Soil Fertility Management

CONVERTING AMONG SOIL TEST ANALYSES FREQUENTLY USED IN MARYLAND

What Do Soil Tests Measure?

Soil tests estimate the fertility status of a soil and help ensure the efficient use of applied nutrients. Soil tests do not directly measure 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 nutrients in the soil is then used to predict the crop yield response the application of the nutrient. As soil test levels increase for a particular nutrient, the likelihood of a crop yield response to the addition of that nutrient decreases.

Over the years, different soil testing procedures and extracting solutions have been proposed to identify the method that provides the most reliable prediction of crop yield response to the nutrient application. Several different soil testing procedures work well for Maryland soils (e.g., Mehlich-1 and Mehlich-3). Other soil tests, such as Morgan extraction, are not recommended in Maryland.

Who is in the Soil Testing Business for Maryland Producers?

Nutrient recommendations in Maryland were developed when the Maryland Cooperative Extension Soil Testing Laboratory was operating (1954-2003). Since the closing of this laboratory, Maryland producers have relied on private-sector laboratories or laboratories operated by universities from neighboring states. As the testing methods utilized in these laboratories are often different from the methods upon which University of Maryland recommendations were established correlations between other testing laboratories and Maryland Cooperative Extension Laboratory were created before its closing. This allowed results from these other laboratories to be useful to Maryland producers.

How to Create Reliable Nutrient Recommendations Despite Different Testing Labs and Methods?

Before the closure of the Maryland Cooperative Extension Soil Testing Laboratory, an exchange of identical sets of 665 soil samples from throughout the State was provided to different laboratories to determine and consider differences in analyses in soil samples. This resulted in the development of equations to convert laboratory tests into a unitless “fertility index value” (FIV) scale. In the FIV scale, results from any of the laboratories in Table 1 can be placed with the assurance that similar recommendations will result regardless of the testing laboratory. In order to provide comparable values, the highest concentration within the “optimum” range is set equal to an 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.

This publication indicates how to convert the analytical results generated by eight regional soil testing laboratories to the FIV scale used by the Maryland Cooperative Extension Soil Testing Laboratory. Table 1 gives a list of the eight regional soil testing laboratories.

Table 2 provides soil testing conversion factors which 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 performed.

These conversion factors are intended to be simple and easy-to-use. The information was updated in February 2021 to include some laboratories established since the original publication date of this report. Conversion of data from the regional soil testing laboratories generates reliable approximations of Maryland soil test FIV to which the Maryland plant nutrient recommendations may be applied.

Do I Need to Worry about the Different Units Reported in Soil Test Reports?

No, you do not need to worry. Maryland soil test FIV takes that worry away. But to convert the values correctly to Maryland soil test FIV you need to be aware of the laboratory and units utilized for reporting and choose the right conversion factors from Table 2.

Because laboratories typically extract nutrients from a fixed volume (Table 1) of the dried, ground, and sieved soil material, units reported as 'ppm' typically mean mg of nutrient per gram (or dm^3) of soil.

Units reported as pound (lb) nutrient per acre make an additional assumption about soil density (usually around 1.3 g cm^{-3}) to provide nutrient concentration using those units, and of course sometimes nutrients are reported in their elemental (e.g. P, K) form or oxide form (P_2O_5, K_2O).

In the end all units can be translated from one to another, sometimes with no assumptions and sometimes with an assumed density either for dried, ground and sieved soil material or for soil intact and in place in the field. Your agricultural extension agent or nutrient management consultant can assist. But because of (unitless) Maryland soil test FIVs the worry associated with different units is taken away.

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This publication, *Soil Fertililty Management* (SFM-4), is a series of publications of the University of Maryland Extension and the Department of Agriculture and the Department of Environment and Natural Resources.

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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
AgroLab	AgroLab, Inc. 101 Clukey Dr. Harrington, DE 19952	P	Mehlich-3 (10 ml:1 cm^3)	ICP
		K	Mehlich-3 (10 ml:1 cm^3)	ICP
		Ca	Mehlich-3 (10 ml:1 cm^3)	ICP
		Mg	Mehlich-3 (10 ml:1 cm^3)	ICP
		pH	Water (10 ml:10 cm^3)	Glass Electrode
Brookside	Brookside Laboratories, Inc. 308 East Main St. New Knoxville, OH	P	Mehlich-3 (20 ml:1.7 cm^3)	ICP
		K	Mehlich-3 (20 ml:1.7 cm^3)	ICP
		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 University	Agricultural Analytical Services Laboratory Penn State University University Park, PA 16802	P	Mehlich-3 (25 ml:2.13 cm^3)	ICP
		K	Mehlich-3 (25 ml:2.13 cm^3)	ICP
		Ca	Mehlich-3 (25 ml:2.13 cm^3)	ICP
		Mg	Mehlich-3 (25 ml:2.13 cm^3)	ICP
		pH	Water (5 ml:5 g)	Glass Electrode
Spectrum Analytic	Spectrum Analytic Inc. P.O. Box 639 1087 Jamison Rd. Washington Court House, OH 43160	P	Mehlich-3 (10 ml:1 cm^3)	ICP
		K	Mehlich-3 (10 ml:1 cm^3)	ICP
		Ca	Mehlich-3 (10 ml:1 cm^3)	ICP
		Mg	Mehlich-3 (10 ml:1 cm^3)	ICP
		pH	Water (5 ml:5 cm^3)	Glass Electrode
University of Delaware[1]	University of Delaware Soil Testing Program 149 Townsend Hall University of Delaware Newark, DE 19717-1303	P	Mehlich-3 (25 ml:2.5 cm^3)	ICP
		K	Mehlich-3 (25 ml:2.5 cm^3)	ICP
		Ca	Mehlich-3 (25 ml:2.5 cm^3)	ICP
		Mg	Mehlich-3 (25 ml:2.5 cm^3)	ICP
		pH	Water (10 ml:10 cm^3)	Glass Electrode
University of Maryland (closed 6/30/03)	University of Maryland Soil Testing Laboratory HJ Patterson Hall Room 0225 College Park, MD 20742	P	Mehlich-1 (25 ml:5 cm^3)	Colorimeter 420nm
		K	Mehlich-1 (25 ml:5 cm^3)	Flame Photometer 768nm
		Ca	Mehlich-1 (25 ml:5 cm^3)	Flame Photometer 623nm
		Mg	Mehlich-1 (25 ml:5 cm^3)	Colorimeter 630nm
		pH	Water (20 ml:20 cm^3)	Glass Electrode
Waters	Waters Agricultural Laboratories Inc. 257 Newton Highway P.O. Box 382 Camille, GA 31730-0382	P	Mehlich-1 (20 ml:5 cm^3)	ICP
		K	Mehlich-1 (20 ml:5 cm^3)	ICP
		Ca	Mehlich-1 (20 ml:5 cm^3)	ICP
		Mg	Mehlich-1 (20 ml:5 cm^3)	ICP
		pH	Water (20 ml:20 cm^3)	Glass Electrode
Waypoint VA[2]	Waypoint Analytical 7261 Whitepine Rd. Richmond, VA 23237	P	Mehlich-3 (20 ml:1.7 cm^3)	ICP
		K	Mehlich-3 (20 ml:1.7 cm^3)	ICP
		Ca	Mehlich-3 (20 ml:1.7 cm^3)	ICP
		Mg	Mehlich-3 (20 ml:1.7 cm^3)	ICP
		pH	Water (10 ml:8.5 cm^3)	Glass Electrode
Waypoint PA	Waypoint Analytical 280 Newport Rd. Leola, PA 17540	P	Mehlich-3 (20 ml:1.7 cm^3)	ICP
		K	Mehlich-3 (20 ml:1.7 cm^3)	ICP
		Ca	Mehlich-3 (20 ml:1.7 cm^3)	ICP
		Mg	Mehlich-3 (20 ml:1.7 cm^3)	ICP
		pH	Water (10 ml:8.5 cm^3)	Glass Electrode

[1]University of Delaware also uses a 10 ml:1 cm^3 ratio, depending upon the analyses requested.

[2]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.

Table 2. Factors used for converting regional soil-testing laboratory report data to Maryland soil fertility index values (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
AgroLab	ppm	1.086	2.5	0.648	(-1.8)	0.126	(-26.6)	0.757	3.1
Brookside	Ppm*	1.1964	3.5	0.7182	(-2.8)	0.1354	(-22.8)	0.7866	11.5
Brookside	lb/a[t]	0.2596	3.5	0.3591	(-2.8)	0.0677	(-22.8)	0.392	11.6
Penn State	Ppm*	1.1138	6.9	0.5973	0.1	0.1171	(-21.3)	0.7555	(-1.1)
Penn State	lb/a[t]	0.245	6.9	0.2509	0.1	0.0422	(-21.3)	0.2267	(-1.1)
Spectrum	lbs/a	0.7544	9.1	0.3318	(-1.5)	0.0763	(-15.9)	0.4273	8.5
Spectrum	ppm	1.056	9.1	0.558	(-1.5)	0.114	(-15.9)	0.752	8.5
U. Delaware	index	1.0092	6.9	1.0964	0.9	1.0547	(-8.6)	0.9675	9.6
Waters (Mehlich 1)	lbs/a	1.1785	4.1	0.03795	(-1.5)	0.0582	(-12.1)	0.4255	3.6
Waters (Mehlich 3)	lbs/a	0.5569	6.9	0.29865	0.1	0.05855	(-21.3)	0.3778	(-1.1)
Waypoint VA & PA (Mehlich 3)	ppm	1.086	2.5	0.648	(-1.8)	0.126	(-26.6)	0.757	3.1
Waypoint VA (Bray P & ammonium acetate bases)	ppm	1.6854	6.3	0.6263	0.8	0.1335	(-18.4)	0.6691	21.4

* Use ppm phosphorus (P), potassium (K), magnesium (Mg), and calcium (Ca) values.

t Use lb/a phosphate (P_2O_5), potash (K_2O), magnesium oxide (MgO), and calcium oxide (CaO) values.

Example: A soil-test report from AgroLab contains the following data:

Phosphorus, P 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 1.086) + 2.5 = 34

K, Maryland FIV = (93 x 0.648) – 1.8 = 58

Ca, Maryland FIV = (1210 x 0.126) - 26.6 = 126

Mg, Maryland FIV = (114 x 0.757) + 3.1 = 89