# SOIL TESTING IS NOT ABOUT FERTILITY

## At least not exclusively!

**FOR OVER TWENTY YEARS** I have been staring at soil tests, writing reports and recommendations. And for over twenty years I have seen, sports turf managers, and golf course superintendents make changes to their properties. Clearly they have produced better turf but more importantly they have made changes to their soil profile. They have improved drainage, strengthened rooting, increased plant recovery and they reduced fertility inputs. Why? Because they have soil tested and their soil testing programs have helped them to discover that improving the physical structure and biological profile of the soil is the precursor to good soil and plant fertility.

The four basics of good soil management are: Air Management, Water Management, Digestion Management and finally Nutrient Management, in that order. Air space in the soil allows for good water movement, without air in the soil roots will not survive and beneficial soil micro-organisms will not proliferate. With too much water an anaerobic condition will prevail and both roots and microbes will die off. With good air and water movement through the soil profile you will create the environment where beneficial soil microbes can freely multiply and in the process carbon is digested down to humus — the ultimate break down of organic matter in the soil. This humus is then used as a microbial food source to generate even more biological activity. It is the back bone of the carbon to nitrogen cycle in the soil, producing free and needed nitrogen to the plant without all the side effects of synthetic applications. If and only if the environment for microbial digestion is present in the soil will nutrient mobility take place. Microbes "eat at the table first" and all nutrient mobility from the soil is done through microbial degradation. A good soil testing protocol allows the turf manager to manipulate the soil physically, by balancing basic cations and relaxing soil particles just enough to allow better air and water movement through the soil profile. This builds a better environment for soil micro-organisms to do their job of digesting carbon, releasing nutrients into the root zone and providing buffers for water, temperature and pathogen attack. So, if 75% of good soil management deals with air, water and carbon digestion (physics and biology), is soil testing really about fertility?

The intention is to change soil physics and improve the environment for soil biology. After more than twenty years of soil testing, tens of thousands of soil tests on hundreds of sites, I have never seen the process fail if the turf manager sticks to the basics. I have, however, repeatedly been told that it cannot work, "you can't change soils physically by changing soils chemically", "there is no research to prove this", "an acre inch is two million pounds of soil much too much to change…" The truth is you can change soils physically by manipulating the soil chemically and you better if your soils are out of balance and you hope to produce better turf with fewer inputs. We are not changing clay to sand or sand to silt and we are not concerned about the entire two million pounds of soil in the acre inch, we are only concerned about the four thousand pounds or so that make up the nutrient profile particularly calcium, magnesium and potassium that affect soil flocculation which impacts soil biology and that we can change. What we are really focused on is Biological Soil Management.

According to the working models presented by Dr.

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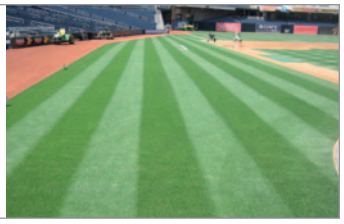

Soil image courtesy of istockphoto.com

Albrecht at the University of Missouri, and Dr. Bear at Rutgers University we are looking to balance the basic soil cations and striving for a profile that presents roughly 68% calcium, 12% magnesium, 5% potassium, 2 % sodium, 3% trace elements and 10% hydrogen. When a colloidal soil moves to these percentages the soil physically works better. Air and water move through the profile more efficiently building an environment where soil biology explodes and the nitrogen cycle increases. In this model if we can achieve 10% hydrogen we will always have a pH of 6.3 which is the point at which we find maximum potential nutrient mobility across the entire nutrient board. These percentages are found in the base saturation section of a complete base saturation soil test and can easily be manipulated by adding what is deficient and knocking off what is excessive. Unfortunately, not all soil tests show a complete base saturation where all six cation groups are present, calcium, magnesium, potassium, trace elements, sodium and hydrogen. Too often a soil testing laboratory will show a limited spectrum of soil cations or they will add up to something more that 100% which is not a true base saturation and makes building a quality recommendation all most impossible.

The following base saturation was found on a soil test of a sports turf client: 35% Ca; 45% Mg; 2% K; 5% Na; 3% traces and 10% hydrogen. He was not able to aerify the soil because it was too hard

## Soil Report

Job Name: STB Hills CC  Date: 1/1/2007

Company: Logan Labs 888-494-7645  Submitted By:

| | | | Ideal | | | | |
|---|---|---|---|---|---|---|---|
| Sample Location | | | | | | | |
| Sample ID | | | 1 | 2 | 3 | 4 | 5 |
| Lab Number | | | | | | | |
| Sample Depth in inches | | | 6 | 6 | 6 | 6 | 6 |
| Total Exchange Capacity (M. E.) | | | 12.00 | 2.74 | 8.89 | 21.03 | 12.80 |
| pH of Soil Sample | | | 6.30 | 5.60 | 6.50 | 7.20 | 6.30 |
| Organic Matter, Percent | | | 3-5 | 0.80 | 3.54 | 1.40 | 1.20 |
| ANIONS | SULFUR: | p.p.m. | 25-50 | 8 | 55 | 18 | 12 |
| | Mehlich III Phosphorous: | as ($P_2O_5$) lbs / acre | 250-500 | 232 | 284 | 250 | 242 |
| EXCHANGEABLE CATIONS | CALCIUM: lbs / acre | Desired Value | 3264 | 745 | 2418 | 5720 | 3482 |
| | | Value Found | 3264 | 459 | 2308 | 4380 | 1777 |
| | | Deficit | -0 | -286 | -110 | -1340 | -1705 |
| | MAGNESIUM: lbs / acre | Desired Value | 346 | 200 | 256 | 606 | 369 |
| | | Value Found | 348 | 138 | 355 | 2038 | 1369 |
| | | Deficit | -0 | -62 | | | |
| | POTASSIUM: lbs / acre | Desired Value | 468 | 163 | 277 | 552 | 396 |
| | | Value Found | 468 | 33 | 279 | 248 | 255 |
| | | Deficit | -0 | -130 | | -304 | -141 |
| | SODIUM: | lbs / acre | 20-50 | 30 | 84 | 176 | 153 |
| BASE SATURATION % | Calcium (60 to 70%) | | 68.0 | 41.88 | 64.90 | 53.07 | 34.71 |
| | Magnesium (10 to 20%) | | 12.0 | 20.99 | 16.64 | 40.38 | 44.55 |
| | Potassium (2 to 5%) | | 5.00 | 1.54 | 4.02 | 1.51 | 2.55 |
| | Sodium (.5 to 3%) | | 3.00 | 2.38 | 2.05 | 1.82 | 2.60 |
| | Other Bases (Variable) | | 2.00 | 6.20 | 4.90 | 4.20 | 5.10 |
| | Exchangable Hydrogen (10 to 15%) | | 10.00 | 27.00 | 7.50 | 0.00 | 10.50 |
| TRACE ELEMENTS | Boron (p.p.m.) | | 1.20 | 0.02 | 0.48 | 0.7 | 0.66 |
| | Iron (p.p.m.) | | 150 | 175 | 319 | 740 | 540 |
| | Manganese (p.p.m.) | | 40 | 2 | 140 | 145 | 77 |
| | Copper (p.p.m.) | | 5 | 2.4 | 2.08 | 2.7 | 2.6 |
| | Zinc (p.p.m.) | | 10 | 1.8 | 7.44 | 5.5 | 3.5 |
| | Aluminum (p.p.m.) | | <1400 | 200 | 419 | 800 | 900 |
| OTHER | | | | | | | |
| | | | | | | | |
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and the metal tines of the aerifier would not penetrate the soil. When it rained the soil would not drain for days, he had very poor rooting, seed germination was weak and he had to apply over 8 pounds of synthetic nitrogen per 1000 square feet to the site each year simply to maintain color. When I asked how his soil was he responded by saying "it's not my soil, I tested it and the pH was 6.3!" He had over a 1700 pound deficiency in calcium, a thousand pound excess of magnesium, low potassium and high sodium. I recommended three applications of high calcium limestone at a rate of one ton per acre, separated by a few months, along with a lot of potassium sulfate. After the second application of lime I called him and asked if he was able to aerify the property and he reported that he could not. So I asked him if he had seen any difference and he did say that he thought they had reformulated his fertilizer because it was working a lot better. With better soil biology fertilizer will work better! One year later he called and told me that he had run his aerifier over this site and did not break a single tine, which was uncommon prior to making the soil adjustments, so he ran the machine off the treated area to an adjacent soil that was not treated and as soon as he hit that soil he broke the machine into pieces! He reduced his nitrogen inputs down to around two pounds per 1000 square feet per year, drainage was no longer a problem, rooting was strong and deep, recovery was excellent and seed germination when he needed it was very good.

## Saturated Paste Report

Job Name **STB Hills CC** Date 1/1/2007

Company Logan Labs 888-494-7645 Submitted By

| | | | Ideal | | | | |
|---|---|---|---|---|---|---|---|
| Sample Location | | | | | | | |
| Sample ID | | | 1 | 2 | 3 | 4 | 5 |
| Lab Number | | | | | | | |
| Water Used | | | DI | DI | DI | DI | Irrigation |
| pH | | | 6.3 | 6.5 | 6.5 | 7.1 | 7.1 |
| Soluble Salts | | ppm | <960 | 134 | 150 | 121 | 114 |
| Chloride (Cl) | | ppm | <50 | 8 | 4 | 8 | 10 |
| Bicarbonate (HCO3) | | ppm | <50 | 40 | 176 | 73 | 366 |
| ANIONS | SULFUR | ppm | 5-10 | 10.72 | 36.67 | 11.71 | 9.59 |
| | PHOSPHORUS | ppm | 1-3 | 0.61 | < 0.1 | 0.38 | 0.46 |
| SOLUBLE CATIONS | CALCIUM | ppm | 40-60 | 42.59 | 25.54 | 14.34 | 13.32 |
| | | meq/l | 0 | 2.13 | 1.28 | 0.72 | 0.67 |
| | MAGNESIUM | ppm | 8-12 | 2.06 | 5.74 | 2.11 | 1.95 |
| | | meq/l | 0 | 0.17 | 0.48 | 0.18 | 0.16 |
| | POTASSIUM: | ppm | 15-20 | 25.52 | 10.86 | 24.51 | 13.06 |
| | | meq/l | 0 | 0.66 | 0.28 | 0.64 | 0.34 |
| | SODIUM | ppm | <20 | 4.56 | 17.39 | 5.17 | 24.82 |
| | | meq/l | 0 | 0.20 | 0.76 | 0.22 | 1.08 |
| PERCENT | Calcium | | 55-60 | 67.34 | 45.71 | 40.87 | 29.64 |
| | Magnesium | | 18-20 | 5.43 | 17.12 | 10.02 | 7.23 |
| | Potassium | | 9-12 | 20.96 | 10.10 | 36.29 | 15.10 |
| | Sodium | | 2-8 | 6.27 | 27.07 | 12.81 | 48.03 |
| TRACE ELEMENTS | Boron (p.p.m.) | | 0.1 | 0.02 | 0.03 | < 0.02 | < 0.02 |
| | Iron (p.p.m.) | | 0.3 | 1.35 | 3.12 | 1.25 | 2.55 |
| | Manganese (p.p.m.) | | 0.1 | 0.03 | 0.15 | 0.03 | < 0.02 |
| | Copper (p.p.m.) | | 0.08 | 0.07 | < 0.02 | 0.08 | < 0.02 |
| | Zinc (p.p.m.) | | 0.08 | 0.08 | < 0.02 | 0.11 | 0.06 |
| | Aluminum (p.p.m.) | | | 1.86 | 7.27 | 1.47 | 2.94 |
| OTHER | | | | | | | |
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When staring at as many soil tests as I do it sometimes becomes hard to see the forest through the trees but a client once told me that when the light bulb finally went off for him was when he realized that base saturation was always 100%, no more and no less. If a soil test shows more or less than 100% base saturation it is not a true base saturation test which is the key here. Understanding that it is always 100% makes it easy to see that if something is high it can be exchanged (cation exchange capacity) by replacing it with what is low. In the previous example magnesium was driving the soil and calcium was low so by adding the proper amount and type of calcium we were able to drive off the magnesium which was tightening the soil and affecting soil biology.

Base saturation is only one of many tools that we use to manage soil profiles and on some soils it is not as strong a tool, such as low CEC sand based soils, but the tool can still give us direction. On these sites the sufficiency levels of nutrients is clearly our first focus. I have become a big fan of the water soluble paste extract test to give me even more information and help me answer some questions that may not be easy to answer simply by reviewing the standard soil tests. I use Logan Labs (www.loganlabs.com) for my lab work but there a number of good labs producing complete base saturation soil tests. A complete base saturation soil test will never lie to you it may tell you that sodium is driving the soil like out west or calcium on the calcareous soils of the mid west or even aluminum like in some of the gumbo soils down south. A good soil testing protocol will give you the map and directions on how to affect physics which will affect soil biology. Oh and by the way all of this improves nutrient mobility! ■

*Joel Simmons is the President of EarthWorks Natural Organic Products and Soil First consulting and teaches the Soil First Academy all across North America. He holds a Masters Degree from Penn State University and is a former Penn State County Extension Agent and Instructor of Soils at Rutgers University. He may be reached in front of his computer at joel@soilfirst.com most likely working on yet another client's soil test.*