CUTT

The "Best" Soil Test

Program Spotlight

I believe that, in fact, the saturated paste test and other water-based extractions are among the easiest of tests to interpret, and that the results are useful, but they are often misinterpreted. No one disputes the appropriate use of saturated paste tests to assess soil salinity, but rather the disputes are over the usefulness of the mineral nutrients extracted by a saturated paste.

Two recent articles have described the saturated paste extraction, and the authors of the respective articles could not have more divergent views on this relatively recent addition to turfgrass soil analysis.

Dr. Carrow from the University of Georgia, along with numerous coauthors from across the United States, wrote in the September 2003 issue of *Golf Course Management* that with the saturated paste extraction, extracted nutrients do not equal soil fertility, and that water-based extraction procedures are inferior to other extraction methods, even for sand-based rootzones.

A different view was presented in the February 2004 issue of *TurfNet Monthly*, where Joel Simmons outlined his thoughts on the usefulness of the saturated paste method. Mr. Simmons has found the saturated paste test to be an essential tool, and he stated that "paste extracts have proven valuable in quantifying problems and indicating sustainable solutions," while finding, in contrast to Carrow et al., that in sand root-based greens, the paste extract becomes a driving factor in fertility determinations.

Who Is Right?

How are we to know which view is correct? The subject of soil testing is complicated enough without having to worry about whether a particular test is useful or not. I have been studying water-based extraction methods (saturated pastes are a type of water-based extraction) on sand-based rootzones for the past few years, and I believe that, in fact, the saturated paste test and other water-based extractions are among the easiest of tests to interpret, and that the results are useful, but they are often misinterpreted. (I should note here that no one disputes the appropriate use of saturated paste tests to assess soil salinity, but rather the disputes are over the usefulness of the mineral nutrients extracted by a saturated paste.)

As the previous authors have clearly described the saturated paste procedure, I will jump right into the interpretation of the results. Why do I say that water-based extractions are among the easiest to interpret? First, water mixed with a soil can only extract water-soluble ions. The water-soluble ions are either the ions in soil solution or the ions present as soluble salts. We know exactly which ions are extracted. Unfortunately the same cannot be said of other methods, such as Mehlich 3, ammonium acetate or Morgan.

Next, water extractions adjust to the pH of the soil, unlike other extraction methods which extract at a different pH than the soil. Since we know that roots take up only those ions that are in solution, and because the roots are growing in a soil with the same pH as the water extracts, it seems likely that the ions extracted are actually readily available to the roots. While the ions extracted in a saturated paste are certainly meaningful, it is not possible to take the numbers and decide that they are low enough to justify fertilizer applications. If you want to use your soil test results to develop a fertilizer program, use a different extraction method.

Some Recommendations

With that said, how should the saturated paste results be interpreted? Here are some suggestions:

- Expect the amount of nutrients extracted to be low. Most of the nutrients in soils (and that includes sands too) are in minerals or organic matter or on exchange sites. Water-based extractants access only the soluble ions.
- Soluble ions are important because those are the ones that the roots can access.
- Low concentrations of soluble nutrients should not be taken as an indication that the nutrient is deficient. In the absence of calibration data relating soil nutrients to turfgrass function, it is not possible to determine if nutrient uptake is limited or not.
- We do know this: tissue calcium concentrations have decreased in experimental plots at Cornell University as we have increased the potassium application rate. Other studies have shown a decrease in potassium uptake when calcium application

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rate is increased. Turfgrass plots at Cornell University receiving no potassium or calcium fertilizer for the past two years have maintained normal levels of tissue calcium and potassium. Grasses are able to take up sufficient levels of many nutrients from the soil as long as they are supplied with enough nitrogen. Be wary of creating nutrient imbalances rather than eliminating them when making applications of calcium or potassium.

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• Wheat produces 95% of maximum yield at soil solution phosphorus at 0.028 parts per million (ppm). For corn the 95% yield threshold is only 0.025 ppm. I would not concern myself with low phosphorus levels in a saturated paste extract. The forms of phosphorus in soil are either insoluble or are bound to soil particles. To diagnose a phosphorus deficiency I would collect a few tissue samples, submit them for analysis to a reputable laboratory, and determine that phosphorus application is required only if the tissue nitrogen is above 4% and the tissue phosphorus is less than 0.5%. If the tissue nitrogen is less than 4%, increase nitrogen fertilizer before worrying about any other problems.

• Bicarbonates in soil do not cause structural problems or sealing, nor are they bound to the soil colloid. High bicarbonate levels in a saturated paste extract are simply an indication that sodium is likely present. Why is this? Simple chemistry. Calcium or magnesium carbonates and bicarbonates are relatively insoluble (thus, they precipitate from solution). Sodium or potassium carbonates and bicarbonates are quite soluble (thus, they dissolve in water). Electroneutrality must be maintained in soils and in solutions, so the negative charge from anions such as bicarbonate must be balanced by positive charge from cations. High bicarbonate levels in a saturated paste extract indicate that sodium is the cation which balances the negative charge of the bicarbonate. That sodium can cause dispersion of soil particles. If high levels of bicarbonate are found in a saturated paste test, I would check the sodium adsorption ratio (SAR) of my irrigation water and take steps to address that problem.

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• Use the saturated paste test to assess nutrient relationships in the soil. In general, I find it much more useful to look at soil test data as an indicator of available nutrients but to use tissue analysis as a means to detect nutrient deficiencies. Roots actually see a flux of nutrients, but current soil analysis methods measure a nutrient concentration, not a flux. Tissue tests tell us what the plant has, so there are no questions about whether a certain nutrient is available or not, deficient or not, or sufficiently mobile or not. In the tissue there are either adequate amounts or there are not. Final answer.

• Keep in mind that we do not have any data that correlates water extractable nutrient levels with turfgrass quality. Think carefully before making fertilizer applications based on soil test data. As a former golf course superintendent myself, I am aware of (and guilty of) the desire to apply a suite of nutrients to ensure a high quality playing surface.

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• If fertilizers are necessary, the saturated paste test is not an ideal method for determining the nutrient requirement.

• With all that said, if one wishes to get the best commercially available approximation of soil solution, run a saturated paste on your soil samples.

A Final Thought

Unfortunately, the relationship between soil nutrients and turfgrass functional quality is not yet clear. Ongoing research at Cornell and other universities is addressing this issue and I am optimistic that it will soon be possible to interpret turfgrass soil tests with more clarity.

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