Importance of Adequate Soil pH

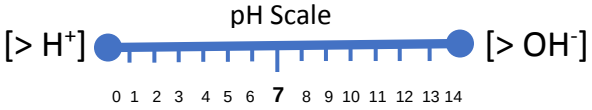
Soil pH and lime recommendations are the most widely used soil test information generated by the NCDA&CS Soil Testing Laboratory. NC soils are naturally acidic (low pH) and require adequate lime for pH management. If acidity is uncorrected, low nutrient availability and poor root growth often result in reduced yields. The pH desired for optimum root growth and nutrient availability is associated with soil class in NC as follows.

Target pH used for most crops as related to soil class by NCDA&CS soil testing.

Soil Class	Desired pH
Mineral	6.0 – 6.5
Mineral-Organic	5.5
Organic	5.0

What is pH and Measurement of Soil pH?

The concentration of hydrogen ions (H^+) in the soil is measured as pH. Remember that water is H_2O, which is essentially a combination of one H^+ ion and one OH^- ion (HOH). Pure water has a **neutral pH of 7** on the pH scale of 0 to 14. A pH less than 7 (< 7.0) is referred to as acidic (more H^+ than OH^-) and a pH greater than 7.0 (> 7.0) is alkaline or basic (more OH^- than H^+). Plants grow best when there is enough acidity to keep nutrients soluble, but without pH being too low to harm roots. Most soils in the southeastern US are acid with pH < 7.0. In the laboratory, a pH combination electrode is used along with a meter to measure H^+ ions. The meter serves as a voltmeter that measures an

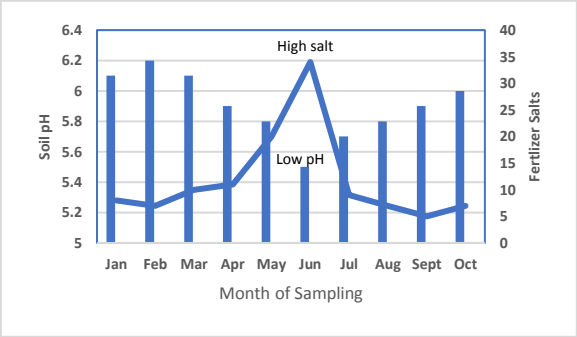


electrical current that depends on the balance of H^+/OH^- ions in a solution. The electrode and the ionic solution complete a circuit, like that of a battery.

Until recently, the standard pH method used by the NCDA&CS Soil Testing Laboratory was a 1:1, soil:water by volume ratio. One part air-dried soil (about 2 teaspoons) is mixed with one part deionized water (about 2 teaspoons) in a small plastic cup to make a slurry that equilibrates for one hour. The electrode and meter are calibrated using buffer solutions of known pH (pH 4, 7, and 10). The electrode is rinsed, placed into the soil/water slurry and stirred; after a few seconds, a reading on the meter stabilizes to supply the actual pH of the soil.

What Affects pH Measurement?

Electrodes require a certain amount of salt to operate correctly, just like a battery needs acid and salt to operate. **When dissolved salt concentrations in soil are very low, instability in the electrode occurs.** This is concerning since all fertilizers are salts and the amount of fertilizer left in the soil after plant uptake and leaching, especially in sandy soils, can vary within a growing season and from season to season. The figure below provides an example of fluctuations in pH from January through October as influenced by salt content in a NC peanut field. **Notice that soil pH (represented by bars) is generally higher when fertilizer salts (shown by line graph) are lower.**



In recent years, some growers and consultants have questioned significant, unexpected differences in pH from year to year and within growing seasons. Typically soils sampled in the early fall after a dry summer will tend to have lower pH readings than soils sampled later in the winter after significant rainfall. The differences seen are largely due to the presence or absence of fertilizer salts. How can we improve on pH measurement given this concern?

A Better Approach in pH Measurement

Measuring pH in a dilute salt solution such as 0.01 M calcium chloride ($CaCl_2$) instead of water is a way to mediate the pH salt effect. **This approach will keep the electrode more stable from the adverse effects of low salt and give a more consistent pH measurement for a given field during the year and from year to year, while still capturing any real changes in acidity.**

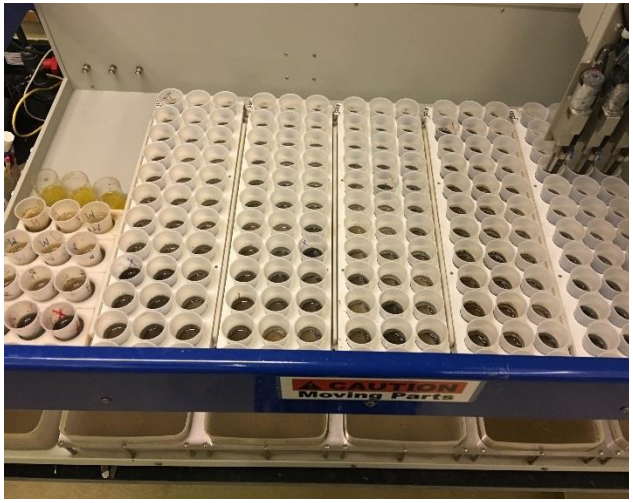
Results of North Carolina's Study of Salt pH

Results from a study of approximately 7,000 soils from three soil classes across North Carolina indicate that using the dilute salt (0.01 M $CaCl_2$) lowers the pH measurement by an average of 0.6 units. For example, a soil pH of 5.7 measured in water would result in a pH of 5.1 if measured in $CaCl_2$ solution. Our results are supported by the University of Georgia's soil testing lab that found the same 0.6 unit difference. NCDA&CS chemists have noticed significant improvement in the performance of pH electrodes/meters with this change. When compared to our previous pH method, lime recommendations with the new method: 1) will be lower when salts are high and 2) will be higher when salt levels are low.

Report and Recommendation Changes

The Soil Testing Section began measuring soil pH in a dilute salt (0.01 M $CaCl_2$) on September 5, 2017. The pH on the soil test report will be a more precise value for a given field from season to season. The reported pH has a positive adjustment of 0.6 units as determined in our study. The lime recommendation will use this reported pH (with adjustment) in the lime equation. The estimated exchangeable acidity (Ac value) that is reported remains unchanged.

The soil test report looks the same and essentially clients will not notice any change. With our new pH measurement, more consistent pH values will be given regardless of presence or absence of fertilizer salts that fluctuate seasonally with rainfall. **The result for growers will be more precise pH values and lime recommendations.**



Soil pH is being analyzed above on a pH robot which analyzes three samples at one time. The pH measurement as seen in the far right is made while the sample is gently stirred.

All fertilizers are salts as seen in the 0-0-60 residue on the soil surface above. When leaching and / or crop removal are high, lower residual salts are present in the soil. The amount of salt present in soil when soil samples are taken influences pH measurement when made in water. The pH measurement made in a weak salt solution will provide a more stable, repeatable measure of soil acidity over time regardless of residual fertilizer salts.

The Agronomic Division has 13 regional agronomists who support our services and help the agricultural industry by making farm visits. Contact your agronomist about pH or other concerns. http://www.ncagr.gov/agronomi/rahome.htm

Additional Information on Soil Testing

http://www.ncagr.gov/agronomi/sthome.htm

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Soil pH Measurement:

A New Method to Address Fertilizer Salts

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