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The Effects Of Organic Fertilizers And Biostimulants On The Bacterial Populations Of Golf Course Greens, Tees, And Fairways

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ABSTRACT:
Organic fertilizers and biostimulants were tested on Grand Valley State University’s Meadows Golf Course in Allendale, Michigan. Five greens, four tees, and three fairways were each treated with a different organic fertilizer or biostimulant. Core soil samples were diluted and placed on several selective media. The isolated colonies were counted and identified. Preliminary data suggest that for the agents tested there is no statistically significant difference in the numbers and kinds of bacteria retrieved. This is meaningful because there is a substantial difference in the ease of application and cost between agents used.

Background for the Study
There has been much speculation lately about the justification for using pesticides and other chemical fertilizers on golf courses, although golf courses use only a small percentage of the estimated 1.2 billion pounds of chemical fertilizers sold annually in America. Approximately 70 percent of fertilizers are used to produce food and fiber (p. 13). The agriculture industry can justify its use of chemicals because food is a necessity; on the other hand, golf is a recreational sport, which many can do without. Although every chemical must be approved by the Environmental Protection Agency (EPA), it is well known that there is no chemical that is 100 percent safe to the environment and people. Even environmentally conscious golfers don’t want to play on a brown, patchy, and ugly golf course. Most want to play on bright, green, picture perfect golf courses. The golf industry needs to educate golfers to understand that it takes extensive maintenance to keep that picture perfect look, and this can cause environmental problems. Non-chemical alternatives, such as organic fertilizers and biostimulants, are being used and researched throughout the golfing community. Since organic fertilizers/biostimulants don’t contain synthetic chemicals, they are thought to be less harmful to the environment than chemical fertilizers.

A recent study, conducted by Antaya and Callahan (1997), CGCS, suggests that beneficial bacteria play a role in soil fertility, which is always changing. Soil’s ability to support growth depends on the presence, availability, and balance of many elements such as phosphorus, potassium, sulfur, and nitrogen (p. 2). Beneficial bacteria help to break down and recycle these elements needed to maintain the soil’s fertility (p. 2) and they also help control many unwanted insects which destroy the golf course appearance. This study also suggests that pesticides being used on golf courses may affect beneficial bacteria and could be doing more harm than good (p. 2). If the soil is fertile, then the grass on the golf course should be healthy. Experimental organic fertilizers/biostimulants contain bacteria, which are beneficial to the soil and its fertility. Other products also claim to “feed” the beneficial bacteria (p. 1).

Currently, there are two theories on microbial populations for enhancing turf growth. Bioject® manufacturers state that desirable bacteria and fungi must be added to soil continually in high inoculum. This procedure must be done on a regular basis and Pseudomonas cepacia is one organism used in this procedure. We didn’t test this procedure because it is too expensive; instead, we tested the second theory; which suggests that to alter bacterial populations, dormant cell forms of beneficial bacteria must be added to the soil. These dormant cells encourage the use of certain nutrient products to maintain soil fertility. Examples of such beneficial bacteria are Streptomyces and Bacillus species (p. 8).

Procedures and Methodology
The study was conducted at Grand Valley State University’s Meadows Golf Course. Samples were taken from five greens, three fairways, and four tees. Sampling dates were scheduled to allow the organic fertilizer/biostimulant a certain amount of time within which to work. The following organic fertilizers/biostimulants were used: Nature Safe®, Nutragenics®, Cytogro®, Panasea Plus®, Seasons with Biotrends®, a Floratine® product program, and Turf Cocktail®. Nature Safe® is composed of blood, bone, and hydrolzed feather meal. It also contains beneficial bacteria in their dormant stage (p. 17). Nutragenics® is comprised of animal waste (p. 18). Cytogro® contains an extract of seaweed meal, amino acids, hormones, proteins, and other organic ingredients (p. 9). Emerald Isle’s product is Pana plus Sea®, and it contains...
seaplant extract (p. 19). Biotrends® contains microbial and plant extracts, marine algae, humus, hydrolyzed fish proteins, and lipids derived from fruit oils (p. 6). The Floratine® product program is comprised of plant extracts’ micronutrients (p. 11). Turf Cocktail® is a hydrolyzed whole fish emulsion (p. 22).

Most of the organisms were isolated on the right side and no Floratine® on the left side; Green 18 with Emerald Isle® on the front side and no Emerald Isle® on the back side; practice Green 1 with Nature Safe® only; practice Green 2 with no treatment; Tee and Fairway 6 with Seasons with Biotrends®; Tee and Fairway 12 treated with Nutragenics®; the driving range tee with Turf Cocktail®; and practice Tee and Fairway 1 with no treatment. All greens received Nature Safe® except for practice Green 2. Right and left were determined by standing on the tee and facing the green. There were no samples taken on rainy days or if frost was present. A total of three sets of samples were taken from each site from May 1997 through July 1997.

Sampling
At each site, three random samples were taken, each measuring 4 cm deep and having a volume of 2 cm³. Thatch, the organic matter directly under the turfgrass, was also measured from each core sample. The three samples were then combined into a sterile test tube and taken back to the lab and planted on several types of prepared media. Media used included: soil extract agar (SEA), used for total population of isolated bacteria (p. 16); glycerol glycine agar (GGA), used for counting and identifying Streptomyces species populations (p. 4); Columbia CAN Agar (CAN), used to count the total number of gram positive bacteria, and for identification of Bacillus species (p. 10); brain heart infusion with Cyclohexamide (B6C), used to cultivate some Bacillus and Streptomyces species (p. 10); MacConkey agar (MAC), used in counting the total gram nonfastidious negative population (p. 10); and Mycosel®, also used for fungal isolations (p. 10). GCA was the second medium used for Streptomyces sp., because the first medium did not work (p. 14). Each sample was diluted to 10⁷ before plating.

Culture and Isolation
There were three different methods used to inoculate the variety of media used. Spread plate method was accomplished by placing 0.1 ml of the diluted sample onto the medium and spreading it with a sterile glass rod. A second method was to place 0.1 ml of the diluted sample on the medium and spread it on the plate using either a 0.01 or a 0.001 inoculating loop. The spread plates were the easiest to read and were adopted. Three dilutions (10⁻¹, 10⁻², 10⁻³) from each sample site were plated on each of the five types of media. The SEA, MAC, and Mycosel were incubated at 30–32°C for 2–3 days. Streptomyces and Bacillus species take longer to grow; therefore, GGA, B6C, and CAN were incubated for 3–5 days at 30–32°C.

Data Analysis Process
The volume of each sample was 2 cm³. Since three samples were combined from each site, the total volume was 6 cm³. The isolated colonies on each countable plate were counted. The final number was adjusted to reflect the number in 1 cm³ of the original sample. The mean populations were used in comparing the sample sites. The organisms were identified using the standard microbial procedures.

Results
Fifteen sites were treated, including five greens, four tees, and three fairways. There appeared to be comparable bacteria isolated from all test sites. The organisms isolated are listed in Table 1. Bacillus thuringiensis was located on the driving range tee, Green 3 left, and Green 18 back. The Meadows Golf Course is located about five miles away from Kent County, where Bacillus thuringiensis was sprayed to control the gypsy moth population in western Michigan. This may explain why they were identified in our study.

Discussion
There have been many technical difficulties in dealing with the Streptomyces sp. The search for a good, selective medium for Streptomyces sp. yielded many different alternatives, most of which were disappointing. The first medium we tried was supposed to be a selective medium for Streptomyces sp. (p. 16); this was definitely not the case, and many other things besides Streptomyces sp. grew on the medium. Streptomyces sp., however, did not grow. Finally, it was decided to use a glycine glycerol agar (GGA). First trials with GGA were unsuccessful because slimy, excessively mucoid organisms overgrew the plate. No organisms resembling Streptomyces sp. were isolated until the third trial. It was concluded that the GGA is not effective for isolating the Streptomyces sp. Sheldon (1997, 20) at the University of Minnesota recommended another Streptomyces medium, which is being currently tested.
During the gathering of the third set of samples, it was discovered that most of the greens, both left and right sides, were suffering from black layer complex (BLC). BLC occurs when an anaerobic environment exists just under the turfgrass. Sulfur-reducing bacteria grow anaerobically and release hydrogen sulfide gas (H₂S). The H₂S reacts with other elements in the soil to create a black layer under the thatch area (p. 5). Some of the troublesome isolates grown on GGA may actually be the sulfur reducing bacteria that are causing the disease.

There were also some difficulties in the process of sampling. Thatch measurements could not be taken at all sample locations because the soil was either extremely dry or moist, causing the samples to crumble. In addition, not all of the samples plated were countable because some of the plates had an overgrowth and did not allow the isolation of discrete colonies. There were also plates that had too many isolated colonies to be counted. The spread plate method yielded the most countable plates. Although overlay plates were countable, the bacteria's pigment was not visible, and there were problems with subculturing, which hampered identification (p. 12).

This study is continuing. Weather permitting, more samples will be taken in future years to further the process of identifying organisms and determining which bacteria are beneficial bacteria or not. All the information is still not available. The playability, the overall appearance of the golf course, and root lengths are still being assessed.

Conclusion
Studies of the relationship between treatment and length of grass roots are in progress. Preliminary data suggest that for the agents tested there are no statistically significant differences in the numbers and kinds of bacteria retrieved. This is significant, because there is a substantial difference in ease of application and product cost. Assessment of playability and qualitative analysis of turf appearance is ongoing. After three trials, the preliminary findings do not justify using the more labor intensive and costly products.

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References


Cytogro® Hormone Biostimulant. Distributed by Plant BioTech, Inc., Corrales, NM, 87048.

Difco Manual Dehydrated Culture Media and Reagents for Microbiology, 10th ed., Difco Lab, Detroit, Mi. 1984.

Floratine® Products Group. 179 S. Main, Collierville, TN, 38017.


Pana plus Sea®. Emerald Isle, Ltd., 2153 Newport Road, Ann Arbor, MI, 48103.


Stoddard, J.M. Standardization of Procedures for Enumeration and Identification of Soil Bacteria.
