Dave Marquardt *Dirt -n- Turf Consulting*

Striking a Balance in Soil Properties During Prolonged Droughts

"My spoon-feed program just doesn't last the two weeks it's supposed to." "I put on a half-pound of N and there just doesn't seem to be much of a response. The only green areas are over the aerification holes. I don't seem to get any color in the greens." "Water puddles and sheets off my greens."

These are but a few of the comments we hear when visiting with superintendents during this difficult summer of 2005. More often than not, they have called looking for fertility correction when the problem is physical or biological. More times than not, a simple change in cultural practices will correct the condition and provide the response the product promises.

Chemical, physical and biological: what are we talking about? The answer is simple—these are all soil properties—but understanding them is not. Now I realize this is nothing new. We continue to be flooded with articles, research and of course sales propaganda, all of which are intended to educate us about these properties. And because so much information is already out there, we will not attempt to duplicate it here. However, what we will do is attempt to help us all understand the **relationships** between these properties.

To begin with, let's look at a brief definition of each.

Chemical, physical and biological: what are we talking about? The answer is simple—these are all soil properties—but understanding them is not.

Chemical properties are perhaps the ones we talk most about and generally refer to the fertilizers we apply. However, what many of us fail to realize is just how much chemistry we are applying though our irrigation water. Now again, *On Course* has been blessed with several well-written articles on how to read an irrigation report, so we will not duplicate that information here. What we will do is show you the impact that the water makes on the soil.

Physical properties refer to soil structure. Over time, the USGA, as well as many private and public institutions, has spent a great deal of time and money researching and writing requirements for the quality of golf course construction materials. With these guidelines as the primary focus, it seems as though we have moved our attention from the structure itself to the products within the structure. Again, since the criteria exist and have been published before, we will not duplicate it here. Our focus will be more on soil structure and how it is altered by the chemistries we apply by spreader, spray or irrigation.

Biological properties refer to all those things we look at under a microscope. This term refers to bacteria and fungi. It refers to aerobic and anaerobic organisms. Algae, antinomyces and mycorrhizae are but a few of the critters that make up this mysterious world below. In contrast to the chemical and physical properties, this area has seen little publication of 'data' but no shortage of opinion. Our goal here is that we all realize that biological properties refer to the life of the soil. This relates to the reason why we either have proper chemistry conversions and aggregate stabilization, or deal with black layer and gas.

So what is the connection? How do these properties affect or influence each other? The physics principle at work here says that for every action there is an equal and opposite reaction. The easiest analogy I can think of is to picture a three-legged stool. It is rather stable provided all three legs are on the floor. However, if one drops off, then the other two will fail to sustain the weight. Taking it a bit further, if one of the legs is shorter than the rest, then even though we may be able to keep the stool upright, it is pretty hard to sit on.

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Elgin
St. Charles
Geneva
Kesinger Rd.
Batavia
Main St
Aurora
Randall Rd.
Dauberman Rd.
64
38
47
31
88
WI
IL
Chicago

With this picture in our minds. let's look at how these properties impact upon and interact with one another. We will begin with sodium, since it has such a profound effect on soil structure. First of all, without getting too deep into electrokinetic charges and atomic weights, let's suffice it to say that each element has a different effect on the soil. Calcium, magnesium and potassium have the effect of flocculating the soil, while sodium has the opposite effect and peptizes or disassociates soil structure. Bearing this in mind, we now refer to our irrigation analysis.

In many area wells and water sources, sodium is the primary cation. Calculations tell us that in many cases, we have waters that are applying as much as a half-pound of sodium per inch of irrigation per 1,000 square feet. In ponds that are affected with snow-removal salts, we are calculating more then 1" of sodium per inch of applied irrigation! This year, unlike any other we have observed, we have used more irrigation with less dilution from rain. To further complicate the matter, we are finding irrigation ponds at all-time lows. This tends to concentrate the salts even further. The result is that many courses are applying from 15 to 20 pounds of sodium per 1,000 square feet.

The effect that increased sodium is having in places is that the soil has become disassociated. In other words, the chemical properties or inputs have dictated soil physical properties or structure. The result is a soil where water fails to move properly. From a physics standpoint, we know that a soil that fails to move water properly will fail to move air properly. The result is that soil oxygen levels will fall much more quickly than we may have observed in years past. And, as we know, low oxygen levels contribute to poor biological activity.

Many years ago, an old-time agronomist explained it to me this way: "The soil is full of biological critters such as bacteria and fungi. Some of these guys are in black hats and some are in white. Our job is to perpetuate the white hats and let them control the black hats." His "good cop/bad cop" analogy makes good sense. Keeping harmful critters under control is the focus of rescue chemistry. Keeping the system alive and well should be the focus of superintendents. A sodium-laden soil (chemical property) that seals or destroys soil structure (physical property) has a profound and lasting effect on the bacteria and fungi within the soil (biological property).

We have observed variations of this connection all year. In some cases, the wrong topdressing sand (physical property) has stratified the soil and reduced water penetration. With low water penetration, we are observing elevated gasses and increased root loss (biological property). The result is that fertility is failing to provide suitable responses (chemical property).

In cases like this, mono-focused approaches are failing. Simple soil tests, which appear to be available on every street corner, fail to provide information about the problem, but attempt to throw everything at the symptoms. Just recently we observed a case where all of these properties came together.

Here is the scenario: The greens here had been gassed and re-grassed some four years ago and have been in excellent condition ever since. Recently they began developing yellow spots that would quickly die. This pattern appeared on all greens and the practice green within a matter of days. At the mat layer, black layer would set in as soon as the tissue deteriorated. After utilization of several pathologists, it was diagnosed that mycorrhizal fungi had become overly aggressive and begun eating away at the mat. This set off a chain of events that affected the physical movement of water.

To complicate this further, the irrigation source on this course is heavily affected by snow-removal salts from an adjacent shopping center. These salts have elevated the chloride and sodium levels to the point that insufficient calcium and potash remained to properly heal and restore the turf. Deep-tine aerification followed by flushing cycles of water, along with balanced inputs of calcium and potassium, have turned this situation around. Balancing the turf's need for calcium and potassium after overdosing on sodium was very important to regaining the vigor needed for healing (chemical property restoration). Just as importantly, the calcium and potassium helped to flocculate these soil greens to once again provide suitable structure for water and air movement (physical property restoration). Anaerobic conditions were corrected and the problem is now under control (biological property restoration).

Proper rinsing rains from Mother Nature would have done three things: first, we would have applied less salt from irrigation. Second, the irrigation water source would have been further diluted with fresh water. And third, rain water would have helped to flush salts that had been applied through normal irrigation cycles. The result easily could have been one-third or less salts than have been applied this season. With less salt and less impact on the soil structure, we may never have seen this problem.

No one is saying just what triggered the mycorrhizae to take off. However, we are sure that some combination of factors provided the right environment that allowed these critters to become the dominant biological authority.

This is just one example, but many others are out there. Black layer is showing up where it has never been before; modeled colors seem not to disappear; spoon-feed applications don't seem to hang around; puffy turf and scalping are everywhere.

The take-home message here is **observation**. If we as superintendents and turfgrass managers are to learn from these conditions, then we must look beyond the symptoms and into the cause. With this season's high heat and increased irrigation, we have been presented many new challenges and we observed similar stresses in spring 2004 with near-record rainfall. The only way to minimize the stresses we will inevitably see is to make sure that all three legs of the stool are planted firmly on the floor so that we don't fall off on our butts. Take the opportunity soon to begin a study on your course that provides you with the data necessary to bring not only the chemical properties or fertility into line, but to look deeper into the physical and biological properties as well.

Keep up the sun block—it will be over soon!

Kurt Sams, CGCS –N–

The Sams family: Kurt, Lexy, Hunter, Vanessa and Nolan.

"When you know, you know."

Kurt Sams, CGCS at Idlewild Country Club in south suburban Flossmoor, applies this truism not only to meeting his eventual wife during the first GCSAA national conference he attended, in 1999, but also to his career choice.

Photos by Jim Trzinski

It's a sure thing as well that Idlewild C.C being the host site for the September MAGCS meeting and golf championship means a memorable day for participants. For some attendees, coming to Idlewild—a venerable par-72 layout playing 6,704 yards from the tips at a 137 slope—will be a homecoming of sorts, as Kurt explains, "A lot of superintendents in the area have passed through here, grew up around here and worked here."

A new tee for no. 12, a 185-yard par 3, was constructed in 1999.

Kurt is NOT among the MAGCS members to have a previous connection to Idlewild. He was born and grew up in rural northwestern Ohio, the grandson of a farmer who imparted to Kurt a strong work ethic. While he started playing golf during his freshman year of high school, at that time the game "was just a hobby, something to do as a kid."

When Kurt entered Ohio State University in 1990, it was as an engineering major. "After two years of that, it didn't feel quite right," Kurt recalls. He initially looked into switching his studies to landscape architecture. Then came a momentous conversation with a career counselor. "She asked my interests, I told her being outdoors and playing golf, and she suggested agronomy," says Kurt. "Two days later I was working at a golf course for the first time, on the grounds crew at Brookside Golf & Country Club in Dublin, a top-three course in the Columbus area."

Working in golf "just clicked." In fact, Kurt credits Carl Wittenhauer, his boss there, as a significant influence. "Working for him struck a chord, I knew within a few days that it was the right thing for me career-wise," notes Kurt.

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Kurt hustled to finish his agronomy degree in two more years. Between his junior and senior years, he interned at another acclaimed golf course, Ridgewood Country Club in New Jersey. Upon his graduation, he returned to Ridgewood as an assistant superintendent, spending two years in that capacity.

Not a huge fan of the East Coast, Kurt headed back to the Midwest in 1997 as assistant superintendent to then-superintendent Dave Holler at Idlewild. In August 1998, at a relatively tender age in today's job market, Kurt became head superintendent. "I have definitely been fortunate," Kurt reflects.

Meanwhile, Kurt's personal life began to percolate. He attended his first GCSAA national conference in 1999, and one evening, out for dinner with some friends, he met his future wife, Vanessa, an Orlando native. "We went to a movie the very next night, and when I came back to Chicago, she started flying up once a month to see me," says Kurt.

Kurt points out that Vanessa had never really been around snow before they started dating. However, the two were immersed in a taste of Midwestern winter in February 2000, when—on a snowmobiling trip in Wisconsin—Kurt proposed and Vanessa said yes. The couple married in December of that year.

Now residing in New Lenox, Kurt and Vanessa have three children: son Hunter, almost 7; daughter Alexandria (Lexy), 3; and son Nolan, 11 months. Reno, a 10-year-old yellow lab, is also part of the family. "He's been a golf course dog his whole life, and Idlewild hasn't had a geese problem since I arrived with Reno," Kurt laughs.

Family life agrees with Kurt, and he says his primary leisure activities involve doing things with family and friends. At this time of year, that includes cookouts and playing with the kids in the backyard. Another pastime—if you can call golf a pastime when the golfer maintains a 6.5 Handicap Index!—is golf. Kurt is also a baseball fan who enjoys both the Cubs and the Sox, though he admits, "I am more at heart a (Cleveland) Indians fan because I watched them stink for a lot of years as a kid!"

Idlewild, Kurt's home course, has been around almost as long as the Indians. In fact, the Indians franchise was only seven years old when Idlewild was founded in 1908. Al Naylor, who went on to become the club's first pro and superintendent, first served as architect at the behest of the club's founding fathers, who wanted a place away from the city but near the train line to convene for golf.

A classic parkland-style course, Idlewild features subtle greens, lots of trees, water in play on several holes and plenty of wildlife, including a couple dens of foxes and numerous deer. Kurt predicts that the key to success here for championship contenders will be the short game. "If you can hit it straight, it's easy to get around here—but maneuvering the old, classic greens with a lot of subtleties can be challenging," Kurt notes.

While Idlewild retains much of its original character, the clubhouse was redone in 2000, and Kurt and his greenkeeping predecessors have made many updates to the course over the years. Some of Kurt's projects have included implementing new tees, a process that involved killing off the existing tees and reseeding with bentgrass. Last fall, Kurt and crew redid the tee and bunkers on no. 2, a project that membership greeted enthusiastically.

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Hole no. 6 at Idlewild is a par 3 playing 210 yards.

Idlewild's no. 14, a 391-yard par 4.

"Everyone liked what we did on no. 2 and continuing similar work in-house is on the docket for the next two to three years," Kurt says. In fact, a full-fledged master plan to continue course improvements like renovating bunkers, removing some trees, etc. is in progress, scheduled for completion to coincide with the club's centennial celebration in 2008.

This summer, owing to the hot, humid weather, Kurt and his team focused on no. 3, which rests in a hollow by a creek, clearing the creek bank of smaller underbrush. "We weren't getting much air movement, so we tried to improve circulation for future years," says Kurt.

"We've had a pretty successful year thus far," Kurt continues. "Overall I'm pretty proud of what we've accomplished here. After a few rough years with membership numbers—we're in the same area as Flossmoor, Olympia Fields, Ravisloe, Calumet, so many other quality clubs—the future looks bright."

Like any successful superintendent, Kurt—who earned his CGCS designation in 2002—is eager to praise his crew. "My staff is consistent, most have been with me five-plus years, so I'm very fortunate there." He gives special mention to Tommy Lee Walker, a 46-year Idlewild veteran who is a jack-of-all-trades and oversees irrigation; Dion Pearce, his assistant of one-and-a-half years; and Enrique Sahagun, his equipment technician.

Come out to Idlewild Country Club on September 19th and enjoy the fruits of their labors for yourself!

Lee Miller *Chicago District Golf Association*

Wetting Agents—The Old, The New, What They Are and What They Do

Concerns over water delivery and usage have certainly come to the forefront this season, leaving many superintendents wishing the sweat dripping from their foreheads could adequately contribute to the amount of water available to their turf. It is even more disconcerting to realize the necessity for not only thinking about getting quality water to the turf, but also what the water does in relation to the physics and chemistry of the turf rhizosphere once it gets there. Wetting agents and surfactants have been leaned on heavily in this drought year to overcome problems associated with the soil-water interaction, which include soil hydrophobicity and localized dry spot formation.

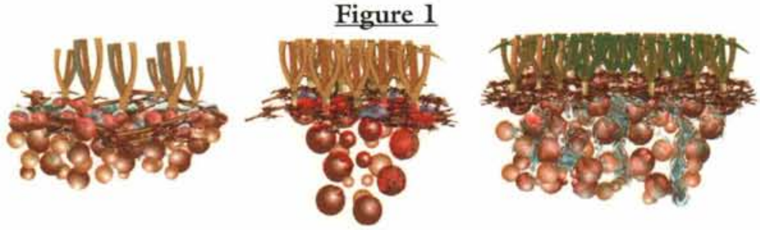
For increased infiltration, wetting agents can act as penetrants. A wetting agent also works within the soil to facilitate hydration and proper water distribution.

Water Chemistry

How water behaves when it gets to the turf, thatch layer and ultimately the soil profile is complex, and is ruled by various factors (including slope, soil type, pore space, etc.) and how they relate to the properties of water. Although going into explicit detail on all of water's properties would be a bit much, the discussion would be incomplete without mentioning a little basic water chemistry. Water is a polar molecule, meaning that it has a large affinity for binding to itself via hydrogen bonds between the oxygen of one molecule and one of the hydrogens on another. These tight cohesive forces cause surface tension and the formation of water droplets.

Adhesion, on the other hand, is water's attraction to other molecules, like soil. The attraction's strength is governed by whether or not the soil molecule is charged (or polar). If charged, the soil will accept or donate an electron readily and bond with water. If the soil molecule has no charge, or is coated by something that is, water will not bond with it. Then cohesive forces will take over, causing the water to preferentially bond to itself rather than the soil. The soil is then termed to be hydrophobic, or fearing of the water. When enough of these hydrophobic molecules get together, they scare away a considerable amount of water that would normally be available to the plant. This "scared" water is either captured up near the surface (poor infiltration), leached through the profile (poor hydration) or pushed into uneven or splotchy patterns in the soil profile (poor distribution). **See Figure 1.**

Figure 1



Poor Infiltration | Poor Hydration | Poor Distribution

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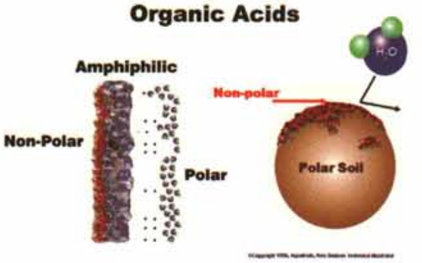
Hydrophobic Soils

Hydrophobic soils are caused by water-repellant coatings from several sources. Organic compounds from decomposing plant materials, microbial deposits and plant exudates are major sources. These organic compounds are amphiphilic (**see Figure 2**), meaning they have portions that are polar and portions that are nonpolar. The polar side adheres to the soil particle and exposes the nonpolar side, therefore taking up a site where water would normally adhere. The situation gets worse when wet-to-dry cycles take place (i.e., irrigation, rain event), presumably because dehydration causes the structure of the organic compound to bend. This bending changes and intensifies the chemical forces of the organic compound while shaping it around a soil particle. This may be one of the reasons why it's hard to rewet a dry sand or soil.

Figure 2

Organic Acids



Another coating source is from soil- and thatch-inhabiting fungi, which explains the link between fairy ring fungi and localized dry spots. The fungi produce a mycelial mat and/or fungal exudates that coat the soil and repel water. In some cases of fairy ring, this can cause a severe burning out of the turf along fairy ring margins. For this reason, adding a wetting agent to fungicide applications has become one of the standard recommendations for attempts at fairy ring control.

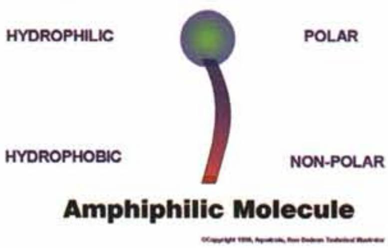
Perhaps a larger area of concern for hydrophobicity is not just the soil, but also the thatch layer. The thatch layer invariably has more organic matter than any part of the rootzone, and therefore has most of the hydrophobic organic compounds and fungi that can cause problems. This seems to be especially true of localized dry spots on fairway turf, as the thicker thatch layer is the main barrier to water infiltration rather than a hydrophobic coating on the soil particle.

Wetting Agents

The basic structure of a wetting agent, surfactant or "high-tech detergent" as one of my colleagues would call it, is very similar to an organic compound that makes soils hydrophobic in that it too is amphiphilic. It has at least one polar or hydrophilic "head" and at least one nonpolar or hydrophobic tail (**see Figure 3**). This structure can serve many functions in the soil profile to assist infiltration, hydration and distribution.

Figure 3

Surfactant Molecule



For increased infiltration, wetting agents can act as penetrants. A penetrant binds to water via the hydrophilic head, leaving the hydrophobic tail exposed to pull the water droplet towards the nonpolar soil or thatch surface (**see Figure 4**). In this way, surface tension is overcome and the water droplet is spread out over the surface for easier infiltration into the soil.

A wetting agent also works within the soil to facilitate hydration and proper water distribution. In this case, the hydrophobic tail of the wetting agent attaches to the hydrophobic soil coating, leaving the hydrophilic head exposed. The hydrophilic surface attracts water and holds it into the soil particle through adhesion. The cohesive forces of surrounding water molecules bind to the adhered one, creating a more uniform water distribution. For a well-designed wetting agent, water then gets out by gravity, leaving pore spaces filled with both air and water.

So how then do wetting agents differ? Shouldn't it be "one size fits all"? The answers to these questions all lie in the miracles of high-tech chemistry. Wetting agents differ in their construction, with the main difference being the length and chemical structure of the hydrophobic tail. This affects molecular weight, size, shape, structure and how intimate the wetting agent is with the hydrophobic soil coating, which translates into different performance characteristics. Who couldn't tell the difference between a hydroxyl-terminated methyl oxirane-oxirane copolymer, an akyl ether of the methyl oxirane-oxirane copolymer or an ethoxylated alkylphenol?

Comparing Wetting Agents

Results with the first wetting agents to hit the market were varied and in some instances unsatisfactory. Major complaints were that they held too much water in the top few inches of the soil profile, or needed to be applied at rates that were too high or at intervals that were too short. In response, industry developed newer wetting-agent technologies (i.e., different hydrophobic tails) to address some of these issues. These newer wetting agents, which are all related to the block copolymer chemistry, have been introduced into the market

Figure 4