Commentary

Q & A: Water-based Extraction Methods for Turf Soils

by Micah Woods

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

Dr. Robert Carrow from the University of Georgia, along with numerous co-authors from across the United States, wrote in the September 2003 issue of *Golf Course Management* (Clarifying soil testing: Saturated paste and dilute extracts) that water based extraction procedures are inferior to other extraction methods in assessing soil fertility, even for sand based rootzones.

A different view was presented in the February 2004 issue of *TurfNet Monthly* (The Paste Extract: a soil management tool), 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." In contrast to Carrow et al., he found that the paste extract becomes a driving factor in fertility determinations in sand-based greens.

Given these contrasting opinions on the utility of water-based extractions, it seems that some additional information about these tests may be helpful.

Q. How are we to know which view is correct?

A. The subject of soil testing is complicated enough without having to worry 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 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 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.

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Q. Why do I say that water-based extractions are among the easiest to interpret?

A. First, water mixed with a soil can only extract water soluble ions, those either in soil solution or present as soluble salts. We know exactly which ions are extracted. The same cannot be said of Mehlich 3, ammonium acetate, or Morgan methods.

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 by water 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. In my opinion, if you want to use soil test results to develop a fertilizer program, use a different extraction method.

Q. What kind of nutrient levels should one expect from these tests?

A. Expect the amount of nutrients extracted to be low. Most of the nutrients in soils (and that includes sands as well) are in minerals or organic matter or on exchange sites.

Q. Why are soluble ions important to know?

A. Soluble ions are important because those are the ones that the roots can access.

Q. If concentrations are low in a water extract, should I fertilize?

A. 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

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possible to determine if nutrient uptake is limited or not.

Q. Can I create problems by fertilizing?

A. 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 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.

Q. What do we know about normal phosphorus levels for "other" grasses?

A. Wheat produces 95% of maximum yield at soil solution phosphorus of 0.028 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 primary 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 0.4%. If the tissue nitrogen is less than 4%, I suggest increasing nitrogen fertilizer before worrying about any other problems.

Q. Are high bicarbonate levels problematic in themselves, or just indicative of a problem?

A. 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? It has to do with solubility. 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).

To maintain electroneutrality in soils and solutions, 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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Q. Why should I use water-based extraction tests on my soils?

A. 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 flow of nutrients as they make their way to the root surface, but current soil analysis methods measure a nutrient concentration, not a flow. 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.

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Keep in mind that we do not have any data that correlates water extractable nutrient levels with turfgrass performance. 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. If fertilizers are necessary, the saturated paste test is not in my opinion 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 test on your soil samples.

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.

Micah Woods is a PhD candidate in Horticulture at Cornell University in Ithaca, New York. His advisor is Dr. Frank Rossi. Prior to graduate school, Woods worked as a golf course superintendent in China and Japan. He can be reached at msw43@cornell.edu.