FOLIAR FERTILZATION OF BENTGRASS - GREENHOUSE EVALUATIONS

Elizabeth Guertal
Professor, Soil Fertility
Agronomy & Soils
Auburn University, AL
eguertal@acesag.auburn.edu

ABSTRACT

Foliar fertilization is often used in turfgrass management, especially on high maintenance putting greens, with weekly application of light rates of plants nutrients (ex: 1/10th lb N/1,000 square feet). This is especially true in periods of stress, such as when bentgrass putting greens are managed through hot, humid southeastern summers, and foliar fertilizers are often applied in the same spray tank as a preventative fungicide application. Turfgrass foliar fertilizers are typically sold as liquids with a complete analysis (containing N, P and K), and may also contain calcium or micronutrients, especially iron. They are heavily marketed in the turf industry, and claims amongst manufacturers as to quality of response, efficacy of nutrient uptake and turf performance are widely varied, and largely lack scientific research to support them. Thus, the objective of this greenhouse study was to examine the relative performance of nine different foliar fertilizers applied to bentgrass maintained at putting green heights. A second objective of the work was to evaluate the impact of overhead irrigation on the movement of product from the leaf to thatch and/or soil.

INTRODUCTION

Foliar fertilizer of agronomic crops has been widely studied. The work has covered many crops, including soybean, cotton, wheat and forages, with a variety of plant nutrients applied at different crop growth stages. Crop responses to foliar fertilization have been widely varied. For example, application of various foliar materials (3-8-15 and 10-4-8 analyses) to soybean at the V5 leaf stage produced a statistically significant yield response in only 2 of 26 field trials (Mallarino and Ul-Haq, 2000; Mallarino et al., 2001). However, when foliar applications were made to soybean at the R3 - R5 growth stage a significant yield response was observed, especially when the soybeans were irrigated and grown in sandy soils (Gascho, 1991). When the research which covers foliar fertilization of soybeans is reviewed for a potential application towards turf, it appears that positive yield responses tended to occur when: 1) fields were short of 100% sufficiency in P and K, 2) stress (cold, drought) reduced plant growth, and, 3) soybeans were grown in high sand soil. Such positive responses to foliar fertilization are applicable to turf, as stress and high-sand soils are typical scenarios under which bentgrass putting greens are maintained in the humid southeast (Guertal et al., 2005).

Because putting greens receive frequent (possibly weekly) application of fungicides, foliar products mesh well in turf maintenance programs. Frequent fertilization coupled with the high-sand soils of a constructed putting green means that foliar application of P and K is also a possibility. In cotton work, foliar application of K produced highly variable results. For example, when foliar was applied at 10 lb/A at 10-14 day intervals (4xs) yield was increased around 40% of time, as compared to when 100% of the K was preplant applied (Oosterhuis, 1994). A similar study (where similar rates of K were applied at a similar time (first flower)) also showed yield increase due to foliar K, but only when the cotton was grown on low K-test soils (Weir, 1998). Foliar fertilizer of cotton with nutrients other than K had less positive results, with two different studies that evaluated N and P containing foliar products concluding that there was little to no yield benefit from application of foliar products (Edmisten et al., 1994; Bednarz et al., 1998).

Unlike crops such as cotton and soybean, which have a wide range of growth stages, and an ultimate goal of maximum yield production from crops managed as annuals, turf has an ultimate goal of continued long-term quality from a perennial crop. Thus, quantifiable measures of turf quality are not bushels per acre, or lint yield, but more qualitative measures such as color and density, which are often meshed into some type of 'quality' component. For example, the only field study ever conducted with foliar application of B on turf found that in 1 of 2 years foliar uptake of B by bentgrass increased as B rate increased, but that turf color, quality, shoot density, or weight of harvested clippings was never affected (Guertal, 2004). In one of the few studies that compared a liquid N source to granular the 100% granular application produced lower turf quality in one month of the study (June), but there were no differences due to application method in any other months (July, Aug.) (Totten et al., 2004).

The one fertilizer nutrient commonly applied to turf as a foliar application which has received considerable study is iron (Fe). Long used to produce a desirable dark green color without promotion of excessive leaf growth, iron is regularly applied to many species of turf. Researchers have consistently found that application of foliar iron darkens turf color (Yust et al., 1984; Carrow et al., 1988). The iron source was an issue, as Kentucky bluegrass sprayed with iron sulfate had greater phytoxicity than when iron chelate was the Fe source (Yust et al., 1984). Additionally, greater damage was observed when Fe sulfate was applied when air temperatures exceed 82F (Carrow et al., 1988). Last, frequent foliar application of iron to turf also served as a continued color enhancer, lessening the need for greater N application (Yust et al, 1984; Carrow et al., 1988).

Given the booming market in foliar products for turfgrass, it is remarkable that so few studies have been published in the refereed literature. Reasons for this lack of data are several: 1) such work is often simple product comparison, and while important for trade journal or field day presentations, it does not always survive the scientific review process, 2) the work has been funded by a given company, and results may be the property of that company, and, 3) much of the foliar market is a recent development, and much research is currently underway, with papers publishing in the scientific literature in the next few years. This last reason is likely, as several oral and posters presentations at the 2007 meetings of the American Society of Agronomy presented first year data in the area of foliar fertilization of turfgrass. Those Abstracts can be accessed at the American Society of Agronomy web site (www.agronomy.org).

Given the paucity of data that examines foliar fertilization of turfgrass, the objective of our research project was to examine a range of commercial foliar fertilizers specially marketed for the turf industry. Specifically, the objective of this greenhouse study was to examine the relative performance of nine different foliar fertilizers applied to bentgrass maintained at putting green heights. A second objective of the work was to evaluate the impact of overhead irrigation on the movement of product from the leaf to thatch and/or soil.

METHODS AND MATERIALS

In April 2007 eighty plugs with a 2 ½ inch diameter (2 inch depth) of creeping bentgrass (cultivar 'G-2') were removed from a 3 year old research putting green located at the Auburn University Turfgrass Research Center (TGRU) and moved to the Auburn University Greenhouse Complex. There each core was washed of all attached soil, and placed into a 2 ½ inch diameter PVC column that was 6 inches high. Each column had cheesecloth taped to the bottom, and the entire core was filled with sand, with the top 2 inches left empty for insertion of the washed bentgrass core.

For the next 8 weeks (until June 1, 2007) the bentgrasses were maintained as follows. The PVC cores were placed into slotted racks so that they were held upright and could freely drain. Each day the cores were clipped to maintain a turf height of 1/8 inch, clippings removed from each core, and the core watered as needed to maintain satisfactory soil moisture. For 6 weeks each core was fertilized with a complete Hoaglands solution at a rate to supply N at 1/10th lb N/1,000 square feet per week. For the remaining two weeks, until foliar fertilizer treatments were initiated, cores were simply clipped and watered, and no additional fertilizer was applied.

On June 1, 2007 the foliar fertilizer treatments were applied. Foliar treatments are outlined in Table 1, below:

Table 1. List of foliar fertilizers applied to bentgrass cores for the greenhouse experiments, Auburn, AL.

Product Name/Treatment	Manufacturer	Analysis (N-P2O5-K2O)	Application Rate (oz N/1,000 sq. ft)
Nutri-Rational True Foliar	Emerald Isle	8-0-4 + 8%Ca + 0.12%B	0.5
Suprema	Griggs Brothers	12-0-12 + 0.005%B + 1%Fe + 0.05%Mn + 0.05%Zn	0.5
Gary's Green	Griggs Brothers	18-3-4 + 0.12%Cu + 1%Fe + 0.1% Mn + 0.1% Zn	0.5
Nutri-Rational True Foliar	Emerald Isle	10-0-10 + 8%Mg + 0.06%Cu + 0.95%Fe + 2%Mn + 0.08%Zn	0.5
15-2-15	Growth Products	15-2-15	0.5
18-3-6	Growth Products	18-3-6	0.5
NutriFoliar	LebanonTurf	18-2-5 + 1.2%S + 0.1%Cu + 1%Fe + 0.1%Mn + 0.1%Zn	0.5
NutriFoliar	LebanonTurf	18-3-8 + 2.5%S	0.5
Urea		45-0-0	0.5
Surfactant Only (Induce)			

All foliar products were applied to deliver an N rate of ½ oz N/1,000 square feet. This rate was chosen because it fit within the recommended rates for every product tested. For example, the product Gary's Green had a recommendation of 4 oz product/1,000 square feet, which equated to 0.7 oz N/1,000 square feet. The NutriFoliar 18-2-5 product recommended 3 oz of product per 1,000 square feet, equivalent to 0.5 oz N/1,000 square feet. No attempt was made to balance other included nutrients to uniformity (Ca, Fe, etc.), as this would have been problematic to do so, especially since many of the products had low analyses of nutrients other than N. Since every product recommended the inclusion of a non-ionic surfactant the product Induce was also added to every treatment, and control treatments (no fertilizer) were also sprayed with the surfactant. All surfactant was applied at a rate of 0.25% by volume, with a spray volume for all treatments (as recommended by all labeled products) of 1 gallon/1,000 square feet.

The study was arranged as a 2 x 10 factorial of N source (10) and watering (surface or below surface). The watering treatment was included because we wanted to test the hypothesis that foliar applied N is washed off the turfgrass leaf by frequent irrigation. To test this hypothesis 8 cores of each fertilizer treatment (4 reps of surface watering and 4 of subsurface) were sprayed with the selected fertilizer treatment using a herbicide application spray table that had been calibrated to apply the fertilizer at the correct rate and spray volume. After all fertilizers had been applied one time the cores were returned to the greenhouse where they were split into subwatering and surface watering treatments.

Fertilizer treatments were applied one time, and were then allowed to grow for one week, with no additional fertilizer applied during that time. First watering treatments were not applied until 48 hr after fertilizer treatments had been applied. All cores were watered twice in the week long period, with surface watered cores watered using the same spray table used to apply the fertilizer treatments, and subsurface water treatments applied by inserting a pipette containing the correct amount of water just at the thatch:soil interface of each core, and slowly injecting the water. Water was applied to equal that lost to evapotranspiration, as measured via weather monitoring equipment in the greenhouse. This was equal to approximately 1 inch water for the week.

One week after fertilizers were applied each core was destructively harvested, with all top growth removed, weighed, dried and reweighed. A subsample was analyzed for total N content. All root material was washed free of sand, dried, and weighed.

This entire experiment was repeated two times, each time following the process described above. Experiment 1 had cores moved to the greenhouse in April, 2007, with the experiment initiated on June 1, 2007. Experiment 2 had a new set of eighty cores moved to the greenhouse in May, 2007, with the experiment initiated on July 1, 2007. All experiments were run in the Auburn University greenhouse facility in a glasshouse with a maximum daily temperature of 85F and ambient light conditions.

RESULTS AND DISCUSSION

In Experiment 1 the watering treatment never significantly affected any of the measured variables, nor was the interaction of watering x fertilizer source significant. However, fertilizer source did affect the dry weight of harvested clippings and root, and N content of the bentgrass. Table 2 (below) illustrates these treatment effects.

Table 2. Effect of various foliar fertilizers on clipping and root weights, and N uptake by bentgrass, greenhouse study, Auburn, AL. Experiment 1.

Product Name/Treatment	Clipping wet wt	Root dry weight	N uptake
	g per core	g per core	g per core
Nutri-Rational True Foliar 8-0-4	0.67 abc	0.17 a	0.0043 abc
Suprema 12-0-12	0.55 c	0.13 abc	0.0036 c
Gary's Green 18-3-4	0.80 a	0.14 abc	0.0053 a
Emerald Isle 10-0-10	0.78 a	0.12 bc	0.0048 ab
Growth Products 15-2-15	0.63 abc	0.12 bc	0.004 bc

Growth Products 18-3-6	0.66 abc	0.14 ab	0.0042 bc
NutriFoliar 18-2-5	0.60 bc	0.14 ab	0.0041 bc
NutriFoliar 18-3-8	0.74 a	0.11 bc	0.0047 ab
Urea 45-0-0	0.56 c	0.09 c	0.0035 c
Surfactant Only (Induce)	0.36 d	0.09 c	0.0024 d

Within each column, means followed by the same letter are not significantly different from each other at alpha = 0.10.

In Experiment 2, either the interaction of watering method x fertilizer source was significant (root weight), or the main effect of watering method was significant (wet weight of clippings, dry weight of clippings, N uptake).

Table 3. Effect of various foliar fertilizers on clipping and root weights, and percent N by bentgrass, greenhouse study, Auburn, AL. Experiment 2.

Product Name/Treatment	Clipping wet wt	Root dry weight	N content
	g per core	g per core	percent
Nutri-Rational True Foliar 8-0-4	0.70 a	0.15 a	2.33 a
Suprema 12-0-12	0.71 a	0.19 a	2.11 bc
Gary's Green 18-3-4	0.73 a	0.18 a	2.15 b
Emerald Isle 10-0-10	0.71 a	0.13 a	2.07 bc
Growth Products 15-2-15	0.73 a	0.15 a	2.10 bc
Growth Products 18-3-6	0.60 a	0.14 a	1.95 c
NutriFoliar 18-2-5	0.67 a	0.17 a	2.03 bc
NutriFoliar 18-3-8	0.68 a	0.16 a	2.11 bc
Urea 45-0-0	0.67 a	0.16 a	2.07 bc
Surfactant Only (Induce)	0.45 b	0.16 a	1.76 d

Within each column, means followed by the same letter are not significantly different from each other at alpha = 0.10.

Table 4. Effect of method of water application on clipping and root weights, and percent N by bentgrass, greenhouse study, Auburn, AL. Experiment 2.

Method by which water applied	Wet weight clippings	Dry weight clippings	Dry weight roots	N uptake
	grams per core			
Watered over top	0.62 b	0.17 b	0.16 a	0.003 b
Applied at side of core - no water touches leaf tissue	0.70 a	0.20 a	0.16 a	0.004 a

CONCLUSIONS

1. In both experiments, application of foliar fertilizers produced significant increases in clipping yield and N content, one week after a single application. Yield and N content were always greater than that measured in the unfertilized (surfactant only) control.

2. The effect of surface watering was mixed, with no affect in one experiment, and reductions in clipping yield and N uptake due to surface watering in the second experiment. This result shows that additional focus and experimentation is needed in this area, both in the greenhouse and field.
3. There were few consistent, strong responses due to a particular fertilizer source, and in Experiment 2 all products produced the same clipping yield (no significant differences).

4. Additional research is needed which: 1) also examines the continued application of products, rather than a single application, 2) includes rates as a treatment variable, and, 3) evaluates the products in the field rather than greenhouse environment.

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