Interpreting Mehlich-3 soil test results (2/15/1999)

For many years soil analysis laboratories in Iowa have used the Bray-P1 (Bray1) and Olsen (or sodium bicarbonate) tests for phosphorus (P) and the ammonium acetate test for potassium (K), calcium (Ca), and magnesium (Mg). The Mehlich-3 test (M3) was developed in North Carolina for routine analyses of P, K, Ca, Mg, sodium (Na), and micronutrients. The M3 test was not recommended by universities of the North Central Region due to a lack of correlation and calibration research in this region. This year, based on several years of research, Iowa State University (ISU) is releasing soil test interpretations for analyses of P and K made with the M3 test.

The advantage of the M3 test is that it may offer the possibility of using one test for P and other nutrients across acid, neutral, and high-pH soils. The M3 extracts virtually the same amount of K as the currently used ammonium acetate test. The Bray test produces erroneously low P values in many calcareous soils. In regions having both calcareous and noncalcareous soils it is reliable on neutral or acid soils but not on calcareous soils. The Olsen test is reliable on neutral and high-pH (calcareous) soils but poor on acid soils. Also, it is not as well adapted for routine analysis as the Bray. Therefore, many soil analysis laboratories use the Bray test for all samples and the Olsen only for samples with high pH, thus reducing laboratory efficiency and increasing costs.

Iowa research shows that the M3 P results are similar to the Bray in acid and neutral soils but are much better in many high-pH soils. Similar conclusions apply to many soils of nearby states, although the M3 does underestimate P in many soils of western states that have higher (and perhaps a different type) of calcium carbonate.

Figure 1, on the next page, shows an example of the relationship between amounts of P extracted by three tests for Iowa soils varying in soil pH. Only the amount of P extracted by the Bray was strongly influenced by soil pH and it extracted less P than the M3 in many calcareous soils (look for data points with Bray values near zero but higher M3 values). Correlations involving the Bray are high only when calcareous soils are excluded. The Olsen and M3 tests are well correlated across all soils. The Olsen, as expected, extracts less P than the other tests. This difference is accounted for when interpreting the results for fertilizer recommendations.

Results from dozens of field response trials with corn and soybean across Iowa confirm that the relationship between crop response to fertilization and soil-test P is similar for the Bray and M3 tests on neutral and acid soils. On calcareous soils, however, the M3 improved the predictability of the yield response to P especially in soils with pH 7.4 or higher. Thus, the capacity of the M3 test to measure available P across soils of varying pH is much better than for the Bray. Another important result is that the Olsen test also works well across all Iowa soils as long as soil pH is above 5.0, but few Iowa soils are so acidic.

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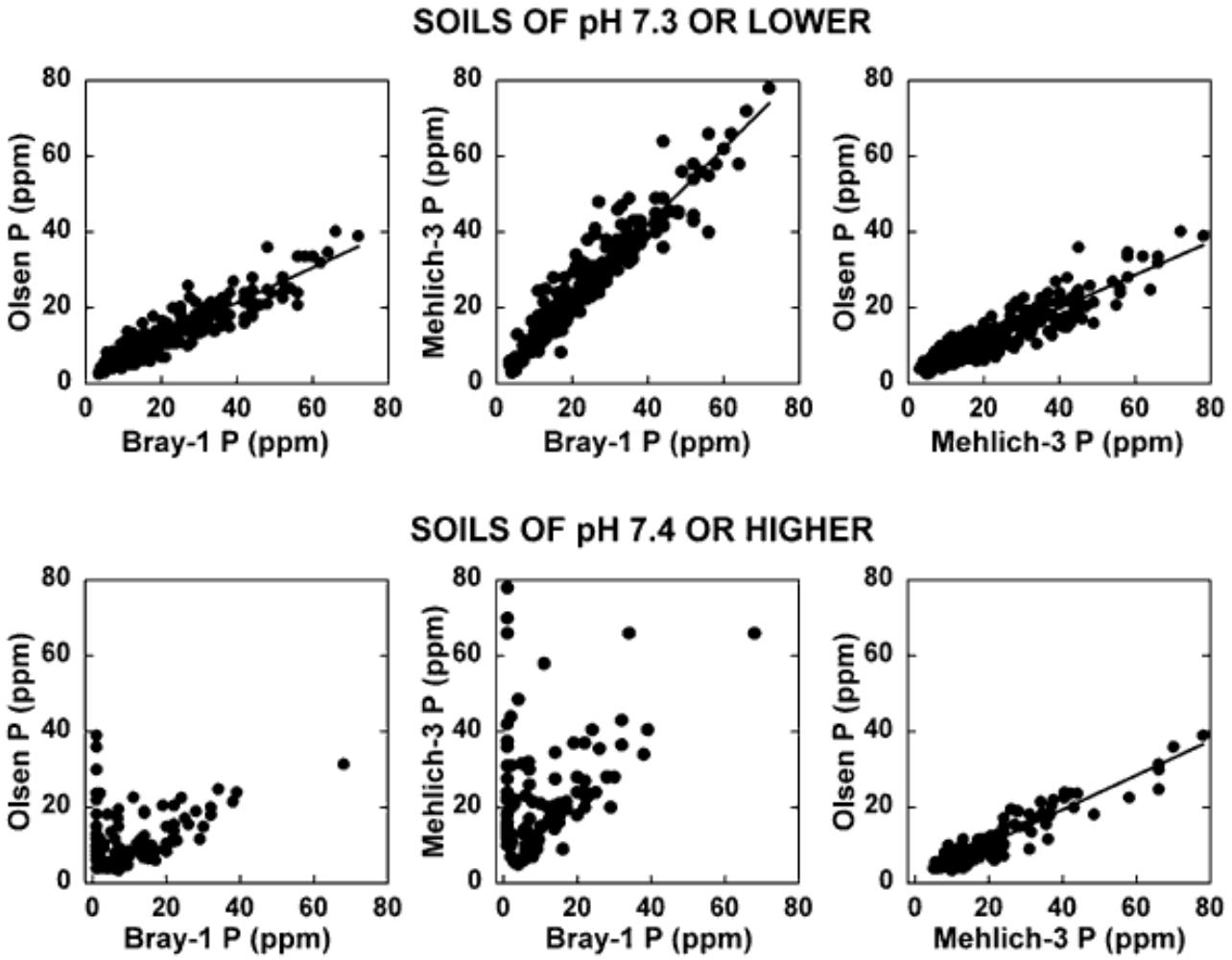

Table 1, on the next page, shows the soil test interpretation classes for P by the Bray, M3, and Olsen tests and for K by the ammonium acetate and M3 tests recommended by ISU. Given the results discussed previously, interpretations for the M3 are exactly the same as those currently in use for P with the Bray and for K with the ammonium acetate test (see ISU Extension publication PM 1688 and the January 1999 issue of the ICM newsletter). These interpretations will be adjusted in the future if necessary.

The interpretations for P must be used with one very important consideration. They apply only when a colorimetric method is used to measure P solubilized by the extractant. A soil test is composed of two parts: the extraction of available P from the soil, which defines the soil test method, and the determination of P solubilized by the extractant. The colorimetric method most widely used in soil testing is similar for all P tests, and measures a blue color that develops with different intensity depending on the P concentration in the extracted solution. The North Central Regional Committee for Soil Testing and Plant Analysis (NCR 13) and ISU do not recommend the determination of P with the ICP (inductively coupled plasma) method for any P soil test, including the M3. This recommendation is proposed because variations in the P concentrations measured by ICP compared with the standard colorimetric method (the ICP sometimes measures up to 40 percent more P) are not well understood. A simple correction factor does not appear effective to correct this difference.

Table 1. Interpretation of soil test values for phosphorus measured by the Bray-P1, Olsen, and Mehlich-3 tests and for potassium measured by the ammonium acetate and Mehlich-3 tests (6- to 7-inch deep soil samples).†

	Phosphorus (P)			Potassium (K)	
	Wheat, alfalfa	All other crops		All crops	
		Subsoil P		Subsoil K	
Relative level		Low	High	Low	High
	Bray-1 or Mehlich-3			Ammonium acetate or Mehlich-3	
	ppm				
Very low	0–15	0–8	0–5	0–60	0–40
Low	16–20	9–15	6–10	61–90	41–80
Optimum	21–25	16–20	11–15	91–130	81–120
High	26–30	21–30	16–20	131–170	121–160
Very high	31+	31+	21+	171+	161+
		Olsen			
		ppm			
Very low	0–10	0–5	0–3		
Low	11–14	6–10	4–7		
Optimum	15–17	11–14	8–11		
High	18–20	15–20	12–15		
Very high	21+	21+	16+		

† The relative levels and the soil-test values in this table are exactly the same as those in Table 1 of ISU Extension publication PM 1688. The table was reformatted to add the Mehlich-3 name as appropriate.

How reliable is the M3 test for measuring Ca, Mg, or micronutrients and estimating cation exchange capacity (CEC)? The amounts of Ca and Mg extracted with the M3 from soils of acid or neutral pH is similar to amounts extracted by the commonly used ammonium acetate test. The amount of Ca and Mg extracted (especially Ca) does not seem the same, however, in calcareous soils. Thus, until more data are gathered, the NCR 13 committee only recommends the use of the M3 test for Ca and Mg and to estimate CEC (in conjunction with SMP buffer pH) for acid or neutral soils. The committee does not recommend its use for Ca, Mg, or CEC in calcareous soils or for micronutrients in any soil. Actually, the problem of estimating CEC in calcareous soils also applies to the ammonium acetate test

ISU does not support soil-test interpretations for sufficiency of Ca, Mg, or micronutrients other than zinc. This decision, made years ago, is based on the lack of reliable information on deficiencies of these nutrients for the major Iowa crops or soils and lack of reliable field response data that could support a recommendation. This policy does not contradict the fact that measurements of Ca, Mg, or CEC, for example, allow for useful inferences about other soil properties that may influence crop yields. Current interpretations for zinc are based on the DTPA test, and for lime requirements on the SMP buffer test (see PM 1688).

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