Bio-Fertilizer Study on 'TifWay' 419 Bermudagrass Fairway Season I (2012) Report Nov. 28, 2012

TO
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Location:

Clemson University Turfgrass Research Plots

Turfgrass:

'TifWay' 419 Bermudagrass
- -maintained as golf course fairway
- -1/2" height of cut

Treatments:

3 Fertilizers with Bio-fertilizer (Humble Acres Organics) included
- -2lb N + Bio/1000ft^2
- -1.5lb N + Bio/1000ft^2
- -1lb N + Bio/1000ft^2

1 Control (synthetic) fertilizer
- -1.5lb N Control/1000ft^2

The applications were made on August 1 and September 12 as the above rates.

Experimental Design:

- -Factorial
- -4 fertilizer treatments x 3 replications = 12 plots

Objectives:

- Determine the longevity of fertilizer applications with/without a bio-fertilizer component.
- Measure the macronutrient status within the turfgrass following fertilizer applications.
- Establish the effects of bio-fertilizer amendments on turf quality, chlorophyll content, potential root growth enhancement, and clipping yield.

Parameters Measured:

Turf Quality (TQ)
Turf Quality is a visual rating on a 1-9 scale with 9 being perfect turf and 1 being completely dead turf. TQ ratings took place on a weekly basis. Two separate evaluations were taken each week, with different evaluators then the data was averaged. This resulted in three TQ means for each fertilizer treatment, which were analyzed separately. Turf quality readings equaling 6 or above are considered as acceptable turf.

Chlorophyll Index
Chlorophyll Index is a measure of the total chlorophyll, measured by the reflectance of the turfgrass canopy. The measurements were acquired with a CM 1100 Chlorophyll Metter. Measurements were taken weekly, with five individual readings per plot.

Nutrient Concentration
Nutrient concentration of leaf tissue is the only accurate method of determining the nutrient status of turfgrass plants. Clippings were harvested with a John Deere reel mower, dried at 80°C for 48 hours, and analyzed at the Clemson University Soil Testing Laboratory.

Root Mass (muffle furnace ash-free root weight)
Root mass was determined by harvesting a turfgrass core measuring 4.25" diameter from each plot with a standard golf course cup cutter with a depth of 10". Samples were collected on October 18th, 2012, 36 days after the second application of September 12, 2012. Samples were washed free of soil, dried 48 hours at 80°C, and dry weight was determined. After the dry weight was recorded, the samples were ashed in a muffle furnace at 525°C for two hours. Upon cooling, the ashed root weight was determined gravimetrically. In other words, the burned off parts were the real roots, any soil residues would remain in the ash. Therefore it is also called ash-free root weight. This method of root measurement is the most accurate, because it allows the researcher to only measure organic matter (roots) while taking into account the inorganic soil material attached to the roots.

Clipping Yield
Clipping yield is an indicator of turfgrass growth and overall plant health. Clipping yield is measured by mowing a known area of the turfgrass plot and determining the mass of clippings collected on October 18, 2012, 36 days after the second application of September 12, 2012. Clipping yield measurements were taken with a John Deere reel mower adjusted to ½" with a clipping collecting basket.

Results

Turf Quality (1-9 Scale) (September 17 to November 23, 2012, average of weekly readings)
Fertilizer treatments provided a significant main effect for turf quality ratings ($p<0.0001$) throughout the first season of the study. Treatment mean TQ ratings from Evaluator I were 7.8, 7.3, 6.6, and 6.3 for 2lb N Bio, 1.5lb N Bio, 1lb N Bio and 1.5lb N Control, respectively. Treatment mean TQ ratings from Evaluator II were 6.4, 6.4, 5.3 and 6.0 for 2lb N Bio, 1.5lb N Bio, 1lb N Bio, and 1.5lb N Control, respectively. When the two Evaluations were averaged the treatment means were as follows: 7.2, 6.8, 6.0, and 6.1 for fertilizer treatments 2lb N Bio, 1.5lb N Bio, 1lb N Bio, and 1.5lb N Control, respectively. (Table 1)Although the separate evaluations were slightly different the general trends of the treatments were similar, as N input increases TQ ratings increase. Interestingly the Average of the two evaluations did not provide a significant difference between the 1lb N Bio and 1.5lb N Control, which provides evidence that using the bio-fertilizer containing lower amount of N can produce similar TQ ratings compared with a control product containing higher amounts of N but no bio product.

Table 1: Turf Quality Averages for Season I (2012) for Bio-fertilizer on 'TifWay' 419 Bermudagrass Fairway: Evaluator I, II and Average

Treatment	Evaluator I		Evaluator II		Average	
2lb N Bio	7.85	A	6.38	A	7.11	A
1.5lb N Bio	7.35	B	6.42	A	6.91	A
1lb N Bio	6.62	C	5.38	B	6.00	B
1.5 N Control	6.27	D	6.00	C	6.13	B

*TQ means based on 1-9 scale. 6 = minimal acceptable.
*Means separated with Student's t ($\alpha = 0.05$), treatments with same letter are not significantly different.

Chlorophyll Index (0-999 Scale)
The chlorophyll index obtained weekly along with TQ ratings revealed a highly significant main effect of fertilizer treatments ($p < 0.0001$). The fertilizer treatment means for season I of the study for chlorophyll index were 367.1, 342.1, 307.9 and 309.1 for 2lb N Bio, 1.5lb N Bio, 1lb N Bio and 1.5lb N Control (Table 2). Again we see a trend of the increased N in the fertilizer provided increased chlorophyll content. Treatments 1lb N Bio and 1.5lb N Control were not statistically different, which provides evidence that 1lb N Bio with lower inputs of N are providing similar chlorophyll production compared to the 1.5lb N Control with higher N inputs.

Clipping Yield (g^{-1} m^{-2})
The clipping yield of the fertilizer treatments provided a significant effect ($p = 0.0251$). The two largest clipping yields came from treatments 2lb N Bio and 1.5lb N Bio with means of 1.22 and 0.91 g^{-1} m^{-2} of dry weight, respectively. Fertilizer treatments 1lb N Bio and 1.5lb N Control had clipping yield means of 0.74 and 0.76 g^{-1} m^{-2}, respectively (Table 2). Along with treatments we obtained clipping yield outside the plots for a check, with had significantly lower growth as the clipping yield mean was 0.46 g^{-1} m^{-2}. The pattern of clipping yield for treatments is similar to that of TQ and Chlorophyll Index, as the more N applied with more growth is expected. Again similar results were seen between the 1lb Bio N treatment and 1.5lb N Control, providing additional evidence to the bio product providing an aid in growth with lower N input compared to the control treatment.

Root Mass (g^{-1} m^{-2})

Fertilizer treatments did not provide a significant effect on root mass (p = 0.9436). Data from root samples provide means of 377.4, 334.5, 377.1, 385.1 and 366.1 (g^{-1} m^{-2}) for the treatments 2lb N Bio, 1.5lb N Bio, 1lb N Bio, 1.5lb N Control and the Check samples, respectively (Table 2). There was not a significant difference or pattern seen between treatments and root mass.

Table 2: Effect of Bio-fertilizer for Chlorophyll Index, Clipping Yield and Root Mass on 'TifWay' 419 Bermudagrass Fairway

Treatment	Chlorophyll Index		Clipping Yield		Root Mass	
	(0-999 scale)		($g\ m^{-2}$)			
2lb N Bio	367.1	A	1.22	A	377.3	A
1.5lb N Bio	342.2	B	0.91	AB	334.5	A
1lb N Bio	307.9	C	0.74	BC	377.1	A
1.5lb N Control	309.1	C	0.77	BC	385.2	A
Check	------		0.46	C	366.2	A

*Means separated with Student's t (α = 0.05), treatments with same letter are not significantly different.

Nutrient Content (N, P, K % Dry Weight)

Nutrient content is expressed in percent dry weight. For N content, fertilizer treatments provided means of 3.30, 3.46, 3.21, 3.14 and 3.00% for 2lb N Bio, 1.5lb N Bio, 1lb N Bio, 1.5lb N Control and the check, respectively. There was not a significant treatment effect on N content (p = 0.4516). Although similar patterns were seen as mentioned above, there were not significant differences between treatments.

Fertilizer treatments did not provide a significant effect for P or K content (p = 0.8524, p = 0.5282, respectively). Samples of 2lb N Bio, 1.5lb N Bio, 1lb N Bio, 1.5lb N Control and check provided means of 0.28, 0.30, 0.30, 0.28, and 0.31, respectively, for P content. No significant differences were found. K content followed the same trend with no statistical difference among treatments, with means being 1.01, 1.04, 0.98, 0.94, 0.90% for 2lb N Bio, 1.5lb N Bio, 1lb N Bio, 1.5lb N Control, and Check, respectively (Table 3).

Table 3: Effect of Bio-fertilizer on Nutrient Content of Nitrogen, Phosphorus and Potassium on 'TifWay' 419 Bermudagrass Fairway

Treatment	Nitrogen		Phosphorus		Potassium	
	% Dry Weight					
2lb N Bio	3.31	A	0.28	A	1.01	A
1.5lb N Bio	3.46	A	0.30	A	1.04	A
1lb N Bio	3.21	A	0.31	A	0.98	A
1.5lb N Control	3.14	A	0.28	A	0.94	A
Check	3.00	A	0.31	A	0.90	A

*Means separated with Student's t (α = 0.05), treatments with same letter are not significantly different.

Season I (2012) Preliminary Conclusions:

The preliminary results for season I (2012) were analyzed and listed above. The evaluations of TQ differed slightly with Evaluator II providing slightly lower average TQ ratings than Evaluator I for fertilizer treatments. Although the evaluations were different, the trends are similar. The average of the two evaluations revealed that treatment with the 1.5lb N with bio-fertilizer provided increased TQ compared to the control of equal N input. Also, the treatment with 1lb N bio-fertilizer provided statistically the same TQ as the control that had higher amounts of N input. This result suggest that applying fertilizer N with the bio-product included, managers could possibly reduce total N input and produce similar TQ ratings to a product with more N but no bio-product.

Chlorophyll index is one indicator of plant health and nitrogen status within the plant. With weekly measurements of chlorophyll index we saw a similar trend to TQ with the fertilizer treatments. The highest chlorophyll index treatment was 2lb N with bio-fertilizer, which is expected as it received the most N. Interestingly, the 1.5lb N bio-fertilizer treatment provided higher amounts of chlorophyll than the 1.5lb N control treatment, which received the same amount of N. This could be a result of the bio-product providing increased amounts of soil N. The treatment of 1lb N bio-fertilizer produced statistically the same chlorophyll index as the 1.5lb N control. A similar process could be developing as previously mentioned, where soil N is being released by aid of the bio-product, to provide more N to the plant than applied.

Clipping yield follows a similar pattern as mention in TQ and chlorophyll index, increased amounts of N to the plant produces increased amounts of growth. Again, 2lb N bio-fertilizer treatment produced the most amount of clippings but was not statistically different that 1.5lb N bio-fertilizer treatment. An experiment check was analyzed as well, with the data acquired outside of the plots. The check had the lowest amounts of clippings as it was not receiving as much N as the treatment plots. The 1lb N bio-fertilizer treatment was statistically the same as the 1.5lb N bio-fertilizer and 1.5lb N control treatments, which provides further evidence that the bio-product could be aiding in soil N uptake of the plant.

Root mass data did not provide any particular trend that follows any of the above mentioned parameters. All treatments were statistically the same, with no pattern developing with fertilizer treatments. With a second season and increased applications, possible treatments effects could develop and be found.

There were no significant treatment effects seen for nutrient content analysis. Although with N content, a slight pattern was seen as N increases with the fertilizer treatment the more N was found in the plant, but these were not significantly different from each other. K content follows a similar pattern where increased N applied provided more K content in the plant but there were no treatment differences. As with N and K content, there were no significant treatment effects seen with P content and there was no possible treatment pattern seen. It is possible with season II data, a clearer trend will form for nutrient content.

Figures for data are listed below:

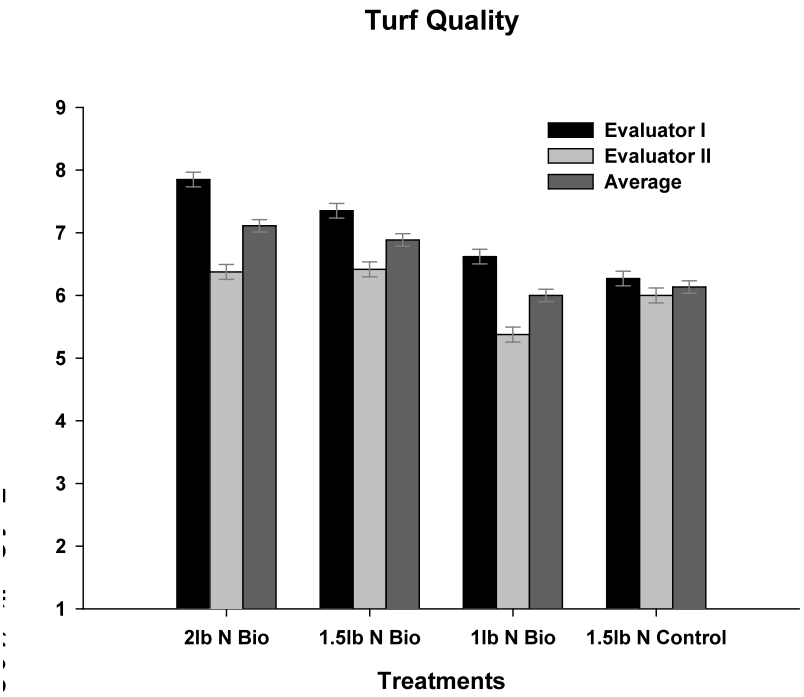

Figure 1. Fertilizer Treatment Turf Quality Averages for Season I (2012).

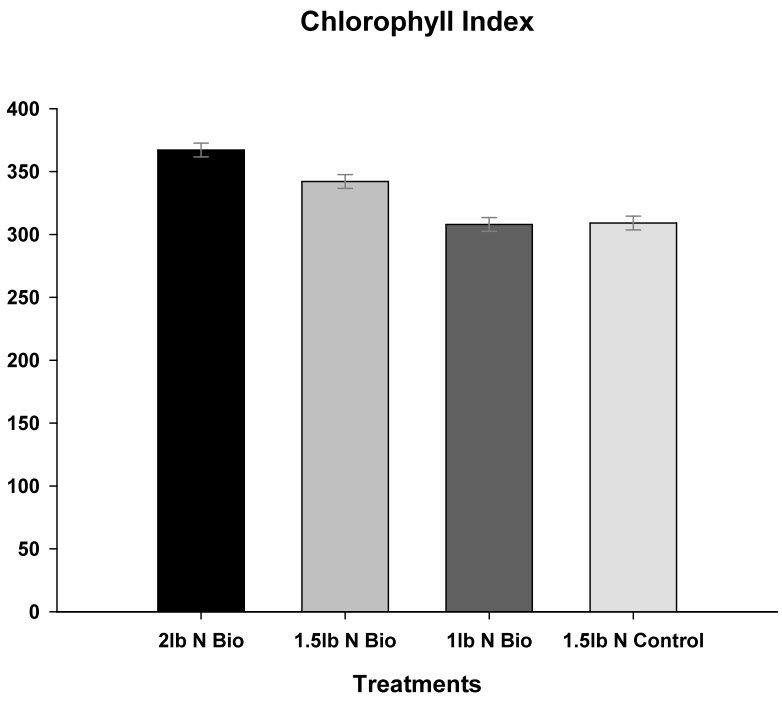

Figure 2. Fertilizer Treatment Chlorophyll Averages for Season I (2012).

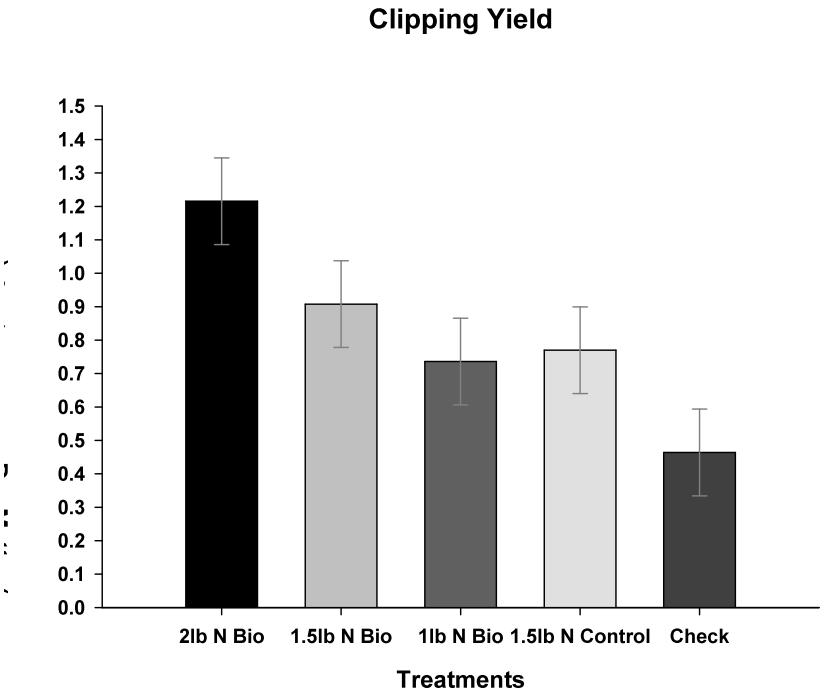

Figure 3. Clipping Yield (grams per square meter) Averages of Fertilizer Treatments for Season I (2012).

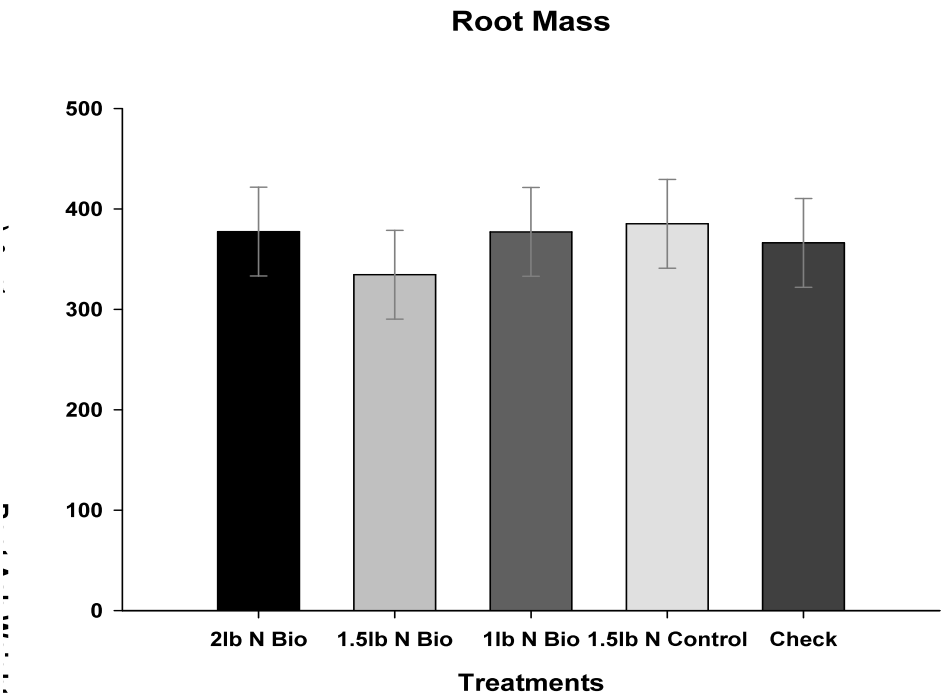

Figure 4: Root Mass (grams per square meter) for Fertilizer Treatments measure by Root Ash Weight for Season I (2012).

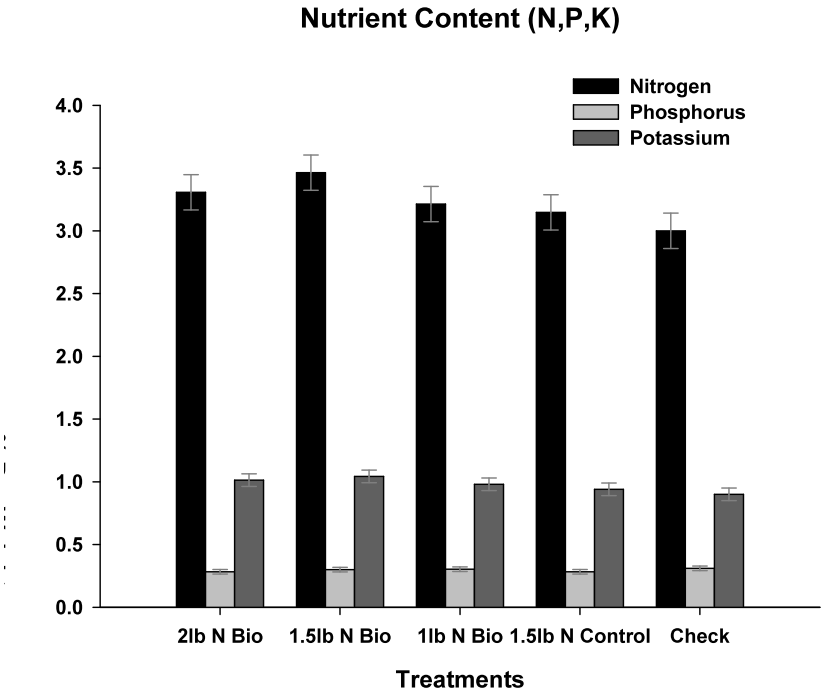

Figure 5. Nitrogen, Phosphorus and Potassium Contents in Clippings (%) for Fertilizer Treatments for Season I (2012).