Relating Mehlich 3 extractable P to Morgan and Bray 1 extractable P for Alaska soils

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INTRODUCTION

Since 1989 the University of Alaska AFES Soil and Plant Tissue Testing Laboratory has used the Mehlich 3 extractant as the routine procedure for testing soil samples submitted through the Cooperative Extension Service. Before 1989, the Morgans extractant was used for these samples and the Bray 1 extractant was used for research soil samples. The change to Mehlich 3 was made based on recent soil research findings at the University of Alaska AFES.

Research on the correlation and calibration of a P soil test for Alaska soils began in 1983. Laboratory studies identified the P sorption character of 10 Alaska soils representing both the Interior (Fairbanks, Delta, and Copper River) and Southcentral (Matanuska and Susitna Valleys, Soldotna, Kenai, and Homer) regions. These soils were found to have widely differing P sorption characteristics (Ping and Michaelson, 1986). A growth chamber experiment was performed in which the P removed by seven different P extractants was related to plant growth at various levels of soil P. The Mehlich 3 extractant was found to be most suitable across the wide range of soils tested. The Morgans extractant was found to be the least sensitive to changes in soil P, and along with the Bray 1 extractant, was found less suitable than Mehlich 3 for use on the soils of volcanic ash origin (Susitna Valley and lower Kenai Peninsula soils) (Michaelson and Ping, 1986).

Field trials were carried out from 1984-1987 at five locations (Delta, Copper River, Palmer, Pt. MacKenzie, and Soldotna) to calibrate the Mehlich 3 extractable P soil test for local conditions. Relationships between Mehlich 3 extractable P and yield levels of cereal forages were developed for six soils (Michaelson and Ping, 1990a). Relationships between Mehlich 3 extractable P and amount of fertilizer added in the field were also developed for each soil (Michaelson and Ping, 1990b). The field and laboratory data were used in creating tables for interpreting Mehlich 3 extractable P tests when making P fertilizer recommendations. These tables vary with soil series across the state (Michaelson and Ping, 1989).

Since many years of farm and garden soil test records contain Morgan extractable P values, and years of research soil tests used Bray 1, the question arises as to how these older soil test P values relate to current Mehlich 3 extractable P values. Equations for relating a soil test P value from one extractant to that of another were identified for soils at the various locations in the calibration trials (Nenana/Volkmar, Copper River, Knik, Kashwitna, and Soldotna series) and on soils used in growth chamber studies (Fairbanks and Kachemak series). These relationships are presented here to allow conversion of one value to another by calculation. The reader is reminded however, of the limited suitability of the Morgans and Bray 1 extractants and that the extraction of P by the Mehlich 3 extractant is the method generally recommended for use in assessing the P fertility status of Alaska soils.

Relating Soil Tests

The linear equations in Table 1 allow the calculation of an approximate value for Mehlich 3 extractable P from either Morgan extractable P or Bray 1 extractable P, and vice versa. These relationships vary significantly from soil to soil. The proper equation to be used is the one for the soil closest in location and with properties most similar to the soil for which the P test is to be converted. The major soil series (from published soil survey reports USDA-Soil Conservation Service) to which each equation can be applied are listed in Table 2. Select the proper soil series and find the equation with the soil test extractant value to be converted on the right side of the equation and the one you wish to calculate on the left. Then, multiply your test value (in mg P/kg or ppm P) by the coefficient and then add (or subtract as the sign indicates) the constant value. This will result in the desired soil test value in mg P/kg or ppm P.

Figure 1 provides graphical representations of the linear equations listed in Table 1. The relationships of either Bray 1 extractable P or Morgan extractable P (on the y-axis) to Mehlich 3 extractable P (on the x- axis) are presented for eight Alaska soil series. These figures can be used to graphically estimate Mehlich 3 extractable P soil test values from either Bray 1 extractable P or Morgan extractable P. Select the graph for the appropriate soil series then find the soil test level for Bray 1 or Morgan extractable P on the y-axis. Draw a horizontal line to the function line of the desired soil test. At the point where the horizontal line crosses the soil test line, draw a vertical line down to the Mehlich 3 extractable P value on the x-axis. This value is the Bray 1 extractable P or Morgan extractable P soil test value converted to approximately the level the Mehlich 3 P extractant would yield.

The graphs and equations should not be used to convert soil test values that are outside the range of points presented in Figure 1. The Fairbanks graph in Figure 1 is extrapolated only for Mehlich 3 values less than about 120 mg P/kg.

Calculation of soil P values using the linear equations provided in Table 1 will result in approximately the same values as those generated utilizing the graphs in Figure 1. Either method can be used and should provide adequate figures for soil fertility evaluation and calculation of P fertilizer application rates.

Literature

Michaelson G.J., and C.L. Ping. 1986. Extraction of phosphorus from the major agricultural soils of Alaska. *Commun. Soil Sci. and Plant Anal.* 17:275-297.

Michaelson, G.J., and C.L. Ping. 1989. *Interpretation of the phosphorus soil test for Alaska agricultural soils*. University of Alaska Fairbanks, Agricultural and Forestry Experiment Station. Circular 66.

Michaelson, G.J., and C.L. Ping. 1990a. Mehlich 3 extractable P in relation to cereal forage production on Alaska soils. *Appl. Agric. Res.* vol 5, no. 4, pp 225-260.

Area Soil series	(M3) Mehlich 3	vs vs	(Mo) Morgans			(M3) Mehlich 3	vs vs	(B1) Bray 1		
				Soil test in mg P/kg or ppm/P						
Tanana Valley										
Fairbanks	(M3)	=	7.27	(Mo)	+ 11.2	(M3)	=	0.98	(B1)	+ 42.3
	(Mo)	=	0.12	(M3)	+ 0.1	(B1)	=	0.84	(M3)	- 16.0
Nenana/Volkmar	(M3)	=	6.67	(Mo)	- 14.0	(M3)	=	1.05	(B1)	+ 1.0
	(Mo)	=	0.13	(M3)	+ 2.6	(B1)	=	0.92	(M3)	- 0.4
Copper River Basin										
Copper River	(M3)	=	2.63	(Mo)	+ 15.3	(M3)	=	1.28	(B1)	+ 1.0
	(Mo)	=	0.27	(M3)	+ 14.0	(B1)	=	0.72	(M3)	+ 9.6
Mat-Su Valleys										
Knik	(M3)	=	6.13	(Mo)	+ 18.7	(M3)	=	0.97	(B1)	- 3.4
	(Mo)	=	0.15	(M3)	- 2.0	(B1)	=	1.00	(M3)	+ 4.7
Nancy	(M3)	=	2.49	(Mo)	- 12.0	(M3)	=	1.14	(B1)	- 0.9
	(Mo)	=	0.34	(M3)	+ 6.2	(B1)	=	0.85	(M3)	+ 1.1
Kashwitna	(M3)	=	9.58	(Mo)	- 32.0	(M3)	=	0.86	(B1)	+ 15.0
	(Mo)	=	0.09	(M3)	+ 4.3	(B1)	=	1.12	(M3)	- 15.0
Kenai Peninsula										
Soldotna	(M3)	=	5.80	(Mo)	- 7.7	(M3)	=	1.10	(B1)	+ 8.7
	(Mo)	=	0.14	(M3)	+ 2.2	(B1)	=	0.86	(M3)	- 6.3
Kachemak	(M3)	=	3.70	(Mo)	- 26.0	(M3)	=	0.55	(B1)	+ 8.9
	(Mo)	=	0.24	(M3)	+ 8.4	(B1)	=	1.68	(M3)	- 10.0

Table 1. *Linear equations for the relationships between soil test P (in mg P/kg or ppm P) extracted by Mehlich 3 and Morgans extractants, and Mehlich 3 and Bray 1 extractants for representative Alaska soils.*

Michaelson, G.J., and C.L. Ping. 1990b. Mehlich 3 extractable P of Alaska soils as affected by P fertilizer application. *Appl. Agric. Res.* vol 5, no. 4, pp 261-267.

Michaelson, G.J., C.L. Ping, and G.A. Mitchell. 1987.Correlation of Mehlich 3, Bray 1, and ammonium acetate extractable P, K, Ca, and Mg for Alaska agricultural soils. *Commun. Soil Sci. and Plant Anal.* 18:1003-1015.

Ping, C.L., and G.J. Michaelson. 1986. Phosphorus sorption by major agricultural soils of Alaska. *Commun. Soil Sci. and Plant Anal.* 17:299-320.

Area Soil series (from Table 1)	Area soil series for which equation may be extrapolated
Tanana Valley	
Fairbanks	Gilmore, Saulich (thawed), Minto, and other upland nonacid loess soils.
Nenana/Volkmar	Beales, Chena, Richardson, Steese,Tanana and other soils of the Salcha-Delta area.
Copper River Basin	
Copper River	All neutral to alkaline soils of the area.
Mat-Su Valleys	
Knik	Bodenburg, Doone, Matanuska, Niklason, and Homestead (mapped along the Matanuska River and the foothills of Lazy Mtn).
Nancy	Chulitna, Rabideaux, Talkeetna, Whitsol and other series in the Susitna Valley.
Kashwitna	Flathorn, Homestead, Kenai, Naptowne, and Shrock series mapped in the Matanuska Valley and Point MacKenzie/Anchorage areas.
Kenai Peninsula	
Soldotna	Cohoe, Kenai, Naptowne, Tustumena, and other series mapped in the Kenai-Kalilof area.
Kachemak	Beluga, Island, Mutnala, and other land soil series of the Homer-Ninilchik, southeastern Alaska,and southwestern Alaska areas.

Table 2. *Soil series to which equations given in Table 1 can be extrapolated. The soil series names are taken from soil survey reports for each area (published before 1982, USDA-Soil Conservation Service).*

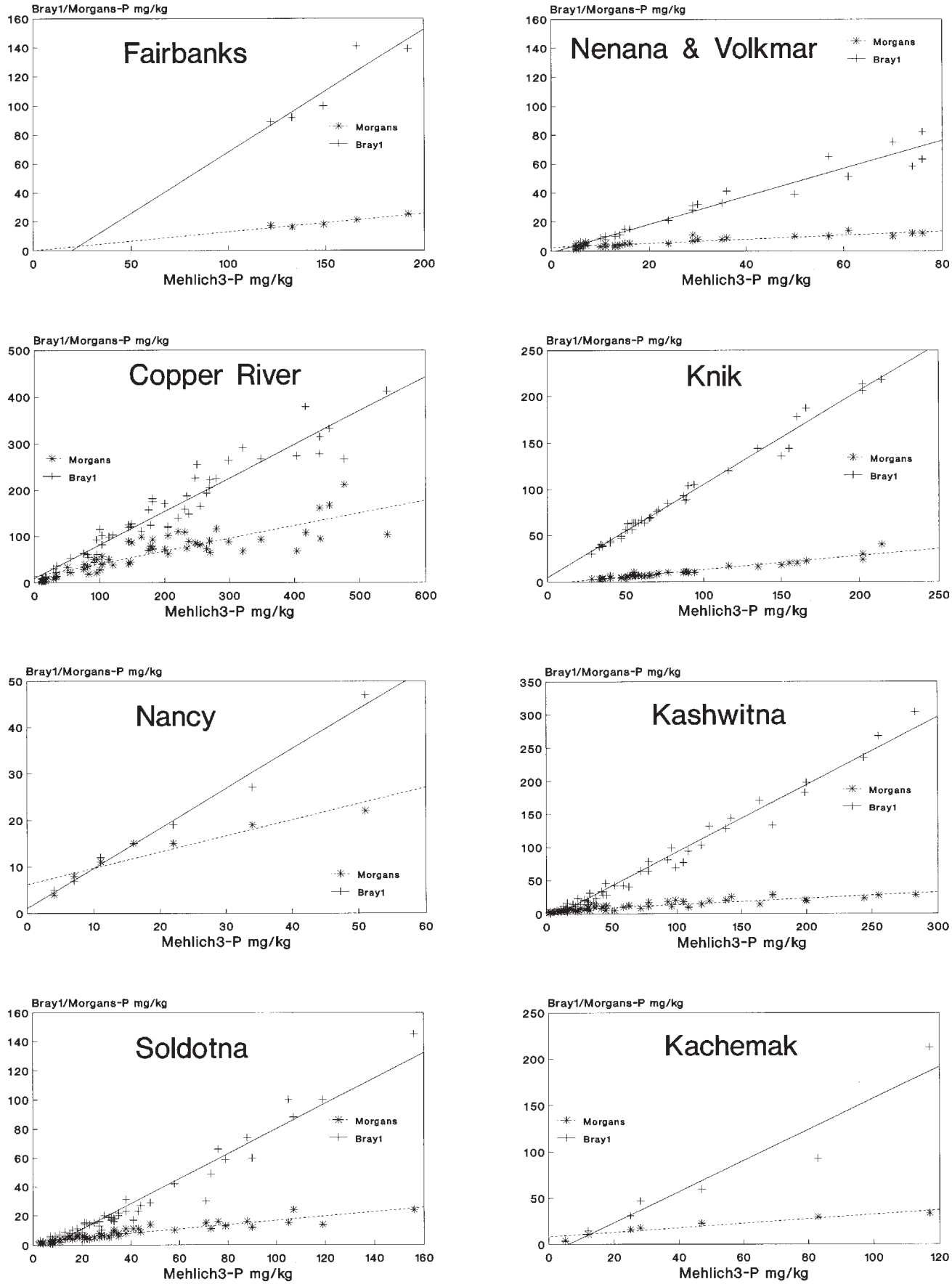

Figure 1. *Relationships between Bray 1 extractable P and Morgan extractable P (y-axis) and Mehlich 3 P (x-axis) by soil series, along with data points used to develop the equation (line) for each.*