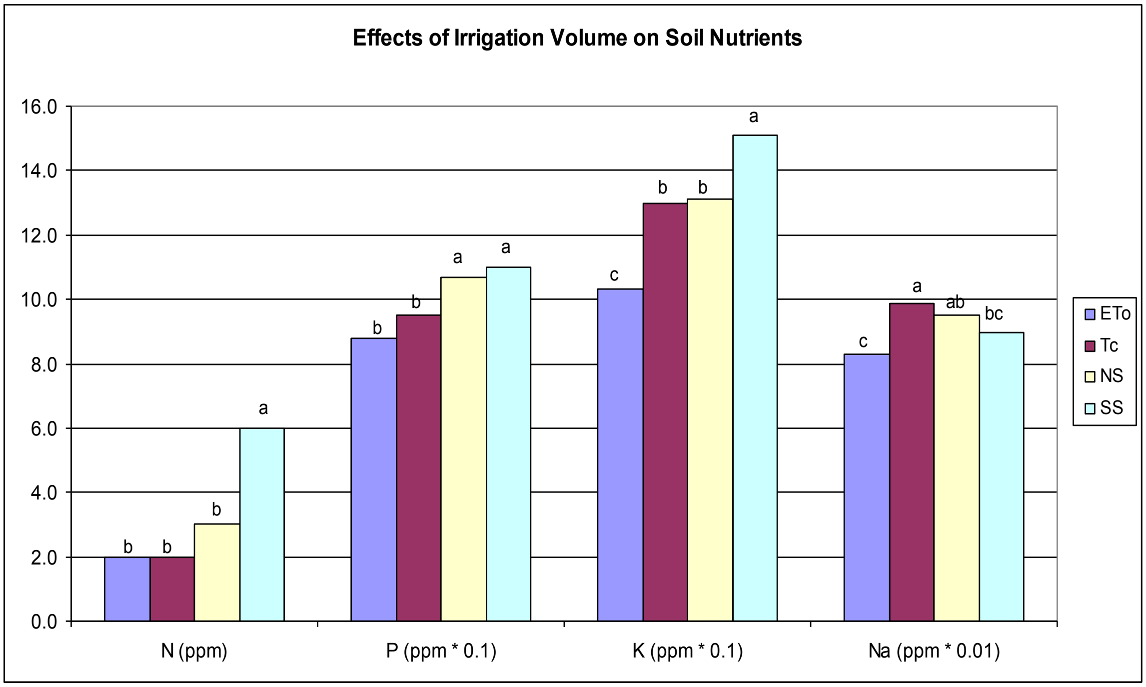

Figure 2. Effects of irrigation volume on soil chemistry. Samples were collected 2 Nov 2011 from each surfactant sub-plot and mixed by fertilizer treatment. (ETo = 100% Historical ETo, Tc = 60% ETo, NS = 60% Tc, SS = 40% Tc). Soil samples were analyzed by the Texas Soil & Water Testing Lab in College Station, TX.

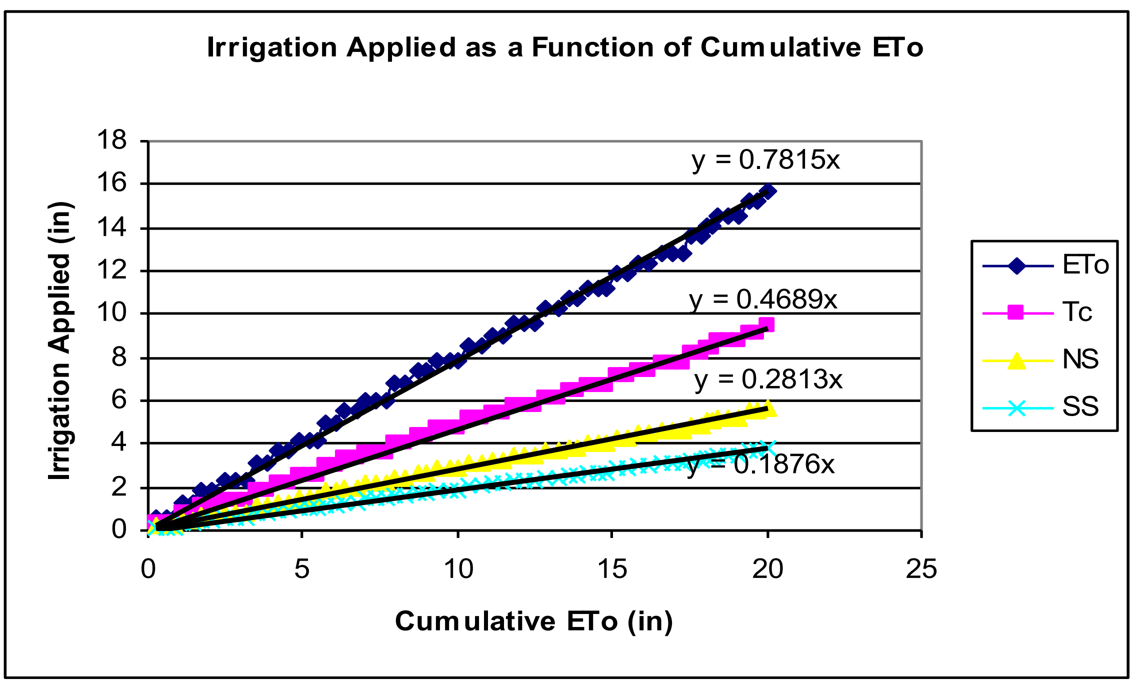

Figure 3. Comparison of irrigation applied to actual ETo from July 1 to Aug 31, 2011, College Station, TX. Meteorological data are averages of three weather stations in College Station, TX (TAMU GC, Veteran's Park, and Agronomy Rd. Turfgrass Field Lab).

Summary Report
Texas Turfgrass Research, Education, and Extension Endowment

Project title:
Develop Alternative Disease Management Strategies for Nematodes

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Project description:
Plant parasitic nematodes can be a critical limiting factor for maintaining warm-season turfgrasses in golf courses. Nematode problems on intensively managed bermudagrass are reported frequently in Texas. The sole effective nematicide, Nemacur, was banned from turfgrass use in 2008, and no effective alternative is currently available. This lack of options for controlling nematode poses a serious problem in turfgrass management, particularly for intensively managed golf course fairways and putting greens

To meet the aesthetic and recreational demands, golf course superintendents are heavily dependent on conventional synthetic pesticides. However, the use of pesticides poses substantial human health and environmental risks. Particularly, conventional synthetic nematicides including Nemacur are more toxic to humans and animals compared to fungicides and insecticides. Silver nanoparticle compounds we have developed will help to alleviate these safety concerns by producing a universal, environmentally friendly nematicide at a comparable cost to conventional pesticides. The silver nanoparticles own multi-site modes of action to kill nematodes and will provide a great alternative of the conventional nematicides. In addition, we will evaluate new nematicide products that are recently labeled for turfgrass but their effectiveness has not been fully evaluated in Texas.

Results from the 2011 field evaluation:
Nematicide efficacy was evaluated on two golf courses in the Houston metropolitan area. The first field trial (**Trial 1**) was conducted on the bermudagrass cultivar 'Tifway 419' putting green (5-inch sand cap) at a golf course in Houston. This putting green had been determined to be highly infested with sting nematode before the field experiment began. The second trial (**Trial 2**) was conducted on the bermudagrass cultivar 'Miniverde' putting green (5-inch sand cap) at another golf course in Sugar Land. This putting green had been determined to be highly infested with root knot nematodes before the field experiment began.

Individual plots measured 24-36 ft^2 and were arranged in a randomized complete block design with four replications. Individual treatments were applied at a pressure of 40 psi using a CO_2-pressurized boom sprayer equipped with two TeeJet 8002 nozzles. All nematicides were agitated by hand and applied at the equivalent of 2 gal dilute nematicide spray per 1000 ft2, with the exception of some treatments that were applied in the dry granular form by hand. Immediately after treatment, additional water was applied until the soil was saturated. Turf quality (1-9 scale: 6 = acceptable and 9 = best) were measured. In addition, to determine the change of nematode populations in turfgrass, composite soil and root samples were collected from each test plot using a standard 2.5 cm diameter soil probe. Soil cores were collected from each plot and mixed to form a composite sample. Nematodes will be extracted from each 100 cc soil sample using a modified Baermann funnel system, identified to genus, and counted using an inverted compound microscope.

Table 1. Efficacy of nematicides on **Trial 1** where the treatments were applied on 28-Mar and 11-Apr

			Turf quality			No. nematode	
Treatment	App rate	Note	11-Apr	2-May		11-Apr	2-May
Nortica WP5	50 #/A	Granular application	5.8	5.0	c	60.0	179.5
Nortica WP5	70 #/A	Granular application	5.3	5.3	bc	104.7	361.0
Nortica WP5	90 #/A	Granular application	5.3	5.0	c	60.0	223.0
Actinovate-AG	6 oz/A		5.5	5.0	c	89.0	204.0
Actinovate-S	6 oz/A		5.5	5.5	abc	86.5	119.0
NanoAg		0.5 liter per plot	5.8	5.5	abc	107.0	249.0
Control	-	-	6.0	6.0	abc	113.0	229.0
Nortica WP5	50 #/A	Sprayer at 2 gal/1000 ft2	6.0	6.5	a		347.0
Nortica WP5	70 #/A	Sprayer at 2 gal/1000 ft2	6.3	6.5	a		366.0
Nortica WP5	90 #/A	Sprayer at 2 gal/1000 ft2	6.5	6.3	ab		463.5
Fisher's Protected LSD (α = 0.05)			NS	LSD =1.038		NS (Not Significant)	

Table 2. Efficacy of nematicides on **Trial 2** where the treatments were applied on 1-Nov and 23-Nov

			Turf quality			No. nematode	
Treatment	App rate	Note	15-Nov	7-Dec		15-Nov	7-Dec
Nortica WP5	70 #/A		6.0	6.3	a	120.7	125.3
Nano Ag		0.5 liter per plot	5.7	5.3	abc	14.0	345.3
MCW-2	60 #/A	Granular application	4.7	5.0	bc	207.3	378.0
MCW-2	120 #/A	Granular application	4.3	5.0	bc	139.3	174.7
MCW-2	240 #/A	Granular application	4.7	5.7	ab	86.5	31.3
Control			3.3	4.3	c	107.0	46.0
Fisher's Protected LSD (α = 0.05)			NS	LSD =1.038		NS (Not Significant)	

Executive summary:

In the 2011 field trials, two consecutive applications at 14-21 days interval of silver nanoparticles were evaluated and compared with other commercial nematicides in terms of turfgrass quality and nematode population in the soil. No nematode treatments significantly decrease nematode population compared with the untreated control. However, the application of nematicides in November significantly improved the turfgrass quality. Silver nanoparticles did not cause any phytotoxicity on turfgrass during the field experiment. Natural populations of nematode are changing by the season. Turfgrass quality was not directly associated with number of nematodes in the soil. The second year field evaluation for silver nanoparticles is ongoing in 2012.