USGA

Turfgrass and Environmental Research Online

...Using Science to Benefit Golf

A series of four experimental putting greens were built in successive years at the Seaton Turfgrass Research Facility at the University of Nebraska to study the long-term changes in physical, chemical, and microbial aspects of various putting green rootzone mixes. Among the results of these studies include the finding that sand-based greens are not as sterile as previously perceived, but, in fact, reach levels of native soils in a relatively short time.

Volume 2, Number 3
February 1, 2003

PURPOSE

The purpose of *USGA Turfgrass and Environmental Research Online* is to effectively communicate the results of research projects funded under USGA's Turfgrass and Environmental Research Program to all who can benefit from such knowledge. Since 1983, the USGA has funded more than 215 projects at a cost of $21 million. The private, non-profit research program provides funding opportunities to university faculty interested in working on environmental and turf management problems affecting golf courses. The outstanding playing conditions of today's golf courses are a direct result of ***using science to benefit golf***.

Editor

Jeff Nus, Ph.D.
904 Highland Drive
Lawrence, KS 66044
jnus@usga.org
(785) 832-2300
(785) 832-9265 (fax)

Research Director

Michael P. Kenna, Ph.D.
P.O. Box 2227
Stillwater, OK 74076
mkenna@usga.org
(405) 743-3900
(405) 743-3910 (fax)

Soil Microbial Characteristics of Aging Golf Greens

Roch Gaussoin and Robert Shearman

SUMMARY

From 1996 to 1998, golf course greens located on 16 golf courses in eastern Nebraska were sampled for microbial properties. In addition, an establish study was conducted comparing the use of microbial inoculants versus conventional methods to establish creeping bentgrass putting greens. Among these studies findings:

- Relatively high pesticide applications do not appear to adversely affect soil microbiology.
- Sand-based greens are not as sterile as previously perceived, but in fact, reach levels of native soils in a relatively short time.
- Soil inoculums/additives may alter soil microbiology in the short term, but their use on established turfgrass soils is questionable.

Turfgrass represents a significant amount of land area and economic impact in the United States. A well-maintained lawn, athletic field or golf course makes a significant contribution to "the good life." When properly managed, turfgrass can improve the quality of life and offer environmental benefits such as air and water quality improvement, erosion control and noise abatement.

In recent years, research at the University of Nebraska and other locations has concentrated on trying to better understand the microbial ecology of sand based golf greens as they mature. Although this research has created new and academically interesting challenges for future research, fundamental questions have been answered and common perceptions or conventional wisdom have been found to be untrue or at least, suspect.

This article will attempt to summarize these studies and indicate implications relevant to golf course operations. Additionally, we will make assumptions from the microbial data concerning the use of microbial inoculants for turfgrass management.

The following are common perceptions about the microbial relationships in turfgrass soils:

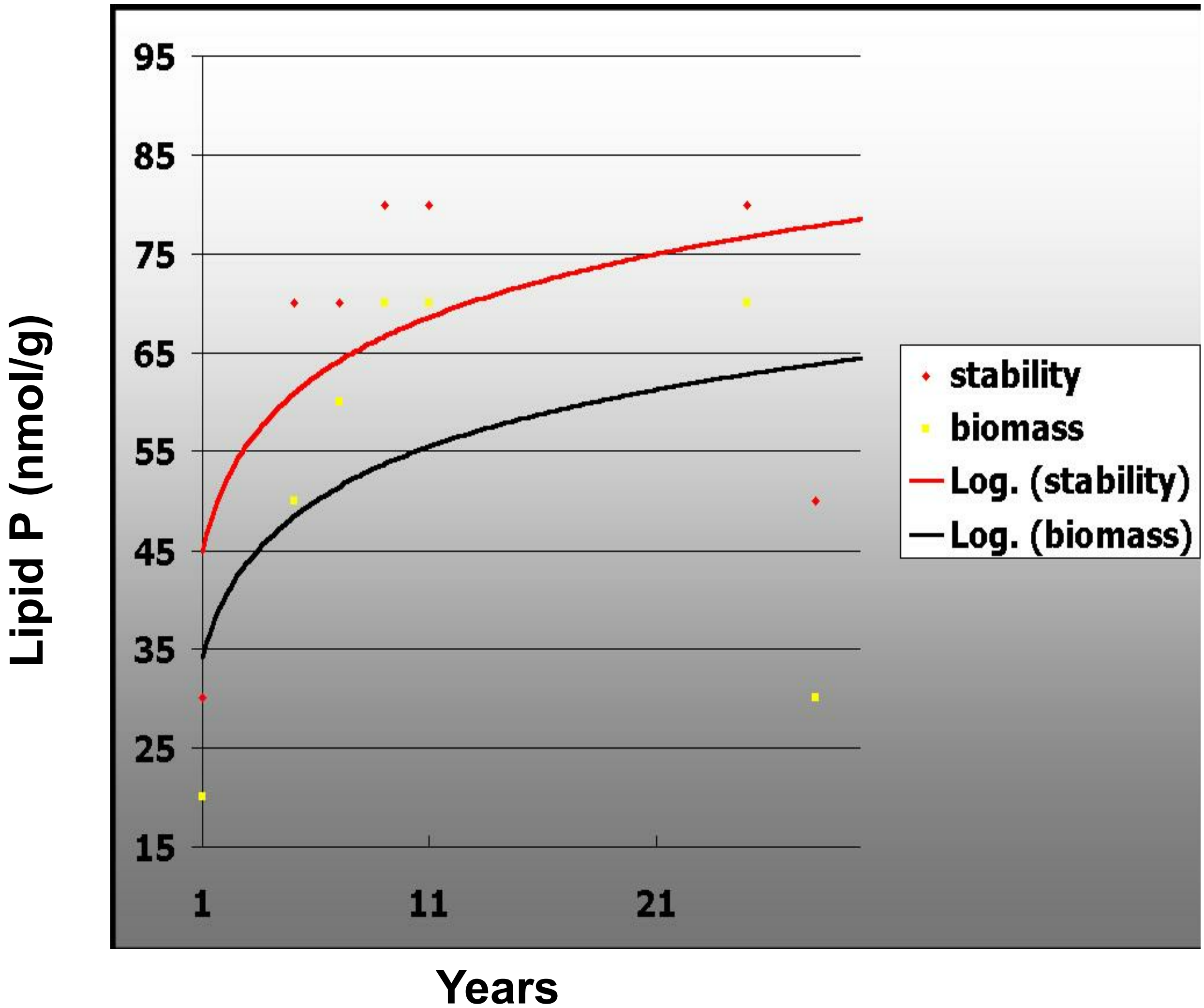
- Excessive pesticide applications adversely affect soil microbiology.
- Sand-based rootzones are relatively sterile.
- Soil inoculums/additives can alter soil micro biology.
- Turfgrass soils are lower in microbial biomass diversity than other soils.

From 1996 to 1998, golf course greens located on 16 golf courses in eastern Nebraska were sampled for microbial properties in a project funded by the United States Golf Association (USGA) and the O.J. Noer Turfgrass research program (5). The 16 courses were separated into three

Work at the University of Nebraska indicates that as a golf green matures, the microbial population is more associated with particulate organic matter (POM) than the mineral fraction. POM is the residue produced from the turnover of the plant root system as it matures and dies, sloughing off roots, root hairs, etc. into the rhizosphere. The rhizosphere is the region in the rootzone that is immediately adjacent to the root system. This region is critical for nutrient transfer and plant uptake, pathogen competition, and plant health.

ROCH GAUSSOIN, Ph.D., and ROBERT (BOB) SHEARMAN, Ph.D., are professors of Agronomy and Horticulture at the University of Nebraska-Lincoln.

USGA Turfgrass and Environmental Research Online 2(3):1-6.
TGIF Record Number: 85613



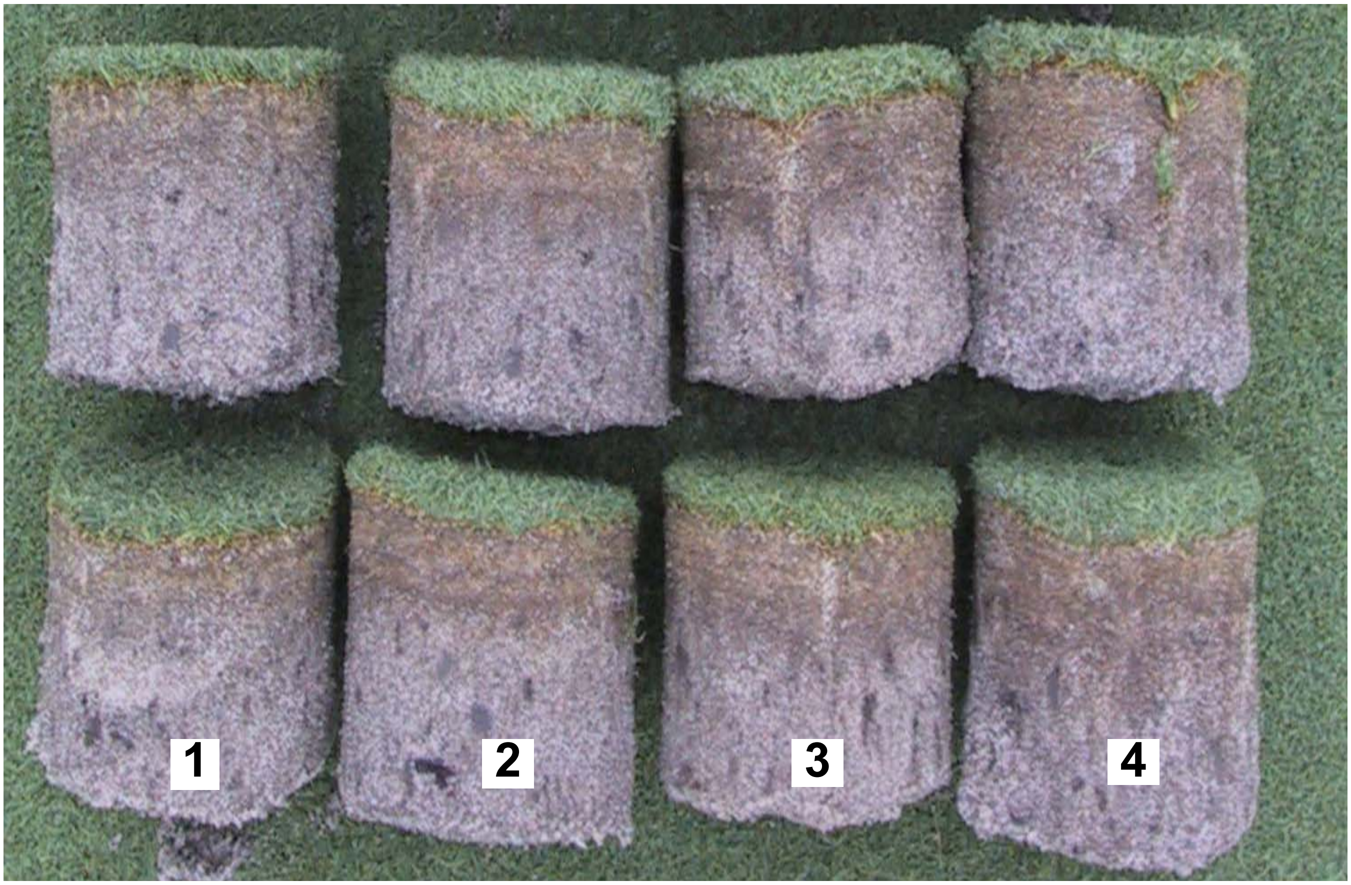
As sand-based greens mature, microbial biomass and stability increase rapidly in the first 1-2 years and then stabilizes in both number and type of microorganisms. The unit Lipid P (nmol/g) for biomass is an estimate of the total quantity of microorganisms present irrespective of bacteria, actinomycetes, or fungi. Stability is a statistical unitless term for diversity of biomass indicating that the population was relativaely erratic initially in terms of type of organisms present, but this fluctuation stabilized over time.

distinctly different management groups based on pesticide and fertility inputs and other pertinent management practices. All greens had sand-based rootzones and ranged in age from 1 to 28 years.

Results indicated that:

- The age of green was the most significant factor in microbial biomass/diversity.
- Management level did not influence microbiology, indicating that higher levels of management, including relatively high pesticide inputs, did not adversely affect soil microbiology. These findings are similar to data reported from Florida and New York (6).
- Significant microorganism levels and stability occurred within 18-24 months after establishment.
- Microbial biomass of sand-based turfgrass soils 18-24 months after establishment was less than native undisturbed soils, but greater than traditional row crop soils.

This work also indicated that as a golf green matures, the microbial population is more associated with particulate organic matter (POM) than the mineral fraction. POM is the residue produced from the turnover of the plant root system as it matures and dies, sloughing off roots, root hairs, etc. into the rhizosphere. The rhizosphere is the region in the rootzone that is immediately adjacent to the root system. This region is critical



Age of Putting Green (Years)

The accumulation of organic matter in the root zone of greens as they mature creates an environment critical for microbial colonization.

for nutrient transfer and plant uptake, pathogen competition, and ultimately plant health.

Similar results concerning microbial levels and stability were reported in work conducted in North Carolina (1, 2). These data indicated that sand-based turfgrass rootzones reached significant microorganism levels and stability relatively quickly (within 12-18 months), and these levels were equal to native soils in the region. They also reported the temporal effects of microbial populations, with the largest populations being associated with the periods of greatest plant growth, i.e., spring and fall, which also agrees with work conducted in Nebraska (3).

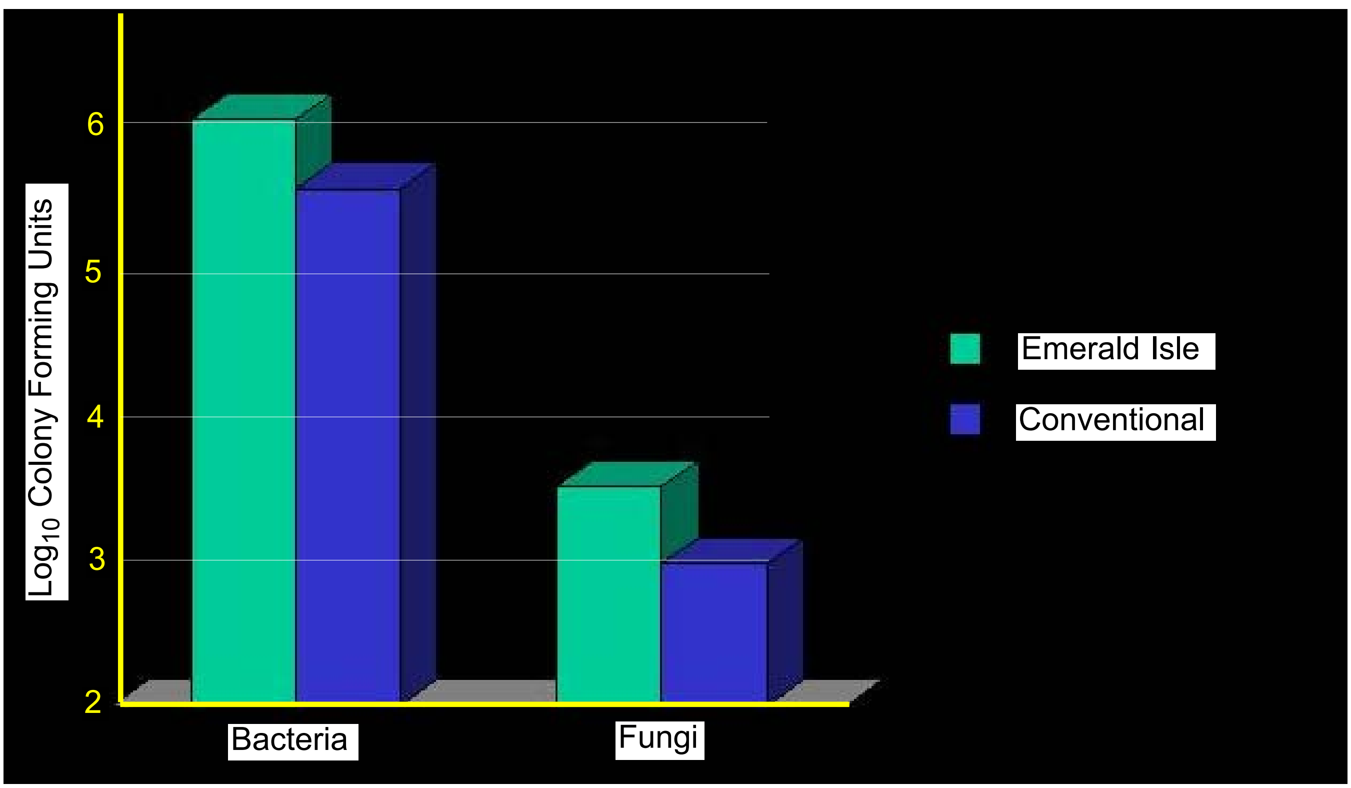
It is interesting to note that the period associated with the lowest microbial numbers also coincides with the period of greatest root pathogen activity and other stresses, i.e., summer. Obviously, these other stresses such as heat and drought are contributing to the grass decline during the summer, but the soils microbial "health" should not be overlooked.

The research at Nebraska and North Carolina indicated that in a relatively short time, sand-based turfgrass rootzones reach microbial levels comparable to other "native" soils. This information can be used to develop a theoretical scenario for the use of microbial inoculants. These are products that are packaged and marketed to turfgrass managers as tools to improve the micro-

Microbial-based products may provide for increased establishment and grow-in and increase microbial populations short term. The long term benefits of their use as a routine cultural practice, however, are questionable. Photos were taken 30 days after seeding.

biology of the soil. These are often beneficial organisms packaged with other ingredients such as iron or biostimulants, or in some cases packaged as spores of the desired microbe.

These products may contain up to 109 organisms per milliliter of product, and application rates range from 1 to 6 ounces per 1000 ft^2. The soil contains 108 bacteria per gram of soil. The relative quantity of actinomycetes is approximately 100 times less than the bacteria and fungi 100 times less than the actinomycetes, but for our theoretical example, we will disregard both the native fungi and actinomycetes. Realizing that many soil microorganisms are sensitive to UV



A study was conducted in 2000 at the University of Nebraska with the Emerald Isle products GrowIn and Optimil for the establishment of creeping bentgrass. The Emerald Isle GrowIn resulted in faster establishment than traditional grow-in procedures, and after the growing season, the Emerald Isle plots had higher populations of fungi and bacteria.

light and/or heat instability, and therefore survival from purchase to application is suspect, let us assume that all applied microorganisms survive and that the maximum use rates of the product are applied - the ratio of applied vs. native bacteria is approximately 6000 native: 1 applied, or the applied represent 0.02 percent of the total bacterial population.

When one considers the total microbial population, this ratio is even more unbalanced. The applied microbes are being introduced into a hostile environment at levels significantly lower than the indigenous microbial population. It appears that the applied microorganisms have little or no chance of effectively competing with the already established population. Further, work at Ohio State University (7) showed that at approximately two years post-construction in a soil/sand/compost vs. sand/peat green, microbial diversity was not different, even though the former green was significantly higher at establishment. While the compost increased microbial taxa initially, a natural equilibrium ultimately occurred.

Do microbial inoculants therefore have no merit? Other research has shown the benefits of the addition of biological pest control products, such as nematodes for grub control, where the goal is control of a specific pest as opposed to increasing beneficial microorganisms in the soil. Structured research is limited, but scientific work in this area is increasing. Since it appears that new sand-based rootzones take one to two years to reach equilibrium, perhaps the use of microbial-based products has merit during establishment of turf on sand rootzones.

A study was conducted in 2000 at the University of Nebraska with the Emerald Isle (EI) products GrowIn and Optimil for the establishment of creeping bentgrass. Product information can be found at the Emerald Isle web site www.emeraldisleltd.com/index.html. The EI grow-in resulted in faster establishment than traditional grow-in procedures, and after the growing season, the EI plots had higher fungi and bacterium levels (4). Work in this area continues, and perhaps future research will shed more light on the use of microbial inoculants in turfgrass management.

In summary, it appears that some common perceptions about turfgrass soils were not true:

- Relatively high pesticide applications do not appear to adversely affect soil microbiology.
- Sand-based greens are not sterile, but in fact, reach levels of native soils in a short time.
- Soil inoculums/additives may alter soil microbiology in the short term, but their use on established turfgrass soils is questionable.

References

1. Bigelow, C.A., D.C. Bowman and A.G. Wollum. 2002. Characterization of soil microbial population dynamics in newly constructed sand-based rootzones. *Crop Sci.* 42:1611-1614. (TGIF Record 81913)

2. Bigelow, C.A., A.G. Wollum and D.C. Bowman. 2000. Soil microbial populations in sand-based rootzones. *Golf Course Management* 68(10):65-69. (TGIF Record 68879)

3. Gaussoin, R.E., R. Drijber, W. Powers, R. Shearman, M. Aslan, M. Vaitkus, and L. Wit. 1999. Grow-in and cultural effects on USGA putting greens and their microbial communities. Univ. Neb. Turf. Ann. Res. Rprt. pp. 57-63. (http://turfgrass.unl.edu/report99.pdf) (TGIF Record 67426)

4. Gaussoin, R.E., R. Drijber, W.Powers, R. Shearman, M. Aslan, M. Vaitkus, and L. Wit 2001. Emerald Isle reduced input fertilizer trial. Univ. Neb. Turf. Ann. Res. Rprt. pp. 41-44. (http://turfgrass.unl.edu/report01.pdf) (TGIF Record 80771)

5. Karek, M., R.A. Drijber, W. L. Powers, R.E. Gaussoin, and A.M. Streich. 2002. Accumulation of microbial biomass within particulate organic matter of aging golf greens. *Agron. J.* 94:455-461. (TGIF Record 80276)

6. Kenna, M. 2001. Nature will find a way:

Common myths about soil microbiology. *USGA Green Section Record* 39(3):10-11. (TGIF Record 73233)

7. Thomas, S.L. and M. J. Boehm. 1999. Bacterial species diversity of sand-based rootzone mixes in turfgrass putting greens. *Agron. Abstr.* 91:139 (TGIF Record 63807)