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.

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

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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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!