



Desert golf has its own unique soil issues when it comes to growing grass and preparing finely-conditioned golf courses. A cross-section of soil layers (inset) beneath the turf surface on your typical desert golf course.

# S.S.oil Science

## Uncovering the role of turf science through chemicals and biology

**T**HE ARIZONA GOLF INDUSTRY has been a leader in the search for turfgrass solutions, whether working to minimize the use of water by limiting courses of 90 acres, to develop and test drought-tolerant grasses or to create innovative management solutions for overseeding issues.

As we currently enduring a drought, superintendents and industry people have made Arizona a test tube for new ideas. The science involved in creating our great golf courses is certainly not a simple equation of “water grass, cut grass” as some would believe. To paraphrase Albert Einstein: “If you can measure it, it’s Science; if you can’t, it’s Philosophy.”

The following articles, written by experts with experience and knowledge

in the fields related to “soil science” (if you will), give an overview of the physical, chemical and biological efforts ongoing at our courses. Though somewhat technical in nature, these articles explain some of the latest advances in turf management science, technology and practices that go into providing the excellently-conditioned golf courses for which Arizona has become known. And as the research continues, it may hold the key for new developments in the future.

### **THE ANSWER IS IN THE DIRT**

*The first step is in chemical analysis of turfgrass soil. By David L. Wienecke*

#### **Chemical Analysis 101**

The best way to know the condition of a turfgrass plant is to look at the soil the

plant is growing in. Decades of research have shown us that biological, chemical and physical aspects of soils affect turf growth in significant ways. The primary purpose of this article is to focus on a few aspects of chemical assessment for optimal turf health.

Golf course turf soils are affected by available soil nutrients such as nitrogen, phosphorus, potassium, calcium, magnesium and sulfur. These nutrients are also found in the irrigation water used on Arizona golf course turf. In addition to these nutrients other salts, such as sodium and chloride, are typically found in irrigation water. We use chemical analysis of irrigation water and turf soils to determine if there is too much, not enough or just the right amount of any chemical that affects root zone soils and

turf health and play quality.

### Sodium problems

One ion (an atomic particle with a positive or negative charge) of concern in regards to healthy golf turf is sodium. Sodium is a relatively small atom with a single positive charge (signified as +). Positively charged ions are called cations. Soil labs test a soil's cation exchange capacity (CEC) to determine how many positively charged nutrient ions the soil is able to hold.

In the case of sodium (symbol Na), the small size and charge can replace larger and higher charged cations, such as calcium, potassium and magnesium. A smaller ion like sodium replacing larger cations in the soil results in less root zone pore space in the soil. Reduced pore space means less oxygen and a more compacted soil that is less able to grow healthy roots. Because sodium is a cation, it also takes away from the soil's ability to hold nutrients needed for growth, such as nitrogen (NH<sub>4</sub><sup>+</sup>), potassium (K<sup>+</sup>), calcium (Ca<sup>++</sup>) and Magnesium (Mg<sup>++</sup>).

Irrigation water with sodium levels higher than 2 meq per liter (or 46 parts per million) will cause compacted soil problems and reduced fertility. A review of water samples from golf courses in Arizona found them to contain an average sodium level of 5 meq/L (115 ppm), which exceeds the minimally acceptable levels for healthy turf.

### Sulfur concerns

In contrast to sodium, sulfur is an important plant nutrient. When soils become anaerobic (without oxygen, such as from compacted soil) sulfur can become a nutrient for microbial growth – which is seen as a black layer. Too much sulfur can interfere with uptake of other plant nutrients. A survey of local



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irrigation water used at Arizona golf courses showed high levels of sulfur. These average sulfur levels found from laboratory irrigation water analysis show 36 pounds of sulfate ion sulfur (SO<sub>4</sub>) are applied for every inch of applied irrigation water.

### Chloride concerns

Chloride ion (Cl) is the other half of table salt (sodium chloride written in chemical shorthand as NaCl). Too much chloride ion interferes with uptake of other necessary nutrients needed for healthy turf growth, including nitrogen and many cations. A survey of Arizona irrigation water showed an average of 31 pounds of chloride is applied for every inch of irrigation water.

### What Can Be Done?

Laboratory analysis of soil and irrigation water is an essential part of proactive and timely golf course turf management. These soil and water tests are similar to

the tests people have when they get a physical from the doctor and have blood tests and other lab samples taken. A qualified agronomist can interpret these soil and water tests to help the superintendent develop appropriate management procedures to minimize chemical problems and maintain healthy turf-grass for the best possible playing conditions. In addition to soil and water laboratory analysis, the following procedures are recommended at least once per year:

(1) Timely and frequent core aeration to maintain adequate root zone porosity for turf root and soil microbial growth. As an example a half-inch diameter core tine will maintain a macropore, ensuring adequate soil porosity for 3-to-4 weeks. Adequate soil porosity is essential to allow the leach-

ing of salts (such as sodium) away from the root zone and out of the soil structure. Timely application of calcium in the form of gypsum or lime will replace the leached sodium with calcium-improving soil porosity for root growth and drainage.

(2) Lime applied calcium in conjunction with leaching is also an effective way to remove excess sulfur from root zones. Maintaining adequate porosity will eliminate the waterlogged and anaerobic conditions that lead to black layer.

Changing your home water conditioner from sodium chloride to potassium chloride will help reduce the sodium levels in the reclaimed water used at many Arizona golf courses. Potassium chloride will condition drinking water as good as sodium chloride without causing any of the turf health problems seen with sodium.

The take-home message is that chemical analysis of both irrigation water and root zone soil is needed to develop satis-

factory turf management procedures for consistent healthy turfgrass and high quality playing conditions. These procedures are especially important in Arizona, due to the irrigation water quality and dense clay soils found throughout the state.

*David L. Wienecke, USGA Agronomist, Southwest Region*

## **SOIL MICROBIOLOGY — TIPS FOR TURF**

*Don't forget the microbes when managing growth. By Vicki H. Bess*

Turf management for beneficial soil microbes can reap some significant rewards since the soil biology is helping to manage the plants. Soil microbes are important for many of the plant functions. A management plan that takes these biological features into consideration can result in healthier plants while reducing the need for water and fertility inputs.

Soil microbes, although invisible to the naked eye, form a protective and active layer around the plant root system. These beneficial organisms are essential for the cycling of nutrients to the plant. The plant sends down nutrients to the roots to help support the microorganisms in the root zone.

In return, the microbes are able to provide the plant with many other nutrients as they are broken down from organic matter and minerals in the soil. Not only do the microbes provide the plants with these nutrients, they also provide a “sink” for nutrients that are held within the plant root zone and become available to the plant as the organisms die and degrade.

This system helps to keep the nutrients that are applied to the soil in the plant root zone and not in the groundwater – also serving to hold down costs while keeping environmental regulators, who are concerned with the impact of turf on groundwater, happy at the same time.

Plant disease protection is aided by these same valuable microbes in the plant root zone. By competing with plant disease organisms, producing compounds that help fight plant disease and

making plants more resistant to disease, this microbial population around the plant roots and in the nearby soil can help reduce the need for pesticides and fungicides.

### **Catch the Thatch**

Thatch buildup is a frequent problem in turf management. This buildup is caused by a lack of microbes and appropriate conditions to allow natural thatch breakdown. Thatch is made from a compound called cellulose. The microbes that break down the cellulose (mostly fungi and actinomycetes) need air, water, nitrogen, phosphorus and other typical nutrients in order to break down thatch.

Often, thatch-degrading organisms are in short supply in turf. Some of the reasons for their absence could include the use of fungicides and other pesticides that reduce their numbers. These organisms can be re-supplied to the turf with products that are naturally high in cellulose degraders, including some composts and biological liquid turf products.

### **Where is the Water?**

Water management in soil is closely related to soil structure. The goal is to have good pore spaces in the soil to allow proper aeration as well as water storage. Soil microbes produce sticky substances that allow soil particles to stick together. The fungi and actinomycetes grow in thread-like strands that bind these soil particles into stable clusters, leaving pore space between them. These pore spaces allow the movement of air and water through the soil. Better management of soil microbiology can result in substantial reduction of water needs.

This fact becomes more important for turf management in areas where water is in short supply and where the water available for turf may have high salt concentrations.

Using less irrigation water can mean that salt build-up, a cause of turf stress and emerging turf diseases, is less likely to occur.

### **Managing Soil Biology**

Some of the methods used to manage for

soil biology include use of high quality composts and other biological products to provide microbes and mixed organic matter to support their growth. Also, reducing the amount of “cidal” products (pesticides, fungicides, etc.) gives the beneficial organisms a chance to grow and provide the favorable advantages mentioned.

When it is necessary to use the “cidal” products, it can be helpful to follow the application with a product that will re-supply beneficial organisms to the soil. Increasing the diversity or variety of beneficial microbes will increase the chances that future use of the pesticide will be less frequent and more successful.

Soil microbes are important tools for turf management and assist in the reduction of water requirements, fertility products, plant disease and thatch problems. A good turf management program needs to incorporate the physical, chemical and biological aspects of the soil for optimal use of resources and the best returns for the business.

*Vicki H. Bess, BBC Laboratories, Inc., Tempe, Ariz.*

## **PUTTING IT ALL TOGETHER**

*An overview of the first biological efforts in soils. By Brian Smith*

In 2002, Arizona Sports Turf (AST) was approached by a California based company, Biologically Integrated Organics (BIO), to help assess whether their products, a range of biologically-based soil inoculants and soil microbial products, would have any value in the turf industry?

This is an area of products that probably has more skepticism associated with it than any other, and we at AST were hesitant. But BIO came to us with high marks from the specialty agricultural market that they serviced, and they agreed that their work would be assessed by BBC Labs in Tempe (arguably the leading soil biology lab in the country) in an attempt to produce measurable results.

After more than two years, thousands of dollars in testing and a couple of fortunate coincidences, we have come a long way towards understanding why there has



Shawn Emerson, the Director of Agronomy at Desert Mountain, Scottsdale, shows the complex root system required for the growth of turf in desert climate golf courses.

have correlated almost exactly with the quality of the turf on those sites, so we felt we had a measurable standard that could be used.

Results from early trials varied widely – from the spectacularly good to comments including “. . . well, we didn’t really see much out of that.” Results such as breakdown of thatch, vast reductions in compaction, better water penetration and significantly improved turf in the good plots were encouraging, but they’re of little value if the results were not predictable.

It was really only after AST got involved with Redox, a company involved in soil chemistry consulting, that the fog started to lift. At a joint seminar, Vicki Bess of BBC Labs and John Kelly of Redox both spoke, and Bess was shocked to see the soil chemistry issues that are present on some of our golf courses, commenting that in these conditions,

some functional groups of soil microbes cannot survive.

Addressing these chemical issues prior to using the microbial products to restimulate biological activity in the soil has proven successful to the point where results are becoming more predictable and the benefits more widely seen.

Russ McNeill, president of BIO, has taken the view that “stimulation of soil biology through the use of soil additives may provide the superintendent with significant tools to minimize the transitions before and after overseeding, and strengthen turfgrass in the process. We are interested in investing in applied research to see if the golf industry can benefit from these products; initial reports are promising.”

*Brian Smith is the president of Arizona Sports Turf.*

## SUPERINTENDENT'S STRATEGY

*Just like a golfer, a successful super needs a good plan. By Shawn Emerson*

been huge variability in the performance of biological products in our soils. We can also see that successfully working through this challenge can have huge benefits for turf managers in terms of turf quality, fertilizer usage and water usage.

Bio-assays carried out by BBC on test sites were interesting – a ranking of about 20 sites by their bio-assay would

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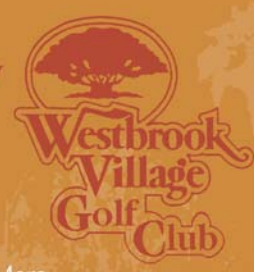


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Golf course superintendents, just like golfers, have many strategies that help them to be successful. Golfers must drive the ball in the fairway, hit greens in regulation and possess a good putting stroke to score. Superintendents, on the other hand, need a soil with good physical properties, they need to balance it nutritionally and the soil must have biological activity for the turf to reach its full potential.

The superintendent's objective is for the golf course to be sound agronomically while achieving a playable surface for the golfer that is in harmony with the environment.

Superintendents are always working on these factors, which include soil physicals, nutrition and biological activity. A superintendent's scorecard is based on the golfer's results and enjoyment of the game, while achieving fiscal responsibility and enhancing the overall environment.

*Shawn Emerson is the Director of Agronomy at Desert Mountain, Scottsdale.*

## IN CONCLUSION: AGREEING TO DISAGREE

The USGA Agronomists disagree with the assertions of the soil micro-biologists, since there is little data presently to support their claims of its benefits. There is little doubt that a successful superintendent's job is much closer to doctoral research than running a mower. The knowledge necessary to produce a top-quality putting green, for instance, requires a background in physics, chemistry and biology with a strong dose of accounting and common sense.

All golfers can take pride in the willingness of companies and courses to try new management techniques and products. Ultimately, Arizona golf will be the winner (as long as the drought comes to an end).

Whether these new biological efforts prove beneficial, or courses simply follow the proven USGA guidelines, Arizona courses are such intensely-utilized, 12-month golf factories, that the proof will be in the putting. – Ed Gowan

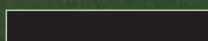
*The Spring 2005 issue of Arizona The State of Golf will address additional soil chemistry and physics to better inform the Arizona golfer. ■*

# Feel the Difference.

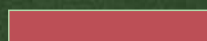


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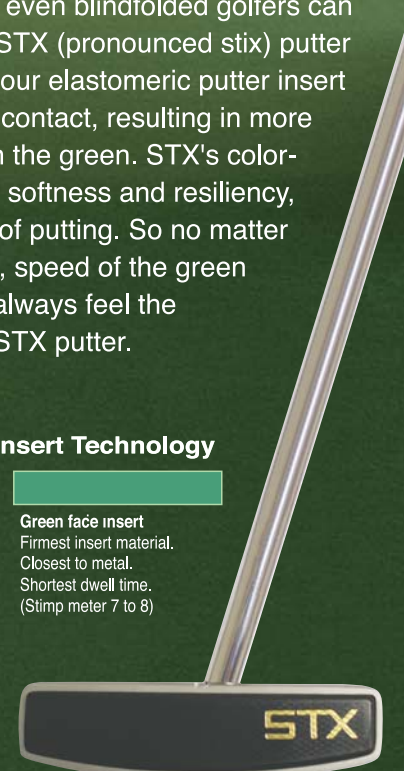


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