

The Soil ~ Plant Analyst



A NEWSLETTER DEDICATED TO THE AGRICULTURAL LABORATORY INDUSTRY
A Quarterly Newsletter of the Soil and Plant Analysis Council, Inc., Spring 2000

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- Minnesota Manure Proficiency Testing Program
- A New Method for Assessing Fixed Soil K Availability

Thoughts From the Prez



Greetings from Iowa. As you can see from the exciting articles in this newsletter that your Council is busy with changes (see pages 6-7 of this issue). We are proud to bring you easier access to the Council board of directors and the programs of the Council via our new web site (www.spcouncil.com). It will also help you get easier and faster access to information in this electronic age.

Change is all around us. I recall many of the conversations I had with folks prior to January 1, 2000 regarding the concerns about change as we were about to begin the new millennium. It used to be that I just worried about getting the correct new year written on my checks and correspondence before July. I never quite anticipated the challenge of learning to spell millennium! As it is turning out, the start of this new century is much like the beginning of any new year. The doomsday prophets had their say but due to the preparations of many, doomsday seems to be something we can continue to look forward to.

It would be safe to say that change is what the Council is all about. Since the founding of the Council, our members have asked for and have created change. The need to establish standard soil testing procedures provided the foundation for this organization. Change continues today, for example the new member services that offer lower cost quality lab supplies through the bulk purchasing program and coming soon CPI International (see page 2). This brings to mind the economic challenges we all face in agriculture. I believe that with the Council's services you will be able to find the means to continue to analyze soil and plant samples for growers who are challenged by this economic climate. Sampling seems to be one area that can be readily identified as one of the key costs of doing business. We must continue to deliver the professional message of the value of soil and plant analysis for profitable agronomic and horticultural enterprises.

As we begin this spring season, please make it a point to keep in mind the idea of change in regards to the Council. Make this the millennium that you begin to share your ideas with us as we try to represent you in causes that are larger than ourselves, but are essential to the well being of our customers. Please contact us by phone, mail, email, web site, or in person. I look forward to hearing from you soon.

Best Wishes for a Prosperous New Millennium

Bob Beck

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Estimating CEC from Mehlich III Bases and SMP Buffer pH

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Introduction

Many soil testing laboratories are offering cation exchange capacity (CEC) and % base saturation values calculated from summation of bases and acid. Exchangeable bases are determined from bases removed with a soil test extractant and exchangeable acidity is determined from a buffer pH used to estimate liming requirements. Before reporting these additional parameters for soils at the University of Kentucky Soil Testing Laboratories, an evaluation of the calculation method was deemed critical. The objective of the study was to determine how to estimate CEC and % base saturation with minimal error from routinely determined soil test parameters of Mehlich III bases and Shoemaker-McLean-Pratt (SMP) buffer pH.

Materials and Methods

A total of 720 representative Kentucky soils that had been previously analyzed (1990-96) were selected for this study. The soils were tested for Mehlich III exchangeable P, K, Ca, and Mg, SMP Buffer pH with initial pH of 7.5, soil water pH, NH_4 -acetate CEC at pH 7, and NH_4 -acetate exchangeable bases at pH 7. Values from the Mehlich III test were reported in lbs/acre with 2 cm^3 scooped soil, assumed soil density of 1 g/cm^3 , and assumed acre-weight of soil being 2 million pounds. NH_4 -acetate CEC and exchangeable bases were reported in meq/100g with 10 g of soil weighed for each test. Conversions from lbs/acre to meq/100g and vica versa were made assuming 2 million pounds of soil

per acre. NH_4 -acetate exchangeable acidity was determined as the difference between NH_4 -acetate CEC and NH_4 -acetate bases. Only soils having percent base saturations less than 100 were used in the analyses.

Buffer pH can not be multiplied by a constant to calculated exchangeable hydrogen.

Results and Discussion

There was good agreement between NH_4 -acetate bases and Mehlich III bases. The following relationships were observed for Ca, Mg, and K in units of lbs/acre:

$$\text{NH}_4\text{-acetate Ca} = -49 + 0.89 \text{ Mehlich III Ca}, r^2 = 0.98$$

$$\text{NH}_4\text{-acetate Mg} = 12 + 0.79 \text{ Mehlich III Mg}, r^2 = 0.98$$

$$\text{NH}_4\text{-acetate K} = -13 + 0.96 \text{ Mehlich III K}, r^2 = 0.98$$

From these equations, a fairly accurate estimate of NH_4 -acetate exchangeable bases can be made from Mehlich III extractable bases. Difficulty in calculating CEC develops from the estimation of exchangeable acidity. Exchangeable acidity can be estimated from a correction factor (CF) that is multiplied by the decrease in the SMP buffer pH (pHd) due to the buffer reacting with soil acidity.

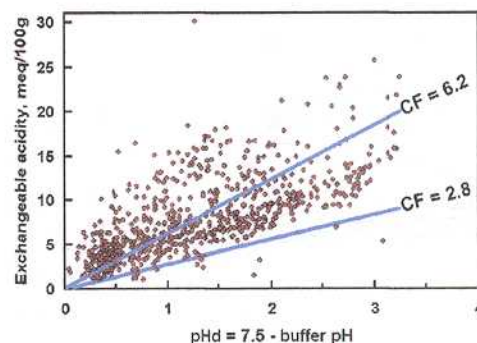


Figure 1. Measured soil acidity versus the decrease in SMP buffer pH.

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For example, if the correction factor were 8, exchangeable acidity would be calculated as:

Exchangeable acidity = $8 \times (7.5 - \text{SMP buffer pH})$.

A plot of NH_4 -acetate acidity versus the SMP buffer pH decrease (Fig. 1) provided little solace in relying on one correction factor to calculate exchangeable acidity from SMP buffer pH.

For one correction factor to provide accurate estimates of exchangeable acidity the data would need to lie on one line with the

acts with the buffer. Thus, correction factors greater than 2.8 are required.

Components of a soil that affect its weak acid characteristics are CEC and acidity level. At higher CEC, protons are held more tightly by soil colloids and therefore do not react readily with the SMP buffer. At low acidity levels (high pH), the few protons present are held tightly onto soil colloids which also results in a lower fraction of the protons reacting with SMP buffer. As CEC increases and acidity levels decrease (high SMP Buffer pH), the correction factor should increase to compensate for the greater fraction of protons that do

Correction Factor vs CEC and pHd

$$Z = 0.482 + 0.527 * X^{0.5} * \text{LN}(X) + 1.1 * Y^{-1} - 0.0886 * Y * X^{0.5} * \text{LN}(X) + 0.115 * Y^{-1} * X^{0.5} * \text{LN}(X)$$

$$R^2 = 0.66$$

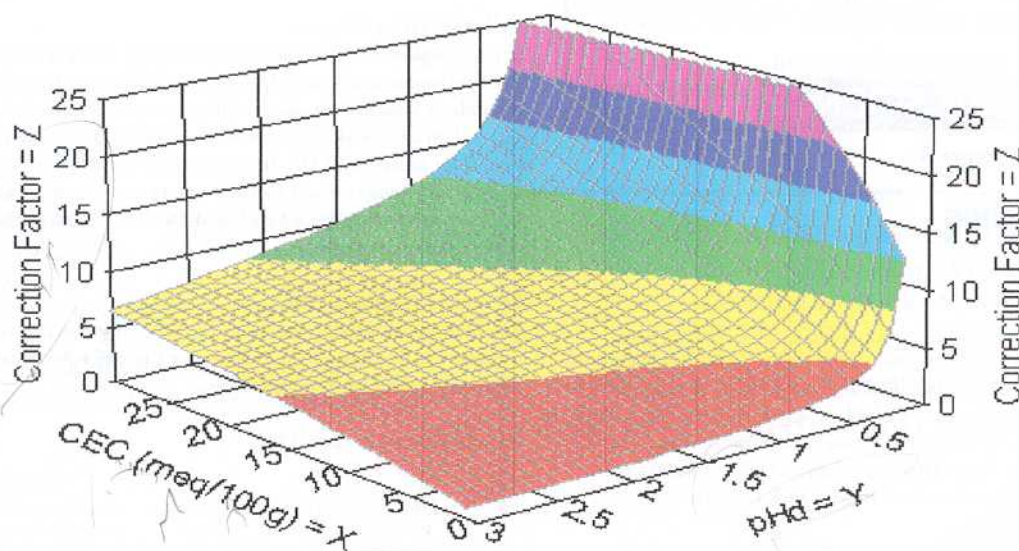


Figure 2. Multiple regression of correction factor versus measured CEC and decrease in SMP buffer pH (pHd).

slope of that line becoming the correction factor. There was a lot of scatter around the median correction factor of 6.2. The theoretical line with a slope of 2.8 is also presented in Fig. 1, which represents the correction factor if the SMP buffer reacted with all of the soil acidity. Because of the weak acid characteristics of soil acidity, not all of the soil acid re-

not react with the SMP Buffer. The correction factor for each data point in Fig. 1 was determined and regressed against CEC and the decrease in SMP buffer pH (Fig. 2). As predicted, the correction factor increased with increased CEC and decreased soil acidity.

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The equation in Fig. 2 provides a potential means of calculating a correction factor to estimate exchangeable acidity. Unfortunately, CEC is present as an independent variable that needs to be calculated as a dependent variable. An iterative approach was adopted where CEC is first estimated and a new CEC is calculated and used as the second estimate to calculate another CEC. The iteration is continued until the newly calculated CEC equals the estimated CEC used to determine the correction factor. Figure 3 shows a comparison of analytically determined CEC versus calculated CEC using the iterative approach or using a constant correction factor of 6.2.

The iterative approach was superior to the constant correction factor in that the data were less skewed and there was a higher R^2 value for the regression.

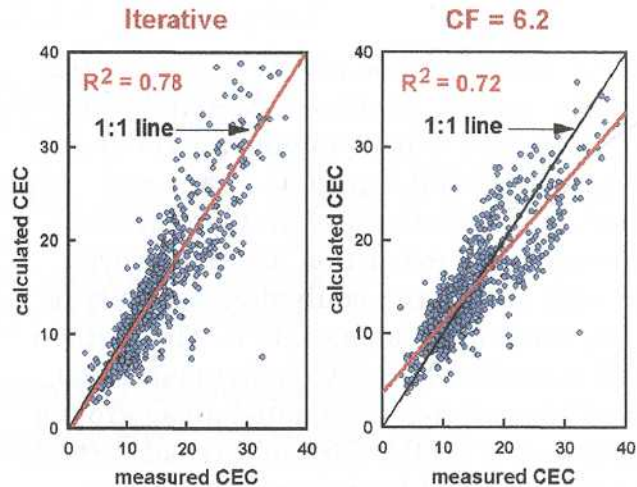


Figure 3. Measured CEC (meq/100g) versus calculated CEC (meq/100g) using the iterative approach to determine the correction factor in comparison to using a constant correction factor of 6.2.



Conclusion

Soil acidity can not be correctly estimated with a constant correction factor. The correction factor must be adjusted based on CEC and SMP buffer pH. The iterative method of calculating CEC and exchangeable bases is being adopted in our new soil test reporting computer program. To avoid reporting incorrect high CEC values due to the presence of carbonates or excess cations in the soil, soils with a water pH greater than 7 will not have CEC calculated. About 15% of Kentucky soils have soil pH above 7. Work is continuing on various soils in Kentucky to evaluate the usefulness of an iterative approach to CEC calculation versus using one multiplication factor.