Soil Extraction and Analysis using Mehlich III and Saturated Paste Extracts

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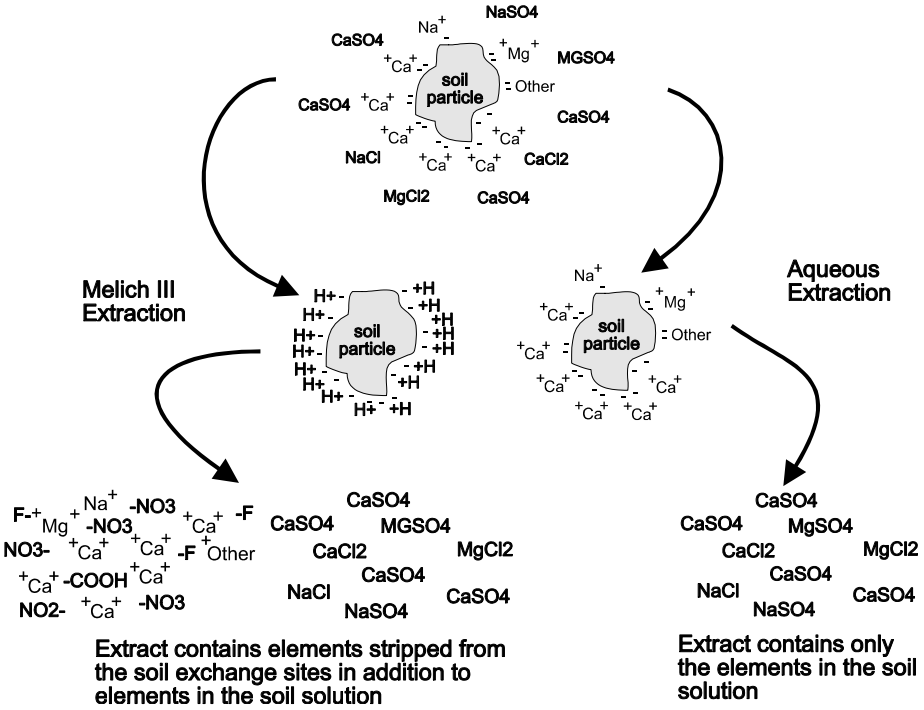
What happens behind-the-scenes at an analytical laboratory will greatly influence our understanding of soil chemistry and the plant's response to soil conditions. Do you know what type of procedures your analytical laboratory is using? Are the techniques appropriate for your environmental and soil conditions? This issue of PACE Insights will describe the two predominant analytical procedures, Mehlich III extraction and aqueous saturated paste extraction, and will report the results of an experiment comparing them with one another.

The Mehlich III extraction was developed in 1984 (Mehlich, 1984) to allow analysis of several elements at once, an advance that reduced the cost and improved the speed of analysis compared to multi-extractant systems. Instead of using several different extraction chemicals for different elements, as other methods do, the Mehlich III extraction solution is capable of removing many cations and anions from the soil matrix and placing them into a liquid solution (Figure 1). Once in a liquid, the solution can be injected into a variety of analytical tools, usually spectrophotometers, that measure the concentration of the elements. The results from Mehlich III extractions are comparable to results obtained from other popular methods for phosphorous, the exchangeable bases (K, Ca, Mg, Na), and for copper, zinc, manganese, and iron. (Carter, 1993). The large commercial soil analytical laboratories, for example, Brookside, A&L, and Harris Laboratories all provide a Mehlich III option for analysis. Standard soil reports provided by PACE Consulting are conducted by Brookside Laboratories using Mehlich III extraction.

Figure 1. Mehlich III vs. aqueous saturated paste extract procedures. The Mehlich III acid extraction solution exchanges the cations adsorbed to the negatively charged soil particle with hydrogen atoms from the acid. The extract also contains the elements that were dissolved in the soil solution (soil salts). The aqueous extraction system does not remove the elements adsorbed to the soil exchange sites resulting in analysis of only the cations that were dissolved in the soil solution.



The Mehlich III method strips cations and anions from the soil surface to provide a general analysis of the soil system. It does not, however, distinguish between elements (salts) that are dissolved in the soil solution from elements that are adsorbed to the soil exchange sites. In contrast,

the more selective aqueous saturated paste extraction system is used to determine the chemical composition of the soil solution that surrounds the plant roots. It has been used since 1954 and it is widely accepted for use in saline soil conditions. However, this method does not account for nutrients that are adsorbed to the soil exchange sites. Most soil laboratories will offer this method of analysis in addition to the Mehlich III analysis. Some laboratories only offer the aqueous extraction system and not Mehlich III.

How do the systems compare? To find out, twelve samples were collected from Big Canyon Country Club, with the cooperation of superintendent Jeff Beardsley and twelve samples were collected from Newport Beach Country Club, with the cooperation of superintendent Ron Benedict. All 24 samples were analyzed using both the Mehlich II and the saturated paste systems. To determine if the results are correlated with each other, linear regression analysis was used. The results show (Table 1) that there was a rough correlation between the two analyses for sulfur, pH, calcium, potassium and other factors that had probabilities of less than 0.050. However, a strong interaction between the two analyses (as indicated by an R^2 value of greater than 0.800) was observed only for sulfur. In other words, the results of our experiment show that the two analytical systems are truly different, and that it is not possible to easily convert the values from one system to the other.

Table 1. Comparison between results obtained using Mehlich III and aqueous saturated paste extraction systems on 24 soil samples. Unless noted otherwise, units are in parts per million (ppm). Probabilities of less than 0.050 indicate that the correlation was significant. The R^2 (regression coefficient) column reports variability that is described by the equation. Values near or above 0.800 indicate a strong interaction.

Factor	Slope	Intercept	Probability	R^2
pH	0.533	3.126	0.009	0.274
Bray 2 Phosphorous.	0.016	0.089	0.028	0.200
Calcium	0.061	44.543	0.001	0.381
Magnesium	***	***	0.750	0.005
Potassium	0.131	-7.377	0.000	0.457
Sodium	***	***	0.174	0.082
Sulfur	0.391	166.801	0.000	0.840
% Calcium	0.416	10.959	0.050	0.163
% Magnesium	***	***	0.374	0.036
% Potassium	0.751	0.235	0.002	0.351
% Sodium	***	***	0.076	0.136
Boron	0.129	0.146	0.000	0.580
Iron	***	***	0.117	0.108
Manganese	***	***	0.977	0.000
Copper	***	***	0.141	0.096
Zinc	***	***	0.800	0.003
Aluminum	***	***	0.686	0.369

*** indicates the interaction was not statistically significant and therefore the slopes and intercept values are meaningless and were omitted.

If the values obtained from the Mehlich III and the aqueous saturated paste systems are not necessarily comparable to one another, which system is the best for use? It depends upon which

factors are of most concern. If soil salinity is the primary concern, the aqueous paste extract system may provide the best view of the elements that are present in the soil solution, not adsorbed to the soil matrix. However, if you want a full assessment of the soil composition, the Mehlich III analysis provides a more complete picture. I prefer the Mehlich III extraction coupled with the historical view of the soils at a course. This is carried out by collecting and analyzing soils in the fall, after summer irrigation, and in the spring, after winter rainfall. These two evaluation times provide a good look at how salts accumulate in the summer (fall sample) and the composition of the soils when salts are not elevated (spring). The Mehlich III system then provides a good tool to understand accumulation of salts in the soil because all of the elements, those adsorbed to the soil particles as well as salts in solution, are analyzed together. Coupled with field salinity monitoring during the irrigation season, your soil chemistry changes will be more easily understood and managed to provide the highest quality turf.

References:

Carter, 1993, ed. 1993. Soil sampling and analysis. Lewis Publishers, Boca Raton.

Mehlich, A. 1984. Mehlich-3 soil test extractant: a modification of Mehlich-2 extractant. Comm. Soil Sci. Plant Anal. 15:1409-1416.

PACE/PTRI Highlights of 1996

Research Program Grows: By conducting an active turfgrass research program, we are able to better develop and keep on top of new management practices, new products, and new problems developing on turf. We had our most productive research year yet with eighteen different projects conducted on over 30 different golf courses. Projects ranged from evaluation of fungicides, insecticides, wetting agents, growth regulators and nematicides to development of predictive models for insects, to the annual soil tissue and water survey. Periodic updates on results have occurred throughout the year in PACE Insights, and a full summary will be provided in the 1997 PTRI Annual Report. The superintendent/ research cooperators on these trials provided invaluable input, support and turf maintenance roles in these trials. Thank you!

Meetings/Education: The First Annual CAPCA/PTRI Turfgrass Research Seminar in June, an all day educational program whose goal was to deliver cutting edge, high quality information to superintendents, exceeded our expectations as far as attendance (over 150!) as well as the quality of information presented. CAPCA has already asked us to do this again in 1997. We'll keep you posted on the date, as soon as it is scheduled. A list of PACE/PTRI meetings held in 1996 appears below:

PTRI Breakfast Meeting, May 5, 1996. Desert Princess Hotel, Palm Springs, CA

First Annual CAPCA/PTRI Turfgrass Research Seminar, June 24, 1996. Pala Mesa Resort, Fallbrook, CA.

PTRI Research Update on Ectotrophic Root Infecting Fungi, August 21, 1996. Arrowhead, Country Club, San Bernardino, CA

Publications: One of our goals is to distribute research results to as wide an audience as possible. We've listed below some of the publications that appeared through PTRI this year. Look for the names of the PTRI Advisory Board at the end of each Golf Course Management and California Fairways article that we've published.

Gelernter, W.D. 1996. Black Turfgrass Ataenius Management in California. California Fairways. January/February 1996.

Gelernter, W.D. 1996. Insect degree-day models for turf: An important pest management tool. Golf Course Management. January, 1996.

Gelernter, W. D. 1996. Environmental persistence of *Bacillus thuringiensis* and other bacterial insect pathogens. Fl. Entomol. *in press*

Gelernter, W.D. and L.J. Stowell. Management of Scarab Grubs on Western Golf Course Turf: Results of a Three Year Study. Agronomy Abstracts, 1996 Anuual Meetings. p. 149.

Robertson, J. L., Preisler, H. K., Ng, S. S., Hickle, L. A., Berdeja, A. and W. D. Gelernter, 1996. Comparative effect of temperature and time on activity of Dipel 2 and MVP preparations of *Bacillus thuringiensis* subsp. *kurstaki* on diamondback moth (Lepidoptera: Plutellidae). J. Econ. Entomol. 89:1084-1087.

Stowell, L.J. 1996. Chemical Control for Turf Diseases. California Fairways. March/April, 1996.

Stowell, L.J. 1996. Water Quality - from ECs to ETs. California Fairways. September/October, 1996.

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