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COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES

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Converting between Mehlich-3, Bray P, and Ammonium Acetate Soil Test Values

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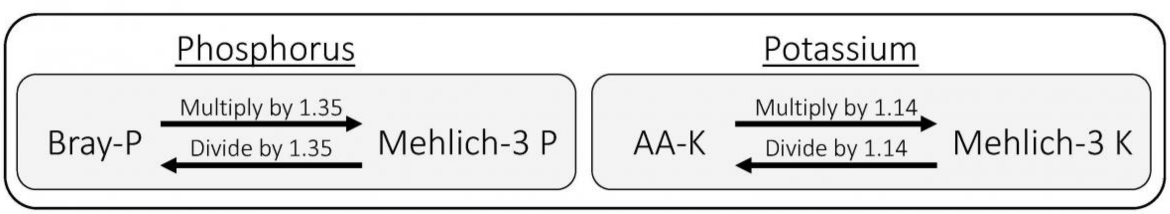
Steve Culman, Meredith Mann, Stuti Sharma, Muhammad Saeed, Anthony Fulford, Laura Lindsey, Aaron Brooker, Libby Dayton, Branly Eugene, Randall Warden, Kurt Steinke, Jim Camberato, Brad Joern

The purpose of this fact sheet is to report the relationships between Mehlich-3, Bray P, and Ammonium Acetate soil test extractants in the Tri-State Region.

Summary of Findings

- Soil samples in Ohio and Indiana were collected from a diverse range of fields and analyzed for Mehlich-3, Bray-P, and ammonium acetate extractable nutrients for phosphorus (P), potassium (K), calcium (Ca), and magnesium (Mg).
- Mehlich-3 P values were highly related to, but 35 percent higher than Bray P values.
- Mehlich-3 K values were highly related to, but 14 percent higher than AA-K values.
- Mehlich-3 is a reliable extractant and will be the basis for updated fertilizer recommendations.

How to Convert Soil Test P and K Values



Background

The Tri-State Fertilizer Recommendations (Vitosh et al., 1995) are based on the Bray-P1 extractant for P and the ammonium acetate (AA) extractant for K, Ca, and Mg. This requires two different extractants to be independently analyzed to estimate plant-available P, K, Ca, and Mg. In the 1990s, soil test laboratories started using the Mehlich-3 soil test extractant, a universal extractant that provides multiple extractable nutrients from a single soil sample. Mehlich-3 increased efficiency, and today, nearly all commercial soil testing labs in this region use Mehlich-3 as the primary soil test extractant.

The updated Tri-State Fertilizer Recommendations will use the Mehlich-3 extractant as the new standard for fertilizer recommendations. Because of this, it is imperative that producers are able to convert back and forth from these different extractants.

To determine the relationships between extractants, we collected and analyzed 2,659 soil samples from a wide diversity of fields across Ohio and Indiana. Bray P1 and Mehlich-3 P were run on 2,323 soil samples using three different reputable labs, quantified both colorimetrically and on an ICP. Ammonium acetate and Mehlich-3 K, Ca, and Mg extracts were run on 1,537 soil samples using two different reputable labs. Mehlich-3 P values ranged from 3–1170 ppm, and Mehlich-3 K values ranged from 25–899 ppm. We examined relationships with all soil test values, but since our focus here is conversions for fertilizer recommendations, we focused on soil test values in the agronomic range. We used the upper limit of the drawdown range as our cutoff and analyzed relationships below this limit: less than 50 ppm for Bray P and less than 200 ppm for AA-K.

Phosphorus

Across all soils, Mehlich-3 P was closely related to Bray P, but extracted more P than the Bray extractant (Figure 1, left panel). After 300 ppm, the Mehlich-3 P extractant begins to extract proportionally more P than Bray P, suggesting the conversion reported here should not be used if values are above 300 ppm Bray P. When only soil test values in the agronomic range were considered (less than 50 ppm Bray P), the relationships were largely consistent with the full data set (Figure 1, right panel). However, using the agronomic range represents a more meaningful conversion, as high values have less influence on the blue trend line.

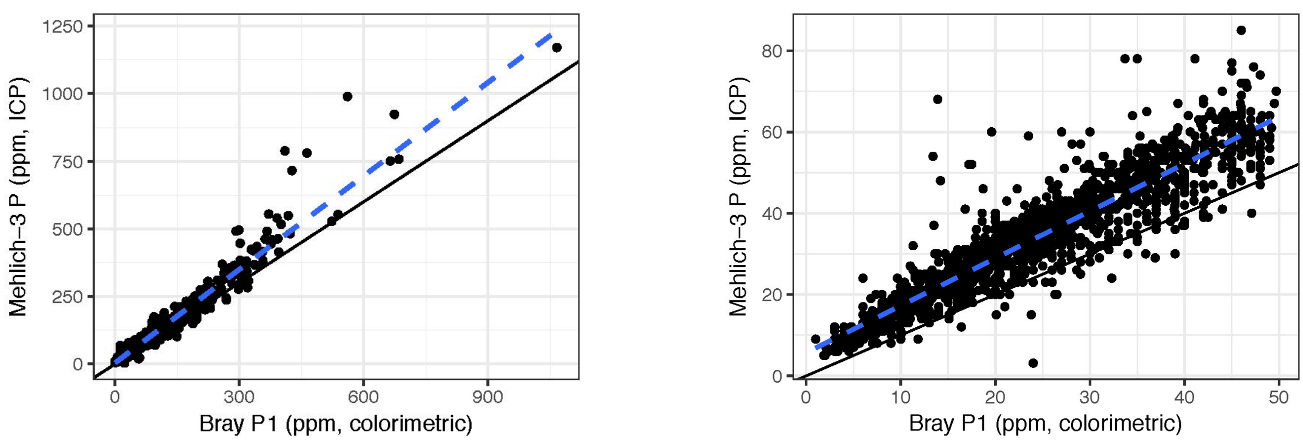


Figure 1. Relationship between Bray and Mehlich-3 phosphorus with all soils (left panel) and with soils less than 50 ppm Bray P. The dashed blue line is the best fit trend line, while the solid black line is a 1:1 line.

To simplify the conversion from Bray P to Mehlich-3 P, the intercept was forced through zero so that users could convert by simply multiplying or dividing by a constant. This yielded very similar results to using the best fit trend line with an intercept. **Within the agronomic range of <50 ppm, Mehlich-3 P extracted 35 percent more P than Bray P. To convert from Bray P to Mehlich-3 P, multiply Bray P by 1.35. To convert from Mehlich-3 P to Bray P, divide Mehlich-3 P by 1.35.**

Note that this relationship is for Mehlich-3 P that is quantified by an ICP and Bray P that is quantified colorimetrically, by far the most common way these two extractants are quantified in commercial labs. If either extractant is quantified by a different means, these relationships will change (Table 1).

Table 1. Phosphorus extractant conversion factors. To convert from starting value to desired value, multiply starting value by corresponding conversion.

Starting Value	Multiply By	Desired Value
Bray-P (colorimetric)	1.35	Mehlich-3 P (ICP)
Bray-P (colorimetric)	1.03	Mehlich-3 P (colorimetric)
Bray-P (ICP)	1.20	Mehlich-3 P (ICP)
Bray-P (ICP)	1.05	Mehlich-3 P (colorimetric)

Equations based on soils with <50 ppm Bray P and the intercept forced through zero.

Potassium

Mehlich-3 K was highly related to AA-K (Figure 2, left panel). At levels above 300 ppm, AA extracted more K than Mehlich-3, suggesting the conversion should not be used if values are above 300 ppm. When only soil test values in the agronomic range were considered (less than 200 ppm AA-K), the relationships were largely consistent with the full data set (Figure 2, right panel). Mehlich-3 extracted on average 14 percent more K than AA. This percentage is much smaller than for phosphorus and many in the soil testing world consider these differences negligible. However, to be consistent, we provide conversions here. **Within the agronomic range of <200 ppm, Mehlich-3 K extracted 14 percent more K than AA-K. To convert from AA-K to Mehlich-3 K, multiply AA-K by 1.14. To convert from Mehlich-3 K to AA-K, divide Mehlich-3 K by 1.14.**

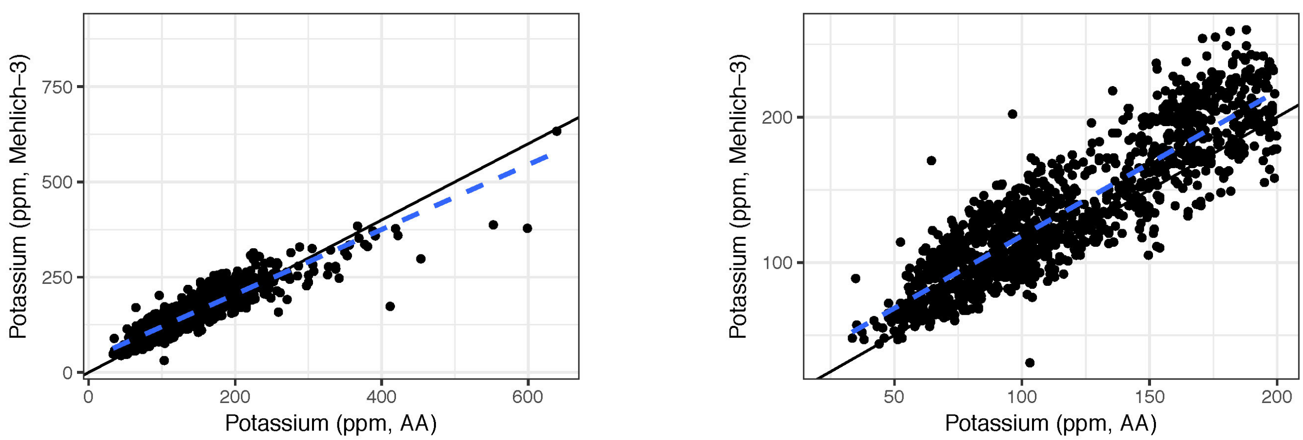


Figure 2. Relationship between ammonium acetate (AA) and Mehlich-3 potassium with all soils (left panel) and with soils less than 200 ppm AA-K (right panel). The dashed blue line is the best-fit trend line, while the solid black line is a 1:1 line.

Calcium and Magnesium

Mehlich-3 Ca and Mg were also closely related to AA-Ca and AA-Mg (data not shown; all R^2 over 97 percent). Conversion values are reported in Table 2.

Table 2. Potassium, calcium, and magnesium extractant conversion factors. To convert from starting value to desired value, multiple starting value by corresponding conversion.		
Starting Value	**Multiply By**	**Desired Value**
Ammonium Acetate-K	1.14	Mehlich-3 K
Ammonium Acetate-Ca	1.15	Mehlich-3 Ca
Ammonium Acetate-Mg	1.24	Mehlich-3 Mg

Equations based on soils with <200 ppm AA-K and the intercept forced through zero.

Conclusions

Comparisons between these extractants have been reported in the past (Eckert and Watson, 1996) and are generally consistent with our findings. The analysis here included a much greater diversity of soils across two states than previous studies, making the findings overall more robust. Recent efforts in other corn belt states have also aligned with our findings (for example, Mallarino et al., 2013). Mehlich-3 P extracts 35 percent more P than Bray P. Mehlich-3 extracts more base cations than AA for K (14 percent), Ca (15 percent) and Mg (24 percent). Overall, the Mehlich-3 extractant is an appropriate and reliable soil test extractant for non-calcareous soils and will be the basis of updated fertilizer recommendations in the Tri-State Region.

References

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