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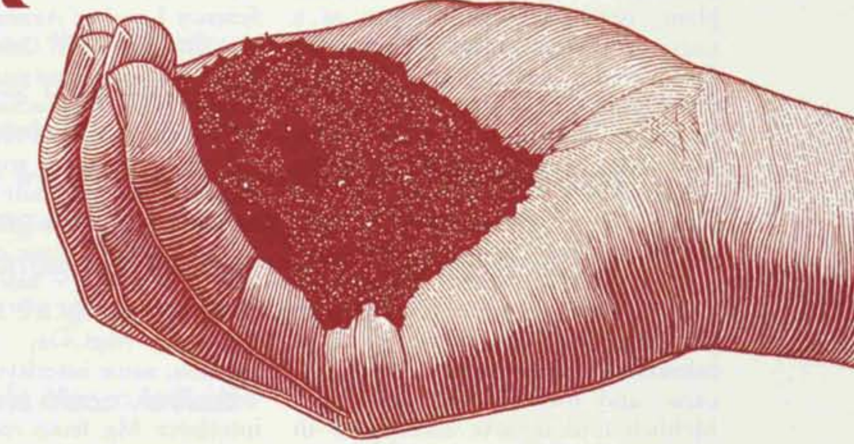
The Dirt on Soil Testing



Do you take soil tests?

I do not mean exams in soils class 101, but soil analyses from your golf course greens, tees and/or fairways. When did you last administer a soil test? How often do you take soil tests? At what locations? What procedure do you use? Why? Answering these questions and comprehending the soil-test report are half the battle. The other half consists of the superintendent implementing the correct procedures per the soil-test recommendations: types of products, timing on products, and how much product to use per application. Soil-testing labs usually standardize the recommendations for balancing the nutrient levels, but superintendents need to customize these reports to fit into their specific programs.

Soil testing is a vital tool in the superintendent's extra-extra-large tool belt. Just as stock analysts use financial reports to predict the future of stocks, a superintendent can predict and prepare for the future by using soil analysis, which identifies nutrient deficiencies, anticipates nutrient needs, evaluates the excess or imbalance of essential nutrients, heavy metals and/or salts, and assesses the pH level, organic matter content and CEC. In that sense, soil testing offers all aspects of evaluating the soil's chemical properties and is not just limited to the identification of essential nutrient deficiencies.

When obtaining a soil analysis, do not fertilize or supplement with micronutrients at least two weeks before and after the analysis. Fertilizing can skew the lab results and give you false recommendations on your soil-test report.

Several guidelines govern the taking of soil samples. Sampling can be done any time of year: spring, summer, fall and winter. The depth of the soil sample should consist of four to five inches of soil and soil mat (if thatch > one inch, then sample to six or seven inches) unless the superintendent is only trying to reduce pH. Then he or she should only sample the first inch of soil. Next, try to obtain at least 10 four-inch samples from one test site to compile a complete sample. When obtaining a soil analysis, do not fertilize or supplement with micronutrients at least two weeks before and after the analysis. Fertilizing can skew the lab results and give you false recommendations on your soil-test report. Also, be consistent year after year on the timing of the soil analysis since soil conditions can change from season to season. Routine sampling may take place every two to three years unless the superintendent is attempting to alter some chemical aspect of the soil. If this is the case, then sampling on a yearly basis is needed.

How do the soil-testing laboratories actually test soil samples? They use chemical extractants to remove the portion of soil nutrient that is plant-available and use two approaches (SLAN or BCSR, explained later) to assess

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the cation nutrient status. The lab starts off mixing the chemical extractant with the soil sample and then filtering out the liquid solution. This solution is a measure of a particular nutrient that is readily available to the plant, not the total quantity of a nutrient. Different soil-testing labs around the nation use different extractants. The absolute values for a nutrient measured by chemical extractants may change from lab to lab; however, the ranking of the nutrient level (low, medium, high) should correlate regardless of the soil-testing lab used. Sometimes extractants are recommended for certain situations, like Olsen for P in calcareous soils, Mehlich III for volcanic and loess-derived soils, and Mehlich I to remove excessive P in calcareous soils. Superintendents that have calcareous sand, soils with free calcium carbonates, should be extra careful and consult their testing lab on the extractant being used.

Two philosophies in assessing cation nutrient status are SLAN (Sufficiency Level of Available Nutrients) and BCSR (Basic Cation Saturation Ratio). Usually, soil-test reports document both approaches. The SLAN approach is based on a chemical extractant from the soil forms of the nutrient that are plant-available. This would include the following sites: cations on CEC sites; cations in solution, Ca/Mg associated with relatively soluble Ca-P, $CaMg(CO_3)_2$, $CaCO_3$, $MgCO_3$, $CaSO_4$, and $MgSO_4$; some interlayer K associated with illite or mica clays; and some interlayer Mg from montmorillonite and vermiculite clays. Therefore, the SLAN approach includes other plant-available chemical forms of nutrients besides relying solely on cations present on CEC sites. It is the best measure on assessing plant-available nutrients P, K, Ca, Mg, Mn and Fe.

What information on the soil-test report is most important and accurate for assessing soil-nutrient status? The soil pH, lime requirement and plant-available nutrients rank at the top.

Taking a different perspective, the BCSR approach is based on determining the percent saturation of cations on the exchange sites and not on the total quantity of available cations. It measures a high concentration of one cation and determines the cations replaced from the CEC sties, unlike the SLAN approach that measures more than one site. This becomes a pitfall when a sample comes from a golf green with 6% K saturation and a CEC of 6.4 meq. per 100 g compared to a soil with 6% K saturation and 25.4 meq. per 100 g of CEC. Both saturation percentages of K are the same; however, the golf green CEC is four times less, causing the level of K to be insignificant in the golf green. Using the BCSR approach alone can be misleading and should be supplemented with the SLAN approach for a more thorough test. The most useful BCSR information is determining the severity of Na influence and categorizing salt-affected soils, providing an accurate measure of total CEC, monitoring a fertilization program to see if the cation percentages are changing on the CEC, and comparing ratios quickly to see if they are in question.

What information on the soil-test report is most important and accurate for assessing soil-nutrient status? The soil pH, lime requirement and plant-available nutrients rank at the top. These readings are accurate, repeatable and have the best scientific basis for making fertilizer recommendations. When using this valuable information, take these items into consideration:

- Extractable nutrient levels are reported as lb per acre or ppm: lb per acre = 2 X ppm.
- In acid soils, Ca may be low but Ca deficiency is very rare and the addition of lime would probably eliminate the deficiency of Ca by raising the pH of the soil where the Ca is more plant-available. The only need for Ca fertilization occurs when high levels of Na exist in the soil or Ca:Mg ratios are low. Ca is a larger cation (atomic weight =40) with a charge of +2 while Na (atomic weight=23) and Mg (atomic weight=38) are smaller. The Ca readily replaces Na on the CEC sites because of the large difference between the +1 charge and atomic weight, but the Ca replaces the Mg at a much slower pace because of the similar size and charge.
- Other nutrients (P, K, Mg) can be deficient in the soil and require fertilization to correct them.
- The lime requirement for turfgrass soils should apply to the first four inches of the soil (not eight inches). Eight inches is usually recommended for agronomic crops and four inches should be assumed when comprehending the recommendations of a turfgrass soil report.
- Dolomitic lime is an excellent choice when pH and Mg levels are low.
- pH can be reduced by sulfur over time but this is very difficult to accomplish if calcium carbonates are present in the soil or water.

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The second-most-important aspect of assessing soil-nutrient status is the CEC level and extractable Mn and Fe. For example, a soil with a CEC below 4.0 meq. per 100 g will be susceptible to leaching of nutrients and require high maintenance practices to maintain adequate nutrition levels. Mn and Fe provide the best meaurable estimate of plant-available nutrients among the micronutrients (Zn, Cu, Mo, B and Ni). If reported levels of Mn or Fe are low, it is normally associated with high-pH (pH>7), calcareous soils. While hot, dry weather inhibits Mn availability to the turf, the exact opposite occurs with Fe in the cold, wet weather. Fe-deficiency symptoms (leaves turn pale yellow to white, spindly) are more pronounced than Mn deficiencies (greenish-gray spots on the young leaves and interveinal yellowing with more extreme deficiencies). After applying Fe and/or Mn from soil-test recommendations, the turf will exhibit a rapid color response if the nutrients are truly deficient.

Next on the list is cation percentages on CEC sites (especially Na), cation ratios based on cation percentages and percent base saturation. Two useful aspects are derived from this category: monitoring the CEC cation status over time to determine if your fertilizer program is affecting the soil, and determining the percent of Na on the CEC site to see if the soil is saline and/or sodic. Remember that this aspect is best utilized over time and not recommended for immediate fertilizer recommendations.

Finally, the fourth category consists of the extractable levels of the remaining micronutrients: Zn, Cu, Mo, B and Ni. These nutrients are usually included in soil tests but are insignificant in the big picture, because they are rarely deficient in the soil. The only precaution would be applying these nutrients at high levels or too often, which in turn may cause toxicities to the turf.

Sometimes comprehending soil tests can be very confusing. Several issues can cause confusion in the soil-test reports.

- The first issue might be that test values are significantly different from last year's results. This may be due to sampling at different soil depths or sending the sample to a different testing lab that is using a different chemical extractant.

- The chemical extractants used for plant-available micronutrients (Fe, Mn, Zn, Cu, Mo, B and Ni) are not well-correlated to turf; therefore, the soil test only gives a general estimate at best of these micronutrients. Extractants used for plant-available Fe and Mn are better correlated than the other micronutrients, but still are a rough estimate. Excessively high or low levels of micronutrients may alarm superintendents, but micronutrient toxicities are very rare and turfgrasses are very efficient in obtaining micronutrients.

- Labs are in competition and try to provide more information than their competitors. This makes the soil-test report harder to comprehend as it comes replete with information that has no significant value. A good example is the buffer pH. It is used to calibrate the lime requirement, but the buffer pH data is meaningless without the calibration curve that provides the lime requirement. Also, superintendents can confuse the buffer pH with the true pH of the soil.

Last, the superintendent is the ultimate decision-maker in the entire soil-testing process. He or she needs to decide on the products to use and when to apply them. Every golf course is different and requires specific maintenance practices, therefore no standard products or recommendations can be utilized. The superintendent has two basic choices for applying products: liquid or granular. Choosing liquid or granular is easy, but deciding on the type of product (slow, quick release, sulfur coat, ammonium sulfate, urea, organic, bios, aminos, etc.) can be endless.

In conclusion, soil testing is a valuable tool for evaluating nutrient status as well as determining important chemical factors (pH imbalances, excessive Na). Interpreting soil-test results can be difficult, but understanding the processes and methods used by soil-testing labs can alleviate some of the confusion. A good soil test requires proper sampling techniques, appropriate chemical extractants, precise analysis and useful recommendations. Remember, the best soil-sample recommendations in the world are only as good as the individual comprehending them and implementing the best corrective procedures. Good luck with future testing.