EVALUATION OF PROGRESSIVE TURF LLC LIQUID PRODUCTS IN PUTTING GREEN FERTILIZATION PROGRAMS

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Objective

To discover attributes of Turf Foundation and Greater Green liquid fertilizers when compared to urea-based liquid analogs as primary sources of a frequent, spoon-feeding nitrogen fertilization putting green protocol. Creeping bentgrass vigor, shoot density, and canopy color are the parameters to be used to base conclusions of fertility management and putting green quality.

Materials and Methods

General Methods and Data Collection

Plots were mowed 6-7 times weekly at a height of ⅛" and clippings were removed. All fertilizer treatments were applied using a CO_2–pressurized (262 kPa), single nozzle (Tee-Jet TP11008E, Spraying Systems Co., Wheaton, IL) wand sprayer (R&D Sprayers, Opelousas, LA). A digital metronome (KORG, Melville, NY) was employed to ensure precise nozzle travel rate across the plot length. Potable irrigation was applied to prevent wilt. Plant protectants and wetting agents were applied as necessary in accordance with label directions. High-resolution, JPEG-formatted plot images (2560 x 1920 pixels, 8.9–mm focal length, various shutter speeds and apertures) were collected at identical orientation to the sun and successively by experimental block, using a hand-held digital camera (Nikon E5700, Nikon Corp., Melville, NY). These plot images were used to measure green coloration (dark green color index; DGCI) of the putting green canopy[†]. On any given date (for either experiment), all observed DGCI values were divided by the maximum DGCI value observed that day. This normalization procedure controls ambient light variability, a particular nuisance in repeated measure field studies. The resulting 'relative' dark green color indices (relDGCI) are used to describe turfgrass canopy color response to fertilizer treatments throughout the following results and discussion.

Experiment 1:

Penn A4 creeping bentgrass (*Agrostis palustris*)/annual bluegrass (*Poa annua*) USGA green, 4-y old, low soil OM (<1.2%). PSU Joseph Valentine Turfgrass Research Center, University Park, PA.

Liquid fertilizer treatments, applied every 7-10 days (9 total applications), @ 2 gal per 1000 ft^2, were made at low (0.1 lbs N/1000 ft^2) and high rates (0.18 lbs N/1000 ft^2) using either Turf Foundation 10-3-5 (Progressive Turf LLC, Canton, GA) or urea 46-0-0 (Table 1). Experiment 1 was initiated 12 June 2006, and run for 80 days (11 weeks). The experiment was established in a randomized complete block design (3 replicates) comprising 12 plots (3 x 6 ft). Digital images of each Exp. 1 replicate plot were captured on 10 dates between 16 June and 30 Aug. 2006. Duplicate measures of 660– and 850–nm light reflectance from the canopy of each creeping bentgrass putting green plot were recorded by an ambient light-excluding FieldScout TCM–500 turf color meter

[†] Karcher, D.E., and M.D. Richardson. 2003. Quantifying turfgrass color using digital image analysis. Crop Sci. 43:943-951.

(Spectrum Technologies Inc., Plainfield, IL) on 21 and 25 June. Reflectance data were used to calculate normalized differential vegetative and leaf area indices (NDVI and LAI). Clipping yields were collected from Exp.1 plots 6 July 2006; 7 days following fertilizer applications. Shoot biomass was dried in a forced-air oven (70 ^{o}C) and weighed.

Experiment 2:

Penn A4 creeping bentgrass (*Agrostis palustris*) green, 2-y old, moderate soil OM (~2.2%). Penn State Univ., Joseph Valentine Turfgrass Research Center, University Park, PA.

Liquid fertilizer treatments, applied every 7-10 days (4 total applications), @ 2 gal per 1000 ft^2, were made at low (0.1 lbs N/1000 ft^2) and high rates (0.18 lbs N/1000 ft^2) using Turf Foundation 10-3-5, Greater Green 5-0-7 (Progressive Turf LLC, Canton, GA); or a compound fertilizer solution prepared in 0.1% acetic acid (Distilled White Vinegar, H.J. Heinz Co.) using urea, potassium sulfate, and technical-grade salts of Fe, Mn, and Mo (Table 1). Experiment 2 was initiated 13 July 2006, and run for 30 days. The experiment was established in a randomized complete block design (4 replicates) comprising 24 plots (3 x 6 ft). Digital images of each Exp. 2 replicate plot were captured on 5 dates between 14 and 26 July 2006.

Results and Discussion

Weather conditions over the experimental period were typical of central Pennsylvania summer months and supported cool season turfgrass growth. Daily high temperatures were observed in the range of 80 to 93 ^{o}F (84.9 ^{o}F mean daily high), while low temperatures ranged from 56 to 77 ^{o}F (65.6 ^{o}F mean daily low). Mean relative humidity ranged from 40 to 100%, and mean daily solar radiation levels between 500 and 900 W m^{-2} were observed. Weather data were collected onsite by an automated datalogging weather station (Campbell Sci. Inc., Logan UT).

Table 1. Fertilizer analysis and application and nutrient delivery rates for Exps. 1 & 2, Penn State Univ., 2006.

	Fertilizer Analysis							Fertilizer	Nutrient Delivery per Application						
	N	P_2O_5	K_2O	S	Fe	Mn	Mo	App. Rate	N	P_2O_5	K_2O	S	Fe	Mn	Mo
	Experiment 1: Penn A4 creeping bentgrass–annual bluegrass mixture–USGA Green														
Fertilizer	% by mass				ppm				lbs per 1000ft^2						
Urea	46	0	0.00	0.0	0.0	0.0	0.0	0.22	0.10	0.00	0.00	0.00	0.00	0.00	0.00
Turf Foundation*	10	3	5.00	1.0	0.0	0.0	0.0	1.00	0.10	0.03	0.05	0.01	0.00	0.00	0.00
Urea	46	0	0.00	0.0	0.0	0.0	0.0	0.39	0.18	0.00	0.00	0.00	0.00	0.00	0.00
Turf Foundation*	10	3	5.00	1.0	0.0	0.0	0.0	1.80	0.18	0.05	0.09	0.02	0.00	0.00	0.00
	Experiment 2: Penn A4 creeping bentgrass–Modified Soil Green														
Fertilizer	% by mass				ppm				lbs per 1000ft^2						
Greater Green*	5	0	7.00	1.0	1.0	0.4	5.0	2.0	0.10	0.00	0.14	0.02	0.02	0.008	<0.001
Urea-based Nutr. Sol.	1.033	0	0.58	0.1	0.1	0.0	0.5	9.7	0.10	0.00	0.06	0.01	0.01	0.004	<0.001
Turf Foundation*	10	3	5.00	1.0	0.0	0.0	0.0	1.0	0.10	0.03	0.05	0.01	0.00	0.000	0.000
Greater Green*	5	0	7.00	1.0	1.0	0.4	5.0	3.6	0.18	0.00	0.25	0.04	0.04	0.014	<0.001
Urea-based Nutr. Sol.	1.033	0	0.58	0.1	0.1	0.0	0.5	17.4	0.18	0.00	0.10	0.02	0.02	0.007	<0.001
Turf Foundation*	10	3	5.00	1.0	0.0	0.0	0.0	1.8	0.18	0.05	0.09	0.02	0.00	0.000	0.000

*Registered trademarks of Progressive Turf, LLC.

Experiment 1:

The relative dark green color index (relDGCI) is a highly-resolute measure of turfgrass color, and is associated with shoot chlorophyll concentrations. Putting green relDGCI responded more significantly to fertilizer rate than type (Fig. 1), as increasing N application rates increased relDGCI over the course of the study. No significant differences between the Turf Foundation and urea fertilizer products were observed at either the 0.1 or 0.18 lbs N / 1000ft^2•week rate.

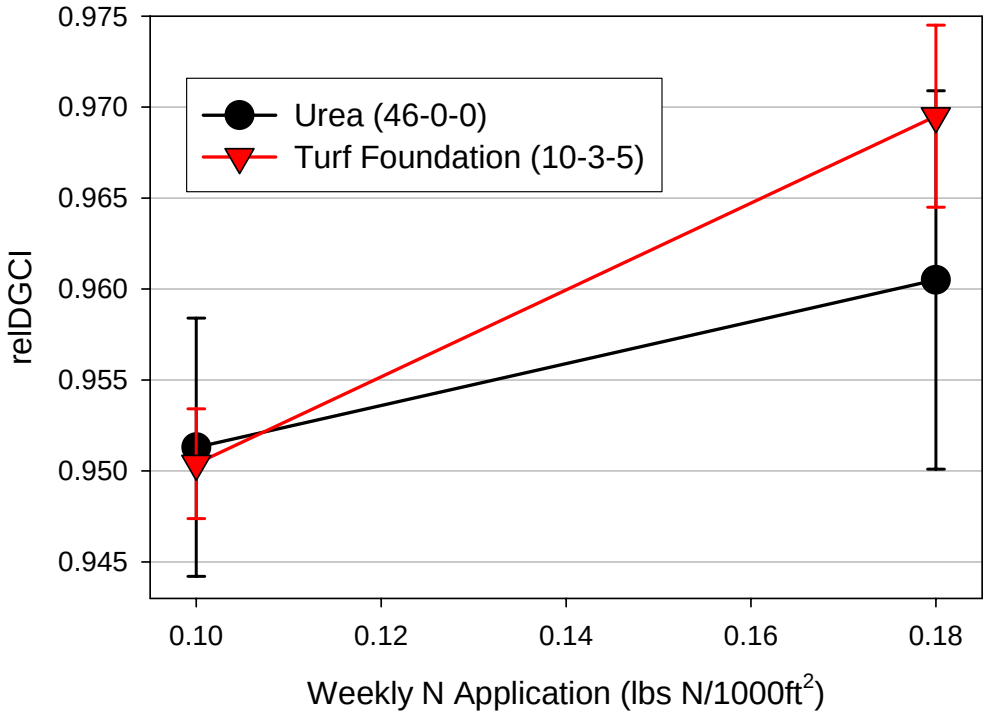

Figure 1 (right). Experiment 1 mean relative dark green color index (relDGCI), by N rate and fertilizer, all dates combined. Each symbol represents the mean relDGCI of 30 independent measures (3 replications over 10 collection dates). Means with overlapping error bars are not statistically different.

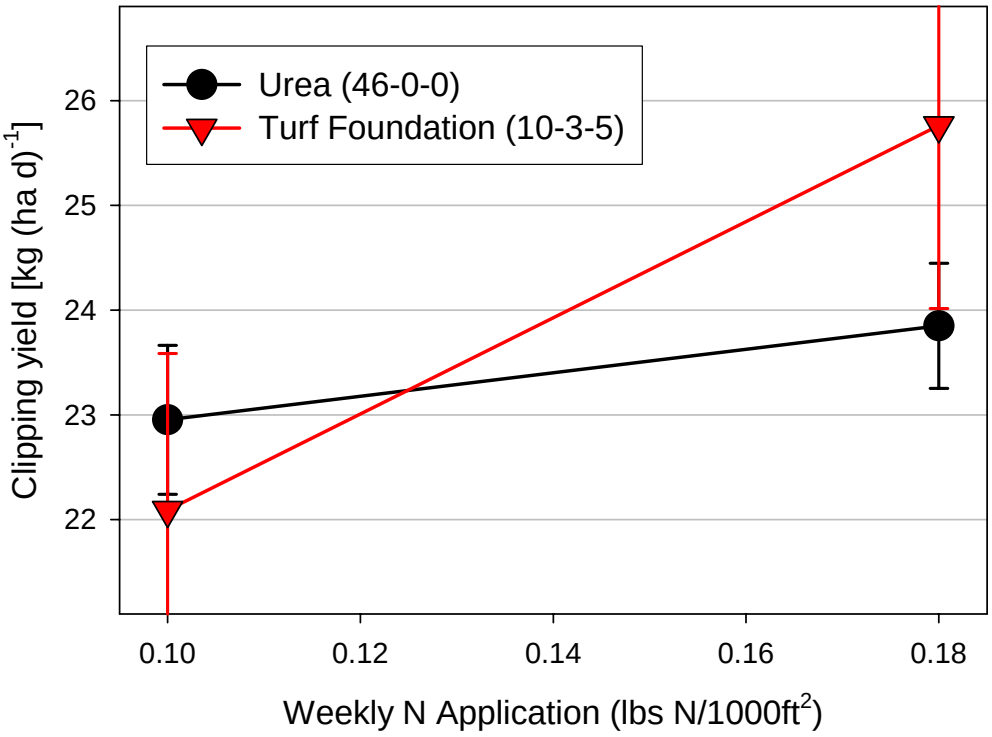

Figure 2 (left). Experiment 1 clipping yields, by N rate and fertilizer. Each symbol represents the mean clipping yield of 3 replications. Means with overlapping error bars are not statistically different.

Putting green clipping yield is a measure of turfgrass growth and vigor, and is associated with optimal growth conditions and nutrient availability. Putting green clipping yield responded more significantly to fertilizer rate than type (Fig. 2), as increasing N application rates increased creeping bentgrass/annual bluegrass growth in early July. No significant differences in shoot growth between the Turf Foundation and urea fertilizer products were observed at either the 0.1 or 0.18 lbs N / 1000ft^2•week rate.

The normalized differential vegetative index (NDVI) and leaf area index (LAI) are similarly calculated indirect measures of leaf/shoot density. During the week of 19–25 June, averaged treatment values (across both collection dates) revealed both density measures responded more significantly to fertilizer rate than type, and no differences were observed between the two fertilizers at either rate (data not shown). On a per date basis, putting green leaf/shoot density increased from 2 to 6 DAT (Figs. 3 & 4). Two DAT, every alternate fertilizer/rate showed significantly greater shoot/leaf density than the 0.1 lbs N / 1000ft^2•week Turf Foundation treatment; yet 6 DAT, the Turf Foundation treatment at the 0.18 lbs N / 1000ft^2•week rate showed the highest NDVI or LAI values (Figs. 3 & 4).

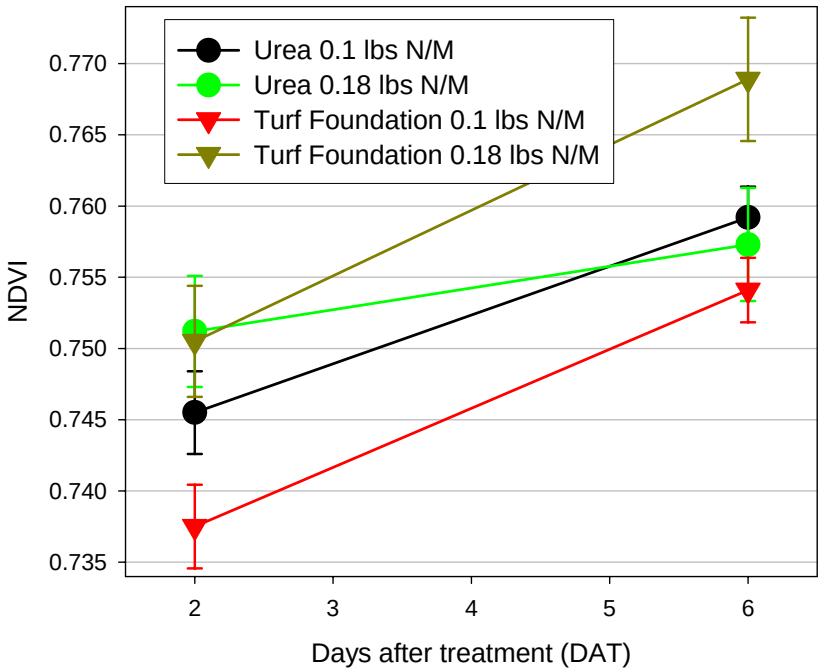

Figure 3 (above). Experiment 1 normalized differential vegetative index (NDVI), by N rate, fertilizer, and days after treatment (DAT). Each symbol represents the mean NDVI of 3 replications. Means with overlapping error bars are not statistically different.

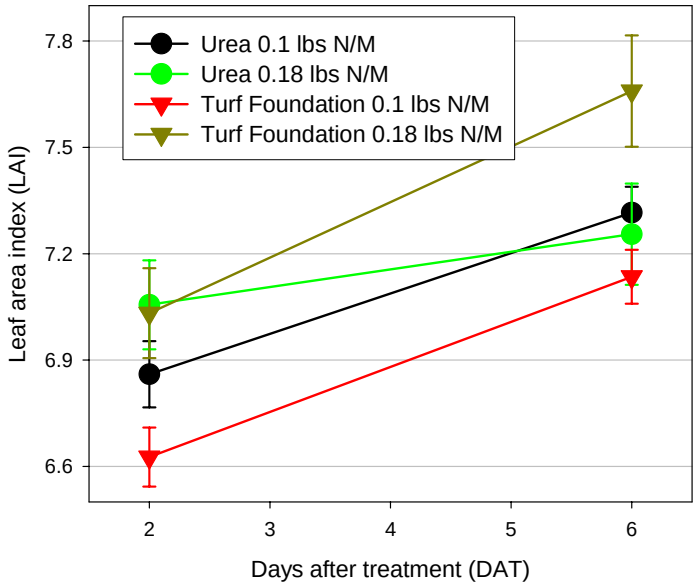

Figure 4 (left). Experiment leaf area index (LAI), by N rate, fertilizer, and days after treatment (DAT). Each symbol represents the mean LAI of 3 replications. Means with overlapping error bars are not statistically different.

Experiment 2:

The mean relative dark green color index (relDGCI) of the Penn A4 putting green canopy in Exp. 2 significantly responded to both fertilizer rate and type (across all collection dates). Increasing N application rates of any/all fertilizer resulted in significant increases in relDGCI over the course of Experiment 2. However, the control micronutrient fortified urea solution fostered significantly better canopy color than the Turf Foundation product at either 0.1 or 0.18 lbs N / 1000ft^2•week rates (Fig. 5). The same was true for the control nutrient solution compared to the Greater Green product at the 0.18 lbs N/ 1000ft^2•week rate (Fig. 5), and at both rates averaged (data not shown).

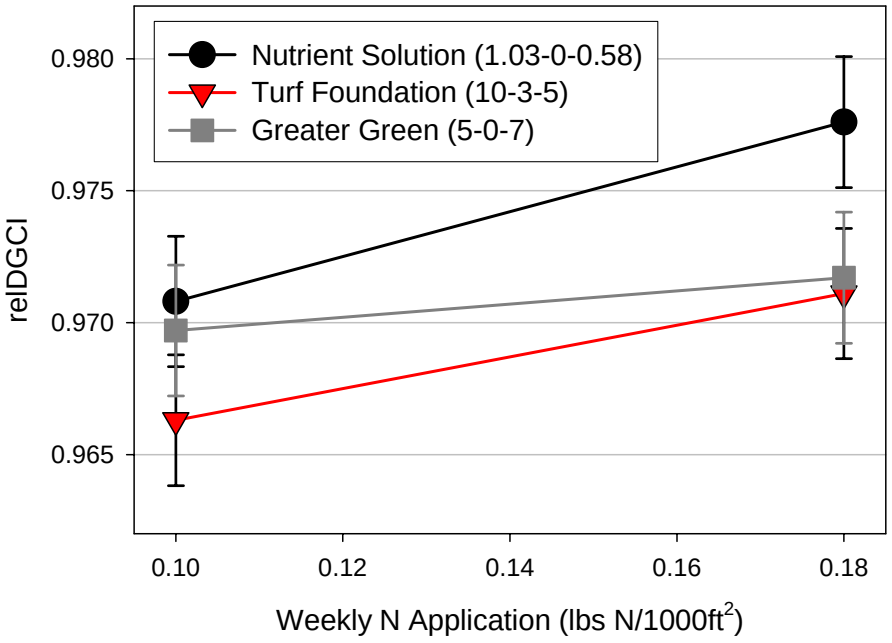

Figure 5 (left). Experiment 2 mean relative dark green color index (relDGCI), by N rate and fertilizer, all dates combined. Each symbol represents the mean relDGCI of 20 independent measures (4 replications over 5 collection dates). Means with overlapping error bars are not statistically different.

Summary

Increasing N rates from 0.1 to 0.18 lbs N/ 1000ft^2•week resulted in greater growth, leaf/shoot density, and color of Penn A4 creeping bentgrass/annual bluegrass putting greens and Penn A4 bentgrass putting greens, regardless of fertilizer type. Despite the inclusion of soybean extract in the Progressive Turf Liquid Products (Turf Foundation and Greater Green), equal N fertilization practice using simple urea solutions provided identical color and growth of Penn A4 creeping bentgrass/annual bluegrass putting greens at either rate (Exp. 1). In only one brief occasion did Turf Foundation (0.18 lbs N rate) significantly enhance Penn A4 creeping bentgrass/annual bluegrass putting green density compared to urea (Exp. 1; June 25), likely the result of greater comparative potassium and/or phosphorous fertilizer concentration in Turf Foundation (Table 1). On the five dates of the Penn A4 bentgrass putting green evaluation (Exp. 2), the control micronutrient fortified urea solution significantly increased canopy color compared to both Progressive Turf products at the 0.18 lbs N/ 1000ft^2 rates, and the Turf Foundation product at the 0.1 lbs N/ 1000ft^2 rates. The favorable performance observed of the fortified urea control nutrient solution occurred despite lesser micronutrient concentrations compared to the Greater Green product (Exp. 2; Table 1).

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