CONVERTING AMONG SOIL TEST ANALYSES REQUENTLY USED IN MARYLAND

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What Do Soil Tests Measure?

Soil testing is a useful tool that can help ensure the efficient use of applied plant nutrients. Soil tests provide a means for assessing the fertility status if a soil, but soil tests do not provide a direct measure of the actual quantity of plant available nutrients in the soil. Instead, soil tests measure the quantity of a nutrient element that is extractable from a soil by a particular chemical extracting solution. The measured quantity of extractable nutrient in a soil is then used to predict the crop yield response to application of the nutrient as fertilizer, manure, or other amendment. As soil test levels increase for a particular nutrient, the expected crop yield response to additions of that nutrient decreases.

Why Are There So Many Different Soil Testing Procedures?

Over the years, many different soil testing procedures and extracting solutions have been evaluated in an effort to identify the method that provides the most reliable prediction of crop yield response to nutrient application. It has been determined that some soil testing procedures are best suited for particular soil types and climatic regions while other soil testing procedures are better suited for different soil types and climates. Also, we have learned that there are often several alternative soil testing methodologies that generate equally useful predictions of expected crop response for a given region. There are several different soil testing procedures that work well for Maryland soils.

Why Are There So Many Different Ways to Express Soil Test Results?

The actual numerical soil test values are products of laboratory procedures that determine the concentrations of extractable plant nutrients in the soil. Thus, soil-test values are merely arbitrary index numbers and not measures of the actual quantity of plant available nutrients present in a soil. Historically in Maryland, the numerical soil test values were converted to units of “pounds per acre” of soil test nutrient expressed as a fertilizer equivalent (e.g. P2O5, K2O). However, pounds per acre of the actual nutrient element (e.g. P, K), concentration of the nutrient element in a given volume of soil (e.g. ppm, mg/dm3), or concentration of the nutrient element in a given weight of soil (e.g. ppm) are all equally valid expressions of soil test results. The numerical soil test values are determined by the units used to express the results.
An alternative method for expressing the relative level of plant available nutrients measured by soil testing uses “fertility index values” or FIV. Soil fertility index values comprise a continuous relative scale that is calculated from the concentration of extractable nutrients measured in the laboratory, where the highest concentration within the “optimum” range is set equal to a FIV of 100. The numerical value of the soil fertility index is not affected by the method of soil analysis or the units used to express the soil test results.

Different Tests Yield Different Results

Different soil testing laboratories use different soil testing procedures. Different soil testing procedures generate different analytical results. Different analytical results may or may not yield different crop nutrient application recommendations. Regardless of the soil testing methods utilized, the analytical results generated must be correlated to crop yield responses under local growing conditions in order to provide reliable nutrient recommendations.

Who is in the Soil Testing Business in Maryland?

At one time, soil testing was almost exclusively preformed by public (university or state agency) laboratories. The Maryland Cooperative Extension Soil Testing Laboratory provided analyses of farmers' soils from 1954 to 2003. Today, many private-sector soil testing laboratories are providing high-quality soil testing services for our agricultural community. In general, the private-sector laboratories have excellent analytical capabilities and generate reliable analytical results. However, direct application of the analytical results generated by different soil testing laboratories to crop nutrient recommendations developed by Maryland Cooperative Extension has been difficult because of the differences in the numerical values and units used in expression of analytical results.

Converting Among Soil Test Analyses

This publication provides simple factors for converting the analytical results generated by seven regional soil testing laboratories to the FIV scale used by the Maryland Cooperative Extension Soil Testing Laboratory. A list of the seven cooperating regional soil testing laboratories is given in Table 1.

The soil testing conversion factors presented in Table 2 permit the direct application of the crop nutrient recommendations developed in Maryland to soil testing data regardless of how, where, or by whom the soil test was preformed.

The conversion indices were intended to be simple, and easy-to-use. The conversions were derived from analysis of 665 Maryland agricultural soils by each of the cooperating regional soil testing laboratories. Conversion of data from the regional soil testing laboratories generates reliable approximations of Maryland soil test FIVs to which the Maryland plant nutrient recommendations may be applied.

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Table 1. Participating regional soil testing laboratories, method of soil nutrient extraction used, and instrumentation used to quantify soil nutrient concentrations.

Laboratory	Address	Nutrient	Extraction Method (extract solution:soil)	Instrumentation
A&L[1]	A&L Eastern Agricultural	P	Mehlich-3 (20 ml:1.7 cm^3)	ICP
	Laboratories	K	Mehlich-3 (20 ml:1.7 cm^3)	ICP
	7261 Whitepine Rd.	Ca	Mehlich-3 (20 ml:1.7 cm^3)	ICP
	Richmond, VA 23237	Mg	Mehlich-3 (20 ml:1.7 cm^3)	ICP
		pH	Water (10 ml:8.5 cm^3)	Glass Electrode
Agri	Agri Analysis, Inc.	P	Mehlich-3 (20 ml:1.7 cm^3)	ICP
Analysis	P.O. Box 483	K	Mehlich-3 (20 ml:1.7 cm^3)	ICP
	280 Newport Rd.	Ca	Mehlich-3 (20 ml:1.7 cm^3)	ICP
	Leola, PA 17540	Mg	Mehlich-3 (20 ml:1.7 cm^3)	ICP
		pH	Water (5 ml:5 cm^3)	Glass Electrode
Brookside	Brookside Laboratories, Inc.	P	Mehlich-3 (20 ml:1.7 cm^3)	ICP
	308 East Main St.	K	Mehlich-3 (20 ml:1.7 cm^3)	ICP
	New Knoxville, OH 45871	Ca	Mehlich-3 (20 ml:1.7 cm^3)	ICP
		Mg	Mehlich-3 (20 ml:1.7 cm^3)	ICP
		pH	Water (7 ml:7 cm^3)	Glass Electrode
Penn State	Agricultural Analytical	P	Mehlich-3 (25 ml:2.13 cm^3)	ICP
University	Services Laboratory	K	Mehlich-3 (25 ml:2.13 cm^3)	ICP
	Penn State University	Ca	Mehlich-3 (25 ml:2.13 cm^3)	ICP
	University Park, PA 16802	Mg	Mehlich-3 (25 ml:2.13 cm^3)	ICP
		pH	Water (5 ml:5 g)	Glass Electrode
Spectrum	Spectrum Analytic Inc.	P	Mehlich-3 (10 ml:1 cm^3)	ICP
Analytic	P.O. Box 639	K	Mehlich-3 (10 ml:1 cm^3)	ICP
	1087 Jamison Rd.	Ca	Mehlich-3 (10 ml:1 cm^3)	ICP
	Washington Court House, OH	Mg	Mehlich-3 (10 ml:1 cm^3)	ICP
	43160	pH	Water (5 ml:5 cm^3)	Glass Electrode
University of	University of Delaware	P	Mehlich-3 (25 ml:2.5 cm^3)	ICP
Delaware[2]	Soil Testing Program	K	Mehlich-3 (25 ml:2.5 cm^3)	ICP
	149 Townsend Hall	Ca	Mehlich-3 (25 ml:2.5 cm^3)	ICP
	University of Delaware	Mg	Mehlich-3 (25 ml:2.5 cm^3)	ICP
	Newark, DE 19717-1303	pH	Water (10 ml:10 cm^3)	Glass Electrode
University of	University of Maryland	P	Mehlich-1 (25 ml:5 cm^3)	Colorimeter 420nm
Maryland	Soil Testing Laboratory	K	Mehlich-1 (25 ml:5 cm^3)	Flame Photometer 768nm
(closed	HJ Patterson Hall, Room 0225	Ca	Mehlich-1 (25 ml:5 cm^3)	Flame Photometer 623nm
6/30/03)	College Park, MD 20742	Mg	Mehlich-1 (25 ml:5 cm^3)	Colorimeter 630nm
		pH	Water (20 ml:20 cm^3)	Glass Electrode
Waters	Waters Agricultural	P	Mehlich-1 (20 ml:5 cm^3)	ICP
	Laboratories Inc.	K	Mehlich-1 (20 ml:5 cm^3)	ICP
	257 Newton Highway	Ca	Mehlich-1 (20 ml:5 cm^3)	ICP
	P.O. Box 382	Mg	Mehlich-1 (20 ml:5 cm^3)	ICP
	Camille, GA 31730-0382	pH	Water (20 ml:20 cm^3)	Glass Electrode

[1] The use of Bray P1 for P and ammonium acetate for Ca, Mg, and K was discontinued as the standard extraction suite in 9/05.
[2] University of Delaware also uses a 10 ml: 1 cm^3 ratio, depending upon the analyses requested.

Table 2. Factors for converting from regional soil-testing laboratory report data to Maryland Cooperative Extension Soil Testing Laboratory's fertility index value (FIV) scale.

To determine an equivalent Maryland FIV value for each soil-test nutrient, multiply the regional laboratory reported value, expressed in the units shown, by the value in column A and then add the value in column B.

		Soil-test nutrient							
Regional Soil-Testing Laboratory	Units	Phosphorus (P)		Potassium (K)		Calcium (Ca)		Magnesium (Mg)	
		A	B	A	B	A	B	A	B
A&L (Mehlich 3)	ppm	1.09	2	0.65	(-2)	0.13	(-27)	0.76	3
A&L (Bray P & ammonium acetate bases)	ppm	1.69	6	0.63	0	0.13	(-18)	0.67	21
AgriAnalysis	lbs/a	0.22[1]	7	0.27	(-2)	0.06	(-21)	0.23	0
Brookside	lb/a	0.26	3	0.36	(-3)	0.07	(-23)	0.39	12
Brookside	ppm	1.20[3]	3	0.72	(-3)	0.14	(-22)	0.79	11
Penn State	ppm	1.11	7	0.60	0	0.12	(-21)	0.76	0
Spectrum	lbs/a	0.75	9	0.33	(-1)	0.08	(-16)	0.43	8
Spectrum	ppm	1.06	9	0.56	(-1)	0.11	(-16)	0.75	8
U. Delaware	index	1.01	7	1.10	1	1.05	(-9)	0.97	10
Waters	lbs/a	1.18	4	0.38	(-1)	0.06	(-12)	0.43	4

[1] For AgriAnalysis, use Phosphate (P_2O_5), Potash (K_2O), and Magnesium (MgO) values.
[2] For Brookside Laboratories, use Easily Extractable P, lb/a P as P_2O_5.
[3] For Brookside Laboratories, use Easily Extractable P, ppm of P.

Example: A soil-test report from A&L Laboratories contains the following data:

Phosphorus, Bray P1	=	29 ppm
Potassium, K	=	93 ppm
Calcium, Ca	=	1210 ppm
Magnesium, Mg	=	114 ppm

To determine an equivalent Maryland FIV for each soil-test nutrient:

P	Maryland FIV = (29 x 1.69) + 6 = 55
K	Maryland FIV = (93 x 0.63) + 0 = 59
Ca	Maryland FIV = (1210 x 0.13) - 18 = 139
Mg	Maryland FIV = (114 x 0.67) + 21 = 97