FEATURE ARTICLE I

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USGA Foliar Product Evaluation for Greens

Back to the Basics is a Good Thing

During winter 2007, I was involved in a phone conversation with the United States Golf Association (USGA) Green Section Staff and other turfgrass scientists. The topic at hand was whether more information might be needed with respect to 'spoon feeding,' a common liquid fertilization method utilized for sand-based putting greens. An idea from the USGA had just surfaced...and I was invited to be part of a team.

I was to help develop a protocol for replicated field experiment. This USGA study would establish a regular USGA product testing initiative. At the time, the view I expressed on the phone was that nitrogen levels in Chicago area had gotten lower than most had ever expected on golf greens. Fertility to promote healthy turf had given up some ground – and that ground was faster than ever before. That ground is known by golfers as the putting surface, which they simply call the green. The current issue is this: When greens aren't so green maybe they might become more prone to abiotic abnormalities during peak heat stress (e.g., midsummer decline) and experience more disease outbreaks (i.e., we have recent evidence that anthracnose basal stem rot gets worse - Uddin et al., 2009).

Today's fertility programs for golf greens must both compliment a superintendent's effort to provide plant health and provide adequate ball roll speed for golfers. As a result, foliar fertility and/or biostimulant programs that can and do allow judicious application of nitrogen have become increasingly popular. The question was..."How do we figure out which products to recommend to golf course superintendents?" Science would help provide that answer.

The Idea

The idea was that a head-to-head product test for foliar fertility of golf greens could greatly help golf course superintendents in their fertility decision making. This project was the brain-child of Jim Moore, USGA, who felt that liquid biostimulants were increasing in number and had not been adequately tested. He was right, and there continues to be limited data on how biostimulants influence plant health and disease outbreaks. Did someone say disease? So, I was teamed up with another plant pathologist, Dr. Peter Dernoeden, University of Maryland. Both Maryland and Chicago have similar cool and humid environments. We felt that the two sites would be complimentary in the study of both issues – health and disease. Both sites would follow exactly the same protocol. We aimed to test about six products that were common in the trade in the northern U.S. Region. If similar research results were obtained from both locations, it would strengthen the findings.

Trial and Error

In 2007, the first year of the study, we learned that the development of dollar spot disease was not greatly influenced by the products being tested. The levels of dollar spot we experienced were unacceptable for a green – infection center levels could quickly exceed 5% damage. Therefore, in 2008 we changed our direction, and controlled plant disease completely. We decided to make the USGA study focus solely on comparison of products to influence plant health. Plant pathologists would become plant physiologists. We would keep measurements simple, but valuable. Two aboveground plant health indicators were used, visual quality and an electronic method known as NDVI (normalized difference index). NDVI quantifies reflectance of red and infrared light from the turfgrass canopy. We expected both methods would provide similar results, but NDVI provides a useful tool because it is not subjective. Unbiased information on turfgrass health is sometimes necessary in order to aid in difficult decisions about golf green health, such as tree removal (Settle, 2008). In this case, NDVI provided a second opinion, an electronic eye's view of golf green health (chlorophyll levels). If in agreement, it would validate the visual

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quality ratings of a trained turfgrass scientist and bolster the results of both.

Defining a Biostimulant

Our aim was to test three commonly used foliar products thought to enhance green health. We included cytokinian plant extract biostimulants, iron, and nitrogen products. While the latter two represent macro-nutrients, cytokininians are plant hormones that have received increasing attention from plant physiologists. Biostimulant is actually a broad term that would define many ingredients on a 2.5-gallon jug's label.

Looking at a label you will find an ingredient list that may be long or short **(Figure 1)**. The list may include cytokinians, humates, nutrients, organic acids, hormones, vitamins, microbial inoculants, plant extracts, and more (Ervin and Zhang, 2008). Frequently, as it turns out, a biostimulant product can contain iron (Fe) and/or nitrogen (N). This fact has consequence because nitrogen effects are known to be the dominant player that stimulates plant health and growth. It makes it hard to understand the effects of most other biostimulants, when they are delivered in combination with nitrogen. In short, we know what nitrogen fertility does when applied to a green (i.e., bentgrass gets greener, denser, and grows longer). We can also 'see' the foliar effects of iron when microscopic metallic flakes paint leaf blades (i.e., a darker color occurs immediately).

Six Products Tested

In 2008, the summer quality of creeping bentgrass research greens in Lemont, IL **(Figure 2)** and College Park, MD was

Figure 1. Five products that were tested on research putting greens in IL and MD that contain cytokinians and other plant extracts, N, Fe, and/or various combinations of ingredients.

Figure 2. Dr. Mike Kenna, USGA's Director of Research, photographs field plots of biostimulant products on Sunshine Course's number 2 green in Lemont IL on 28 June, 2007.

monitored in response to six liquid fertilizer and biostimulant products and to urea **(Table 1)**. The products tested were IronRoots, Roots Concentrate, Knife, PanaSea Plus, Lesco's 12-0-0 Chelated Iron Plus Micronutrients (hereafter Lesco 12-0-0), Ultraplex, and urea. Three of these products did not contain nitrogen as a primary nutrient, so they were also mixed with urea. Those treatments were IronRoots + urea, Roots Concentrate + urea, and PanaSea Plus + urea. All products were tested at label application rates and intervals. All treatments were applied at a 14-day interval, except Knife which was evaluated, as the label recommends, at two rates either every 14 or 28 days.

Treatment and analysis *urea = 0.15 lb N/14 days*	Application rate/1000 ft²	ᶻApplication cost Acre⁻¹	Manufacturer	Additional micronutrients or other biostimulant (%)
Ultraplex 5-0-3	6.0 fl oz	$170.00	Grigg Bros.	0.05% B, 0.05% Cu, 2.0% Fe, 0.4% Mn, 0.4% Zn
Iron Roots 0-2-4	2.0 fl oz	$79.00	Novozymes	4.0% Fe
Knife 12-0-0	1.5 fl oz	$43.00	Floratine	4.0% S, 6.0% Fe
Knife 12-0-0 *28 days*	2.5 fl oz	$57.00	Floratine	4.0% S, 6.0% Fe
PanaSea Plus 0-2-2	3.0 fl oz	$151.00	Emerald Isle	Unspecified sea plant extracts
urea 46-0-0	0.15 lb N	$7.50	N/A	None
Lesco 12-0-0 + Micros	4.0 fl oz	$29.00	Lesco	4.0% S, 6.0% Fe, 2.0% Mn Chelated Iron + Micro
Roots Concentrate 0-0-0	2.0 fl oz	$43.00	Novozymes	4.6% humic acids, 3.9% kelp extract, 3.0% vitamin C, 1.0% amino acids, 0.5% myo-inositol, 0.3% vitamin B_1, 0.1% vitamin E

ᶻApplication costs are estimates based on the purchase of small amounts of product, which may vary from year to year in different markets.

Table 1. Products evaluated in IL and MD on creeping bentgrass research greens in 2007 and 2008.

Treatment and analysis *ranked by AUC values*	Rate *1000 ft⁻²*	ˣ10 Oct *visual quality*	ʸAUC *visual quality*	Percent dates (>6) *with acceptable value*
Iron Roots 0-2-4 + urea	2.0 fl oz	*8.5 a	130 a	15 of 15 = 100%
urea 46-0-0	0.15 lb	8.5 a	129 a	15 of 15 = 100%
PanaSea Plus 0-2-2 + urea	3.0 fl oz	8.5 a	127 a	15 of 15 = 100%
Roots Concentrate + urea	2.0 fl oz	9.0 a	124 a	15 of 15 = 100%
Ultraplex 5-0-3	6.0 fl oz	6.8 b	108 b	15 of 15 = 100%
Lesco 12-0-0 + Micros	4.0 fl oz	6.8 b	105 b	14 of 15 = 93%
PanaSea Plus 0-2-2	3.0 fl oz	6.3 bc	98 bc	11 of 15 = 73%
Knife 12-0-0	1.5 fl oz	5.8 cd	88 cd	2 of 15 = 13%
Iron Roots 0-2-4	2.0 fl oz	5.3 de	87 cd	2 of 15 = 13%
Untreated	—	5.3 de	86 cd	2 of 15 = 13%
Knife 12-0-0 *every 28 days*	2.5 fl oz	5.3 de	85 cd	2 of 15 = 13%
Roots Concentrate 0-0-0	2.0 fl oz	4.8 e	76 d	0 of 15 = 0%

ˣVisual quality was assessed visually on a 0 to 10 scale where 0 = entire plot area brown or dean; 6 = minimum acceptable color and quality for a putting green; 10 = optimum greenness, texture and uniformity.
ʸArea Under the Curve summarizes 15 visual quality rating dates from 24 Jun to 10 Oct.
*Column means with the same letter are not significantly different according to Fisher's LSD, P < 0.05.

Table 2. The season summary for visual quality of foliar products evaluated on a bentgrass green in Lemont, IL, 2008. Final rating date was 10 Oct and last application occurred on 3 Sep.

Materials and Methods

Both study sites used preventive fungicides every two weeks at label rates to control dollar spot (*Sclerotinia homoeocarpa*) and brown patch (*Rhizoctonia solani*). Chemistries that were rotated included Chipco 26GT, Daconil Ultrex, or Emerald. The studies were conducted on mature stands of 'Penn G-2' + 'L-93' in Lemont (hereafter IL) or 'Providence' in College Park (hereafter MD). The research greens were mowed five to six times weekly to a height of 0.156 inch. Other than for green-up, at no time during 2008 did supplemental fertilization occur. The IL site received 0.5 lb N/1000 ft² during May 2008 and the MD site received 1.75 lb N/1000ft² between April and May, 2008. Treatments were applied in 50 (MD) or 87 (IL) gallons per acre of water using a CO2 pressurized backpack sprayer equipped with two 8004 Tee Jet flat-fan nozzles. Plots were

....data showed best color/chlorophyll levels were provided by urea alone or when urea was mixed with another product in the test.

4 ft by 6 ft (IL) or 5 ft by 10 ft (MD) and arranged in a randomized complete block with four replications.

Turfgrass color and quality were assessed visually on a 0 to 10 scale where 0 = entire plot area brown or dead; 7 = minimum acceptable color and quality; and 10 = optimal greenness, texture and uniformity. Color and chlorophyll levels were estimated using normalized difference vegetation index. The small NDVI device that captured percent reflectance of red and near-infrared wavelengths from the turfgrass canopy **(Figure 3)** was a Field Scout TCM 500 Color Meter (Spectrum Technologies Inc., Plainfield, IL).

Figure 3. NDVI was used to capture light reflectance of red and near-infrared wavelengths to quantify chlorophyll content of a bentgrass green.

Results

Very similar results were obtained at both IL and MD with respect to urea. Suffice it to say, Dr. Dernoeden noted at study conclusion that near-identical results at two sites is "rare." Though we had expected to see similar trends, the research project was more successful than we had anticipated. Plant health data was limited in 2007. In that year we were focused on investigating disease suppression. NDVI in IL showed urea had a positive impact on plant health compared to other treatments. Using NDVI, which allowed avoidance of dollar spot infection centers, data showed best color/chlorophyll levels were provided by urea alone or when urea was mixed with another product in the test. Surprisingly, using NDVI comparisons, no other treatment in the study fared better than the untreated control. In 2007, the season long NDVI average represented 20 dates from 3 July to 13 November. Treatments similar to untreated were Ultraplex, Lesco 12-0-0, Knife, PanaSea Plus, and Iron Roots.

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The following year, similar results were found in IL. Highest NDVI levels again were measured with urea alone or urea in combination. In 2008, the season average represented 15 dates from 24 June to 10 October **(Figure 4)**. We also compared results in IL and MD based on visual quality, and found that urea had provided best plant health in both locations **(Figure 5)**. Looking at weekly measurements of plant health in IL, the effect of urea was obvious **(Figure 6)**. In fact, where visual quality ratings showed optimum plant health, the positive effect of urea lasted the entire season **(Figure 7)**. The line graph also shows that 'spoon feeding' low amounts of urea, 0.15 lb N/1,000 ft^2 every 14 days, provided a relatively smooth level of visual quality.

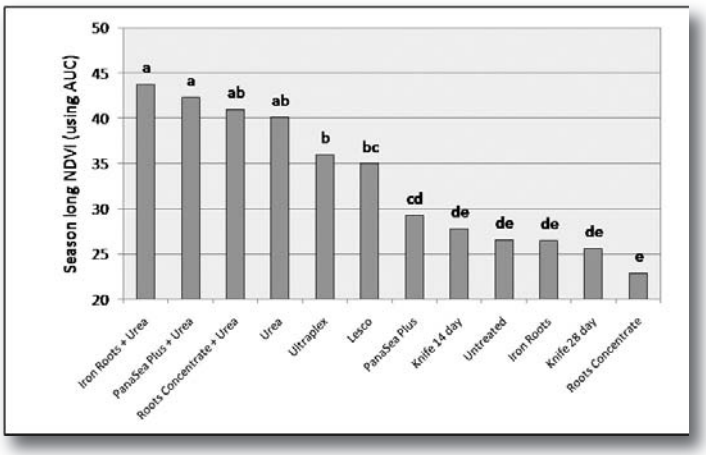

Figure 4. NDVI for all treatments when data were averaged over the 2008 season in IL.

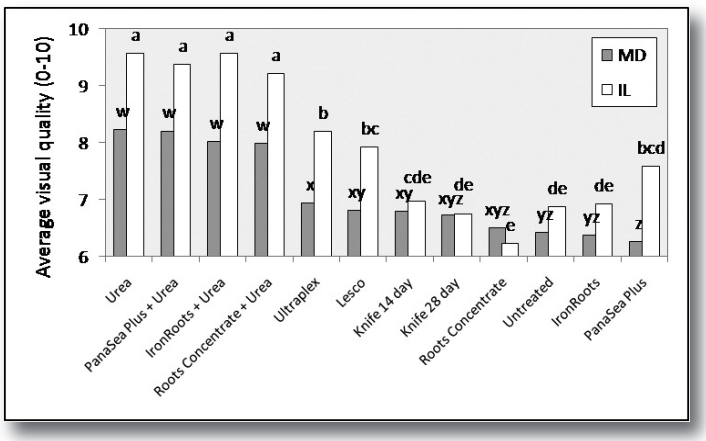

Figure 5. Visual quality ratings for all treatments when data were averaged over the 2008 season in IL and MD.

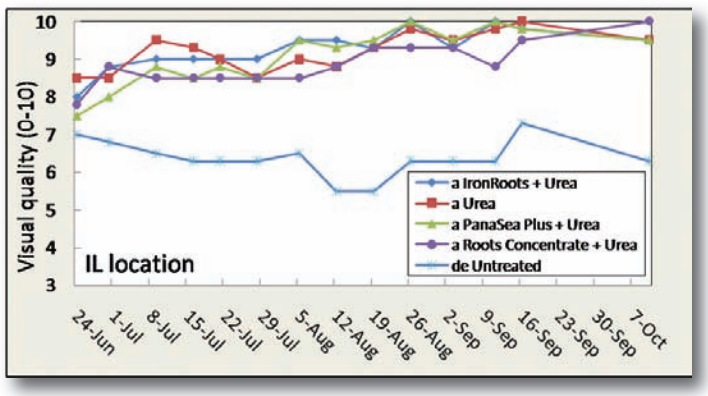

Figure 6. Weekly measurements of visual quality on a bentgrass green in Lemont, IL during 2008.

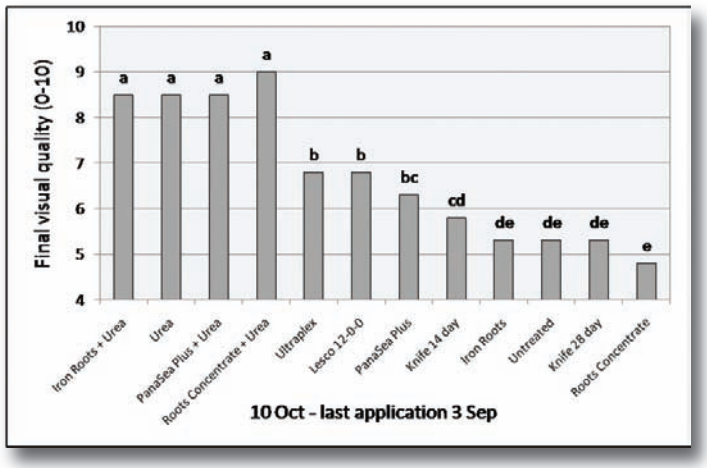

Figure 7. Residual effect of treatments in IL on visual quality when rated 10 October with last product application was 3 September, 2008.

A Lesson Learned

As one of two plant pathologists given the task of a head-to-head evaluation of several popular biostimulants and/or iron and of nitrogen products for their effect on bentgrass greens...I had learned a lot. The study provided strong evidence that there are ways to save money without sacrificing plant health. In fact, it appears that a return to urea as the primary source of nitrogen may actually improve plant health compared to the plethora of other products sometimes simply called biostimulants. As planned we had gathered plant health information from two regions – Chicago and Maryland. This suggests that urea will provide a beneficial effect for bentgrass greens in the northern U.S. region. This is real world stuff. We had used nitrogen rates that would accurately reflect current golf green fertility practices. A survey of Chicagoland Golf Course Superintendents in March of 2006 indicated that, for the season, most golf greens are limited to no more than 3 lbs of nitrogen.

Fast Forward and Back to Basics

Fast forward to 2009, declared a recession year by economists the world over. At educational meetings the talk is of "going back to basics." To me that means that we need to play our cards conservatively, we need to use our skills, our experience, and our training in the field of turfgrass science to save money. I was attending a Superintendents meeting earlier in March and heard comments by David Fearis, GCSAA Director of Membership, that were helpful. In his presentation he spotlighted the gcsaa.org website. He showed a tool that had recently been developed for the website. Several articles had been collected for reference. The tab on the pull-down menu was labeled "Economic Survival Kit." Of the dozen or so articles available online, one struck me as especially useful. The article's title was simply "Budget Crunch," and was written by David Oatis, USGA Director for the Northeast Region, on December 1, 2008. It is current information to help us during tough economic times. In the two page article he states, "So, where can dollars be cut from the budget? Perhaps the more important question is: where can corners NOT be cut? A key in working through your budget dilemma is to go back to basics." As I looked at David's nine points that might help save money... there it was, second from the end...point number 8. It read:

"FERTILIZATION – going back to the basics in terms of fertilization can save some courses hundreds, and perhaps even thousands, of dollars a year." I got to thinking, and I thought ...He's right. I have some research on that point, that number 8 point.

Although frequent spray applications of nitrogen to golf greens is nothing new, we may have forgotten its roots – that in the past superintendents had dissolved urea (46-0-0) into a spray tank using a water volume of approximately 1-2 gallons per 1,000 sq. ft. and N rates that were measured in tenths of a pound. The practice, which at some point was termed "spoon feeding," dates back to the '80s, '70s, '60s and possibly beyond (according to Dr. Randy Kane). It seems we may have forgotten that urea was the N-source. This study was not about urea, instead the urea was just meant a comparison to other biostimulant products applied at label rates. The lesson learned – from Chicago to Maryland – to achieve healthy looking greens with good color, plant density, and vigor, urea just might be the right thing to do. Consider urea in your foliar fertility program in 2009. After all it's going to be a good year for back-to-basics, keeping it simple, and saving some money wherever we can. Urea-ka! I mean Eureka! **-OC**

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