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Correlation of Sikora and Smith-McLean- Pratt Soil Buffer pH Measurements

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Abstract

Historically, the K-State Research and Extension Soil Testing Laboratory has used the Smith-McLean-Pratt (SMP) buffer solution to estimate total soil acidity and estimate lime recommendations. The SMP solution contains hazardous chemicals and poses a health risk to lab workers. The Sikora buffer solution was designed as a replacement for SMP and contains no hazardous chemicals. A study was conducted to investigate the relationship between these two buffers in Kansas soils. A strong positive correlation was observed between SMP and Sikora buffer pH measurements. However, linear regression suggests that the relationship is not 1:1 (slope = 0.88). Therefore recommendation equations using the Sikora buffer would require different equations than those currently used for the SMP buffer pH measurements.

Keywords

pH, Sikora, SMP, buffer pH

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Correlation of Sikora and Smith-McLean-Pratt Soil Buffer pH Measurements

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Summary

Historically, the K-State Research and Extension Soil Testing Laboratory has used the Smith-McLean-Pratt (SMP) buffer solution to estimate total soil acidity and estimate lime recommendations. The SMP solution contains hazardous chemicals and poses a health risk to lab workers. The Sikora buffer solution was designed as a replacement for SMP and contains no hazardous chemicals. A study was conducted to investigate the relationship between these two buffers in Kansas soils. A strong positive correlation was observed between SMP and Sikora buffer pH measurements. However, linear regression suggests that the relationship is not 1:1 (slope = 0.88). Therefore recommendation equations using the Sikora buffer would require different equations than those currently used for the SMP buffer pH measurements.

Introduction

Crop yields in acidic soils can be limited by several factors, namely reduced root growth and vigor caused by metal toxicity (e.g. aluminum (Al), iron (Fe), and manganese (Mn)), and reduced availability of essential plant nutrients. For example, the availability of phosphate (PO_4^{3-}) is highly dependent on pH, and precipitation of Al, Fe, and Mn phosphates is an important mechanism for reduced phosphorus (P) availability to plants grown in acidic soils. As such, neutralization of soil acidity is often necessary to maintain crop production and farm profitability.

Remediation of acid soils requires the neutralization of the total soil acidity, which can be conceptualized as two main pools, active acidity and reserve acidity. Active acidity is simply the hydrogen ions (H^+) in the soil solution and can be measured through soil pH measurements. Reserve acidity buffers the soil pH (active acidity) and requires some form of titration to measure, as it is caused by acidic cations (e.g. Al^{3+} , Fe^{3+} , and H^+) sorbed to the cation complex. Given the time-consuming nature of soil titrations, pH buffers are often used instead to quantify total soil acidity and to generate lime recommendations. In practice, both soil pH and buffer pH are used, where soil pH is used to determine if lime should be applied and the buffer pH is used to determine the amount of lime required to achieve the target pH.

Several different buffer solutions are used at labs across the U.S. Historically, the KSRE soil testing lab has used the Smith-McLean-Pratt (SMP) pH buffer. However, this solution contains hazardous chemicals, such as p-nitrophenol and chromium, and poses a risk to human health and the environment if not handled and disposed of carefully.

Buffers without these hazardous chemicals have been developed in recent years, such as the Sikora buffer solution, and many soil testing labs are using them to reduce operating costs. The Sikora buffer solution was designed as a direct replacement for the SMP buffer. The goal of this study was to evaluate the correlation of the Sikora buffer solution with the SMP solution in Kansas soils and the potential to estimate reserve acidity and provide lime recommendations.

Experimental Procedures

Soil samples were randomly selected from across the state of Kansas. Samples were dried at 40°C overnight and ground to pass a #2 sieve (approximately 2 mm) using a flail type soil grinder. Samples were then analyzed for organic matter (OM), soil pH, SMP buffer pH, and Sikora buffer pH. Soil pH was measured from 1:1 soil-water suspensions. Organic matter was determined via the loss on ignition approach with a muffle furnace operating at 400°C. Both Sikora and SMP pH values were measured according to procedures recommended in North Central Regional Research Publication No. 221 (revised). Given the nature of random sampling, some samples were deemed inappropriate for use in the study. Soil samples with a soil pH > 6.4 or OM content > 10% were removed from the data set prior to analysis. The relationship between Sikora and SMP buffer pH values was investigated using Pearson's product-moment correlation and linear regression techniques.

Results

Soil pH ranged from 4.5–6.4 and soil OM from 0.8–9.2%, in the set of samples included in the study (279 samples). Sikora and SMP pH values ranged from 5.5–7.2 and 5.3–6.9, respectively, with a strong positive correlation ($r = 0.9$) (Figure 1). The strong correlation and linear nature of the relationship between Sikora and SMP suggests that Sikora could suitably replace SMP for lime recommendations in Kansas soils. However, since Sikora pH values were higher than SMP values, new equations should be used (Figure 2).

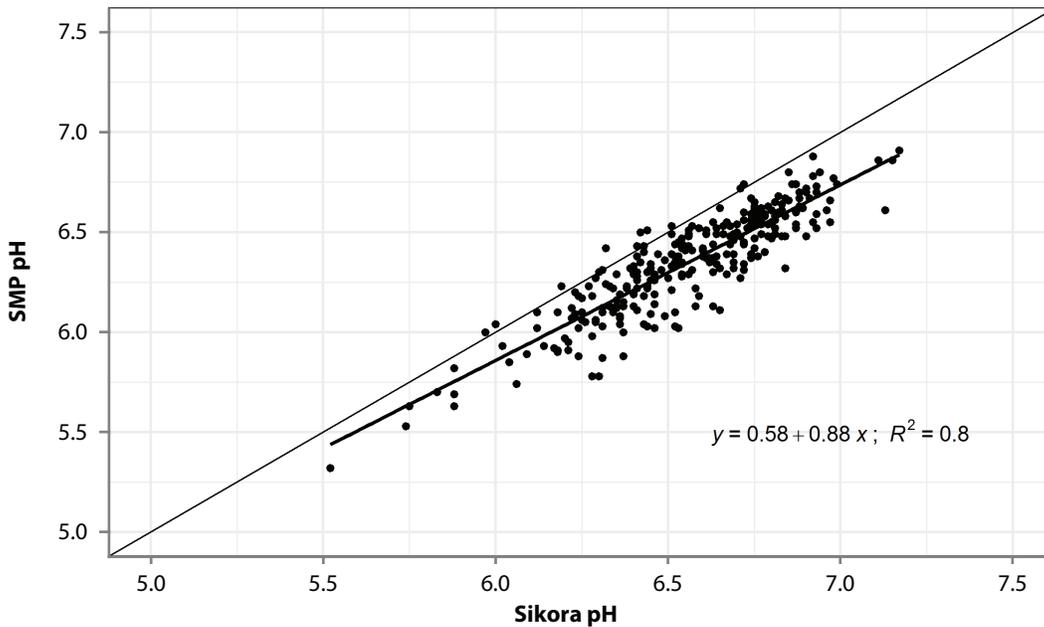


Figure 1. A strong correlation was observed between the Smith-McLean-Pratt (SMP) buffer solution and Sikora buffer pH ($r = 0.9$). On average, Sikora pH values tend to be higher than those measured using SMP and corrections will need to be made to lime recommendation equations.

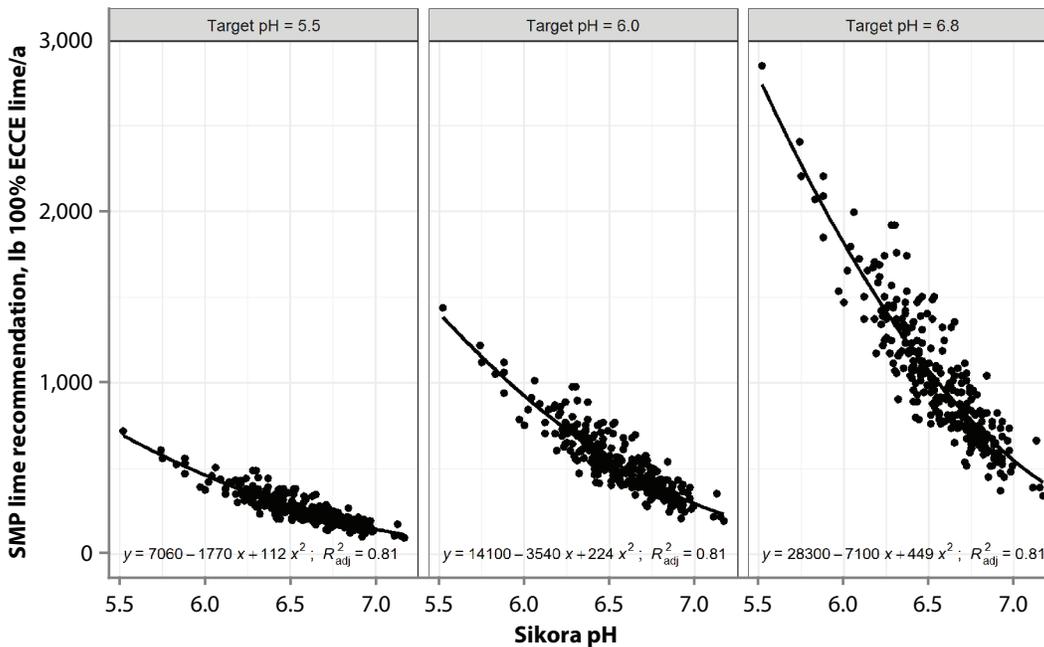


Figure 2. Lime recommendation equations for the Sikora buffer derived by regressing the Smith-McLean-Pratt (SMP) buffer solution lime recommendations against the Sikora pH values measured for each sample.