

Southern Regional Fact Sheet



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CONVERSION EQUATIONS FOR SOIL TEST EXTRACTANTS: MEHLICH-1 and MEHLICH-3

Plant available phosphorus (P) and potassium (K) in soil are estimated by a soil test method that involves extracting a portion of total P and K from soil. The extracting solution contains a mixture of various chemicals that react with soil and release some soil P and K into solution. Because of the variable nature of soils, many different extracting solutions have evolved. Soil test extractants used in North America include Bray P1, Bray P2, AB-DTPA, Lancaster, modified Morgan, modified Kewlona, Mehlich-1, Mehlich-3, and Olsen. Soil test extractants used at University laboratories in the southeastern United States are summarized in Table 1. Details on the soil tests such as extractant composition, soil sample size, soil:solution ratios, and shaking times are given by Hanlon (2001).

Table 1. List of extracting reagents used at University laboratories in the southeastern United States for assessing plant available P and K.

State	extracting reagent for P	extracting reagent for K
Alabama	Mehlich-1	Mehlich-1
Arkansas	Lancaster (soils with pH>7) Mehlich-3	Lancaster (soils with pH>7) Mehlich-3
Florida	Mehlich-1	Mehlich-1
Georgia	AB-DTPA (soils with pH>7.4) Acetic acid (organic soils) Mehlich-1	Mehlich-1
Kentucky	Mehlich-3	Mehlich-3
Louisiana	Bray P2	Ammonium acetate
Mississippi	Lancaster	Lancaster
North Carolina	Mehlich-3	Mehlich-3
Oklahoma	Mehlich-3	Mehlich-3
Puerto Rico	Bray P1	Ammonium acetate
South Carolina	Olsen (calcareous soils) Bray P2 Mehlich-1	Mehlich-1
Tennessee	Mehlich-1	Mehlich-1
Texas	Morgan (modified)	Morgan (modified)
Virginia	Mehlich-1	Mehlich-1

Phosphate and potash fertilizer recommendations from a soil test were developed from field studies in which crop yield response to P and K fertilizer additions were calibrated against the amount of P and K extracted with a soil test. Since each extractant will measure a different amount of P and K, each calibration is different depending on the extractant used. Therefore, if an individual or consultant is providing their own recommendation from a soil test, it is extremely important to note the extract used to obtain the soil test value since the recommendations should be for that particular extractant.

The availability of multiple soil test extractants from various laboratories sometimes makes it necessary to convert a soil test value to its equivalent value for another extractant that is well calibrated and accepted for fertilizer recommendations in the area. Converting one soil test value to another may be done if many comparisons are made between soil test extractants and if conversion equations are developed from the comparisons. The purpose of this publication is to provide conversion equations based upon published and continuing research. Converting one soil test value to another should be done with extreme caution. There are some cautionary words that should be heeded when converting soil test values. These cautions are also outlined. Currently, this fact sheet has conversion equations for converting between Mehlich-3 and Mehlich-1 for phosphorus and potassium.

Abbreviations

M1P = Mehlich-1 Phosphorus, M1K = Mehlich-1 Potassium, M3P = Mehlich-3 Phosphorus, M3K = Mehlich-3 Potassium, NAPT = North American Proficiency Testing

Cautionary words on using conversion equations

When converting from one soil test value to another, there are two errors associated with the converted number. The first error arises from obtaining the original result. The second error arises from doing the conversion since the equations are not perfect. The r^2 value is a measure of these errors. If there is no error at all, the r^2 is 1.0. If the error or uncertainty in the original result is 8% and there is no conversion error, r^2 will be around 0.97. An error of 8% means that for a soil test P value of 30 mg/kg, the actual value may be as low as 27.6 mg/kg or as high as 32.4 mg/kg. With r^2 of 0.95 and 0.90, total relative errors are 10% and 15%, respectively. With r^2 of 0.70, total relative error rises to 30%. The higher the r^2 value, the better the conversion because errors in the converted number are lower. Using conversion equations with r^2 below 0.80 is discouraged because total relative error in the converted number is greater than 22%.

The conversion equations should be used only when the soil test result to be converted is within the range of data used to create the equation. There is some level of certainty, defined by the r^2 value, that the conversion equations have predictive abilities within the data range used to create the equation. There is no level of certainty about the equations predictive abilities outside of the data range.

Just as a soil test value to be converted needs to lie within the range of data used to create the conversion equation, the soil tested needs to be similar to the soils used to create the conversion equations. Conversion equations are presented for soils from various parts of the United States and sometimes separated by soil type or soil pH. Conversion equations are also presented from an external quality control program (NAPT) where soils are representative of a wide range of locations across North America. The wide range of soil types makes the NAPT equations unsuitable for conducting actual conversions. The equations from the NAPT program are presented here for comparative purposes only.

When making conversions, it is important to know the unit of the soil test value being converted. There is no standard unit for presenting soil test values. The most common units used are ppm and lbs/acre. The ppm stands for parts per million and is equivalent to milligrams of nutrient per kg soil (mg/kg). A unit used in scientific literature and advocated by Mehlich (1972) is milligrams of nutrient per cubic decimeter (mg/dm^3). All units have the weight of nutrient measured in the numerator. This weight can be in the metric unit of milligrams (mg) or English unit of pounds (lbs). Difference in the units mentioned arises from what is in the denominators. The denominator contains either a measure of soil metric weight (kilogram, kg), land area (acre), or volume of processed soil (cubic decimeter, dm^3). There are no assumptions made when presenting the weight of nutrient measured in the numerator (mg or lbs) or when presenting the volume of tested soil in the denominator (dm^3). Assumptions are necessary when presenting the weight of processed soil (kg) or area of soil (acre) in the denominator if soil was measured with a scoop. Most laboratories measure the amount of soil tested on a volume basis using a scoop after drying and grinding the soil. The volume of soil used can range from 1.7 to 5 cm^3 and depends on the test performed. To present test results on a weight basis of soil an assumption is made on the density of the processed soil which usually ranges from 1 to 1.2 g/cm^3 . To present test results on an acre basis of soil, an additional assumption is required on the quantity of soil in an acre-furrow slice which is commonly assumed to be 2 million pounds. Another method that is used by some laboratories is to present a soil test result as an index related to nutrient recommendation. This value has no units.

The conversion equations in this fact sheet are in units of mg/kg. When a soil test value is in a unit other than mg/kg, you first have to convert the value to mg/kg. The laboratory providing the test result should be able to provide information on how to convert the value to mg/kg. In general, lbs/acre divided by two equals mg/kg if the laboratory assumed 2 million pounds of soil in an acre-furrow slice. After converting the value to the desired soil test extractant, you may then still need to convert the result to another unit used in a fertilizer calibration table. The laboratory that developed the calibration table should be contacted on how to make this conversion.

The conversion equations are intended for occasional soil test results that need converting to make proper

recommendations using recommendation data derived from another soil test extractant. They can also be used for whole-farm conversion of soil test records if there is a need or desire to switch to another soil test method. The conversion equations presented in this paper are not intended for routine analysis of soils with one extractant with the values converted so fertilizer recommendations could be made based on another extractant. The equations should not be used in this manner because there is an error associated with the conversion.

Even when using the same soil test extractant, there are differences that can occur in test results from various labs due to minor differences in protocols on performing the test. These protocol differences include method and speed of shaking the sample, weighing versus scooping a sample, soil:solution ratio, and analytical method of determining the nutrient in the extract. Because these minor differences exist from lab to lab, the best approach is to have soil tested at the same laboratory that provides the lime and fertilizer recommendation from the test result. Good soil test laboratories have evaluated and calibrated lime and fertilizer recommendations against soil testing protocols they perform. An appendix is available in this report with the methodology for the soil test extractions used to derive conversion equations in the Southern Region. A section on miscellaneous conversion equations from the literature from a wider region of soils is presented in this report without detailed methodology. The methodology for this data can be found in the literature cited for these equations.

Care must be taken in obtaining a converted soil test value to be used in nutrient management cost-share programs or for regulatory purposes. The governing authority that makes decisions based on soil test values may or may not accept a converted value. The governing authority should be contacted to determine if converted soil test values are acceptable.

MEHLICH-1 AND MEHLICH-3

Mehlich-1, Mehlich-2, and Mehlich-3 soil test extractants were developed by Adolf Mehlich in North Carolina (Mehlich, 1953, 1974, 1978, 1984). Currently, Mehlich-1 and Mehlich-3 are widely used by private and public laboratories across the United States and Canada to assess the nutrient status of soils. The Mehlich-2 extractant was never used extensively due to analytical concerns related to its chemical composition. Chemical composition of the Mehlich-1 and Mehlich-3 extracts and methodology using these extracts are presented in the Appendix.

Soils across North Carolina range from clayey in the Mountains and Piedmont regions in the west to sandy textures in the central and eastern part of the state. Along the coast, there is also a narrow border of organic soils. This diversity of soils gave Dr. Mehlich an excellent field laboratory to test the versatility of soil extractants. Mehlich-1 was the original extractant that worked well in predicting plant available P in acidic coastal plain soil (pH<6.5) with low cation exchange capacity (CEC<10meq/100g) and low organic matter (<5%). He learned Mehlich-1 was not always adequate in predicting plant-available P in soils with a high pH and CEC and significant accumulations of iron and aluminum. Therefore, he developed the Mehlich-3 extractant that had more acidity and contained fluoride to facilitate extraction of phosphates associated with iron and aluminum minerals. Other improvements made to the Mehlich-3 extractant were addition of ammonium nitrate to extract exchangeable cations and a chelate (EDTA) to extract micronutrients.

Florida: Mehlich-1 and Mehlich-3

The University of Florida Extension Soil Testing Laboratory uses Mehlich-1 for testing P and K in acid mineral soils in Florida. Comparisons of Mehlich-1 extraction to Mehlich-3 for P, K, Ca, Mg, Cu, Zn, Mn and B are presented by Mylavarapu et al. (2002). Conversion equations from the comparisons between P and K are presented in Table 2.

There was considerable error and uncertainty in the comparison between M3P and M1P when considering all 519 soils as indicated by a low r^2 value of 0.64 (Table 2). When just the lower values were considered with

M3P less than 445 mg/kg and M1P less than 240 mg/kg, there was some improvement in the comparison with an r^2 value of 0.72. The conversion equation at the lower Mehlich-P levels indicates the M3P values are approximately 1.5 times greater than M1P values.

The comparison between M3K and M1K was much better with an r^2 of 0.97 (Table 2). The conversion equation between M3K and M1K indicates that these values are nearly the same.

Table 2. Conversion equations for M3P, M1P, M3K, and M1K from Florida (Mylavarapu et al., 2002).

Equation	M3 range*	M1 range*	N**	r^2
$M3P=0.725(M1P)+52.7$	0 to 900	0 to 1300	519	0.64
$M3P=1.43(M1P)+18.6$ (for lower range of data)	0 to 445	0 to 240	490	0.72
$M3K=0.957(M1K)+2.54$	0 to 530	0 to 588	519	0.97

* Values are in units of mg/kg.

** N is the number of samples

Kentucky: Mehlich-1 and Mehlich-3

Phosphorus and potassium fertilizer recommendations from the University of Kentucky are based on Mehlich-3 soil test results for P and K. Therefore, equations are presented in Tables 3 and 4 for the conversion of Mehlich-1 to Mehlich-3 test results. Details on the collection and analysis of the data from Kentucky can be found in the Appendix.

Soils were collected from five of the six physiographic regions in Kentucky, which included the Purchase Area, Western Pennyroyal, Eastern Coal Field, Eastern Pennyroyal, and Bluegrass regions. With the Bluegrass region being the exception, no differences were observed in the relationships between M3P and M1P with soils grouped according to physiographic region. Differences were observed for the M3P and M1P relationships when data were grouped according to soil pH (Table 3). Mehlich-3 P was greater than M1P at both pH levels. The differences between M3P and M1P were greater at lower pH.

To obtain M3P from M1P test results, the soil pH has to be known. Mehlich-1 P is then multiplied by the appropriate conversion factor according to soil pH. As found in Table 1, the conversion factors are 2.13 with soil pH < 6.0 and 1.44 with soil pH \geq 6.0.

Data from the Inner Bluegrass region of Kentucky from Woodford county were omitted when developing the equations in Table 2. The relationship between M3P and M1P in the Bluegrass soils followed a pattern very different from the other regions. Soils with higher P levels had M1P much greater than M3P. The regression equation was $M3P=0.290(M1P)+82.3$ with an r^2 of 0.39. The M1P ranged from 9 to 672 mg/kg and the M3P ranged from 9 to 444 mg/kg. Soils from the Inner Bluegrass formed from phosphatic limestone beds containing fluorapatite, collophane, and carbonate apatite (McFarlan, 1950). These minerals have weathered to form apatite as the primary P compound in the soils (Karanthanas, 1991). The dissolution of

apatite is very sensitive to the pH of the extracting solution with an exponential increase in dissolution as pH decreases below 3 (Benbi et al., 1988). The Mehlich-3 extractant has a pH of 2.5 and the Mehlich-1 extractant has a pH of 1.25. The lower pH of the Mehlich-1 extractant results in greater dissolution of apatite in Bluegrass soil compared to the Mehlich-3 extractant. As a result, the slope of the M3P versus M1P relationship was much less than one. There was considerable variability in the relationship between M3P and M1P for the Bluegrass soils, resulting in an r^2 of only 0.39. Because of the unique P chemistry of these soils, use of Mehlich-1 to extract P is not recommended.

Mehlich-3 K was slightly greater than M1K in a majority of the soils tested. There were no differences in the relationships between M3K and M1K when data were grouped according to physiographic region or soil pH. Therefore, only one relationship was developed from the data (Table 4).

Table 3. Conversion equations for M3P and M1P from Kentucky (omitting Woodford county from the Inner Bluegrass region).

Soil pH	Equation	M3P range*	M1P range*	N**	r^2
<6.0	M3P=2.13(M1P)	3 to 326	2 to 136	143	0.92
>= 6.0	M3P=1.44(M1P)	4 to 320	1 to 200	366	0.86

* Values are in units of mg/kg.

** N is the number of samples

Table 4. Conversion equations for M3K and M1K from Kentucky.

Equation	M3K range*	M1K range*	N**	r^2
M3K=1.27(M1K)+12.0	34 to 598	24 to 479	578	0.89

* Values are in units of mg/kg.

** N is the number of samples

South Carolina: Mehlich-1 and Mehlich-3

A survey of South Carolina soils from 50 sites was conducted to assess issues related to land application of wastes and metal loading to surface waters (Franklin and Simmons, 2005). Samples were collected from two depths at each site. Soils were tested for phosphorus and potassium extracted by Mehlich-3 and Mehlich-1.

The conversion equations for P and K tested by Mehlich-3 and Mehlich-1 are presented in Table 5. The r^2 of

the relationship was 0.90 between M3P and M1P and 0.97 between M3K and M1K. Mehlich-3 P and M3K were both greater than the Mehlich-1 values as indicated by slope values of 1.45 and 1.23 for P and K, respectively.

Table 5. Conversion equations for M3P, M1P, M3K, and M1K from South Carolina.

Equation	M3 range*	M1 range*	N**	r ²
M3P=1.45(M1P)+10.8	0 to 350	0 to 220	89	0.90
M3K=1.23(M1K)+7.34	0 to 330	4 to 263	100	0.97

* Values are in units of mg/kg.

** N is the number of samples

North American Proficiency Testing (NAPT) Program: Mehlich-1 and Mehlich-3

The Soil Science Society of America sponsors a program for soil test laboratories to check on the quality of the data they produce. This program is entitled the North American Proficiency Testing (NAPT) program (Soil and Plant Analysis Council, 2000a). Five soil samples are sent to participating laboratories every 3 months. Soil samples are tested at each laboratory using their normal extractants. The test results are compared with the results obtained from other laboratories performing the same test. The program allows laboratories to check their level of accuracy on various analytical tests they perform. The program had 167 laboratories enrolled in the fourth quarter of 2002.

Equations for the conversion of Mehlich-1 P and K to Mehlich-3 P and K were developed from 116 soil samples from the NAPT program and are shown in Table 6. Samples were collected from across North America. Because the soils came from such a wide background of locations, the conversion equations are presented here for comparative purposes only and should not be used for actual conversions. Details on the analysis of the NAPT data are provided in the Appendix.

Soil pH was not a factor affecting the relationship between M3P and M1P or M3K and M1K. Therefore, one equation for M3P versus M1P and one equation for M3K versus M1K for all 116 samples of the NAPT program are shown in Table 6. Mehlich-3 P was about 20 mg/kg greater than Mehlich-1 P values. There was a very poor relationship between M3P and M1P as indicated with a low r² of 0.46. Mehlich-3 K was about double the M1K values.

Table 6. Conversion equations for M3P, M1P, M3K, and M1K from NAPT data[†].

Equation	M3 range*	M1 range*	N**	r ²
M3P=0.976(M1P) + 18.9	3 to 611	2 to 434	116	0.46
M3K=1.95(M1K)	21 to 1710	3 to 652	116	0.88

* Values are in units of mg/kg.

** N is the number of samples

[†] unpublished data, J. Kotuby-Amacher, Utah State University and R. Miller, Colorado State University.

Miscellaneous Sources: Mehlich-1 and Mehlich-3

Relationships between M3P and M1P and M3K and M1K from various sources are shown in Table 7. Mehlich-2 P (M2P) is shown for a study conducted in Georgia. Mehlich-2 is very similar to Mehlich-3. The difference in the two extractants is that nitrate salts and acids are used in Mehlich-3 whereas chloride salts and acids are used in Mehlich-2. The Mehlich-2 extractant was the first improvement made to the Mehlich-1 extractant. The chloride proved to be too corrosive in the laboratory. Thus, Mehlich-3 was developed.

Table 7. Conversion equations for M3P, M2P, M1P, M3K, and M1K from miscellaneous sources.

State	Soil	Equation*	N**	r²
Georgia (Shuman et al., 1988)	Rome cl	$M2P=(1.61) M1P - 8.2$	60	0.81
	Pacolet scl	$M2P=(1.39) M1P + 2.4$	60	0.87
	Goldsboro scl	$M2P=(1.43) M1P + 0.3$	60	0.94
19 states in the southeast, north central, and northeastern regions (Wolf and Baker, 1985)	noncalcareous	$M3P=(1.85) M1P - 4.3$	91	0.75
Delaware (Sims, 1989)	Coastal plain (all)	$M3P=(1.61) M1P + 21.8$	400	0.91
		$M3K=(1.12) M1K + 5.9$	400	0.90
Delaware (Gartley et al., 2002)	Delaware soils	$M3P=(2.04) M1P + 14.8$	300	0.91
		$M3K=(1.37) M1K - 7.7$	300	0.97

* Values in units of mg/kg except for data from Delaware which is in units of mg/dm³.

** N is the number of samples

CONCLUSIONS

Conversion equations for soil test methods should be used with considerable caution. Errors are introduced with the use of conversion equations because of the variable nature of soils and how they react with different soil test extractants. Conversion equations are not recommended for routine use. The best approach is to obtain fertilizer and lime recommendations from the laboratory conducting the test. Occasionally, recommendations are desired from a soil test that was not used to calibrate the recommendations. When conversion equations are used on an occasional basis, the soil that was tested should be similar to the soils used to derive the conversion equations. Several equations were presented for conversion between Mehlich-1 and Mehlich-3 with emphasis on soils in the Southern Region.

APPENDIX

Methods for Mehlich-1 and Mehlich-3 Comparison

The chemical composition and original method for using Mehlich-1 and Mehlich-3 are presented in Table 8. General methodology for soil tests using Mehlich-1 and Mehlich-3 are described in "Soil Analysis Handbook of Reference Methods" (Soil and Plant Analysis Council, 2000b), Mehlich (1953), and Mehlich (1984). For Mehlich-3, 2.5 cm³ of soil is mixed with 25 ml of the extract (Mehlich, 1984). For Mehlich-1, 4 cm³ or 5 g of soil is mixed with 20 ml of Mehlich-1 extract (Mehlich, 1953). Soil and extractant are shaken for 5 minutes and filtered. Specific details on methodology used in developing conversion equations from the Southern Region and the NAPT program are presented below.

Table 8. Chemical composition of extractants, soil:extractant ratios, and shaking times for the Mehlich-1 (Mehlich, 1953) and Mehlich-3 (Mehlich, 1984) soil tests.

Soil Test	pH	Total acidity (eq/L)	Chemical composition	Soil:extractant ratio	Shaking time
Mehlich-1	1.25	0.075	0.05 N HCl, 0.025 N H ₂ SO ₄	4 cm ³ (or 5 g) : 20 ml	5 minutes
Mehlich-3	2.50	0.22	0.2 N acetic acid, 0.015 N NH ₄ F, 0.25 N NH ₄ NO ₃ , 0.013 N HNO ₃ , and 0.001 M EDTA	2.5 cm ³ : 25 ml	5 minutes

Florida

The study conducted to obtain the conversion equations is reported in Mylavarapu et al. (2002). A total of 519 acid mineral soils routinely submitted to the University of Florida Extension Soil Test Laboratory were selected. Calcareous and organic soils were not included.

For the Mehlich-1 extraction, 5 g soil was shaken with 20 ml of extractant. For the Mehlich-3 extraction, 3.1 g soil was shaken with 25 ml of extractant. Soil was shaken with the extractant for 5 minutes. The soil slurry mixture was filtered and P and K in the filtrate were determined via inductively coupled plasma spectrophotometry (ICP). Results are presented in units of mg/kg. No assumptions are made in reporting the value as mg/kg since soil was weighed for the extraction.

Regression analysis was performed on the data to establish the linear dependence of the two Mehlich procedures.

Kentucky

Soils were selected from 5 physiographic regions in Kentucky. Soil samples were taken from those routinely sent to the University of Kentucky soil testing laboratory from Woodford county (Bluegrass), Adair county (Eastern Pennyroyal), Todd county (half in Western Coal Fields and half in Western Pennyroyal), McLean and Webster counties (Western Coal Fields), and Graves county (Purchase Area) during the spring of 1999. The number of samples analyzed from each county were 79, 91, 47, 100, 191, and 70 from Adair, Graves, McLean, Todd, Webster, and Woodford, respectively, for a total of 578 samples.

Five cm³ of soil was shaken with 20 ml of Mehlich-1. Two cm³ of soil was shaken with 20 ml of Mehlich-3. Shaking occurred on an end-to-end shaker at 240 cycles per minute for 5 minutes. The soil slurry was filtered through Whatman no. 2 filter paper for 10 minutes. The filtrate was analyzed for P and K via inductively

coupled plasma spectrophotometry (ICP). Results are presented in units of mg/kg assuming a processed soil density of 1 g/cm³.

Comparison of data sets was conducted with regression analysis using linear models. If the 95% confidence interval for the y intercept overlapped 0, the regression analysis was conducted again forcing the y intercept to be 0. Soils were grouped according to counties of origin or soil pH level. Two soil pH groups were defined as <6 or ≥6. If the 95% confidence intervals for the slopes of the linear models overlapped one another, the slopes were not considered to be different.

South Carolina

Soils were collected from 50 sites in South Carolina. The sites were located in the Blue Ridge, Piedmont, Carolina Sandhills, and Upper and Lower Coastal Plains. Soil was collected at two depths of 0 to 15 and 15 to 30 cm at each site which resulted in a total of 100 soil samples.

For the Mehlich-1 extraction, 10 g soil was shaken with 40 ml of extractant. For the Mehlich-3 extraction, 4.5 g soil was shaken with 45 ml of extractant. Soil was shaken with the extractant for 5 minutes. The soil slurry mixture was filtered and P and K in the filtrate were determined via inductively coupled plasma spectrophotometry (ICP). Results are presented in units of mg/kg. No assumptions are made in reporting the value as mg/kg since soil was weighed for the extraction.

Regression analysis was performed on the data to establish the linear relationship between the two Mehlich procedures. Outliers were excluded from the P analysis.

North American Proficiency Testing (NAPT) Program

Samples from the third quarter of 1998 through the first quarter of 2004 in the North American Proficiency Testing (NAPT) program was used to assess relationships amongst Mehlich-1 and Mehlich-3 extractable P and K. Median values were used in the analysis. In 2001, NAPT began reporting two median values for M3P. One was for determination via ICP and the other was via colorimetry. An average M3P value was determined for each sample according to

$$M3P = [(N_{ICP} \times M3P_{ICP}) + (N_{color} \times M3P_{color})] / (N_{ICP} + N_{color})$$

where N is the number of samples reported for the ICP or colorimetric determination of M3P. $M3P_{ICP}$ and $M3P_{color}$ are the median values reported for ICP and colorimetric analyses of M3P, respectively. One sample was omitted from the group because of extremely high levels of extractable P and K. The sample ID is 99104 and had median M3P and M3K values of 1385 and 2737 mg/kg, respectively.

There are no strict stipulations on method protocol for analysis of NAPT samples. Samples should be analyzed according to accepted standard methodologies as listed in one of the five soil workgroup regional publications. In general, the Mehlich-1 extraction involves 5 g of soil and 20 ml of Mehlich-1 and the Mehlich-3 extraction involves 2.5 cm³ soil and 25 ml of Mehlich-3 (Table 8). Values are reported in units of mg/kg in the NAPT program. Variations can exist across different labs because of differences in scoop volumes, scooping techniques, and calculations to arrive at soil test concentrations on a soil mass basis.

Comparison of data sets was conducted with regression analysis using linear models. If the 95% confidence interval for the y intercept overlapped 0, the regression analysis was conducted again forcing the y intercept to be 0. Soil pH was considered as an independent variable in a multiple regression of M3P versus M1P and soil pH. Likewise, soil pH was considered in a multiple regression of M3K versus M1K and soil pH. Soil pH was

not a statistically significant variable in the regression models.

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