



USING A PH METER FOR IN-FIELD SOIL PH SAMPLING

Soil Acidification Series

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FS205E

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Introduction

Soil pH continues to decline across much of the Palouse and the Pacific Northwest, primarily as a result of the application of nitrogen (N) for the production of wheat and other crops. Mahler and Harder (1984) and Veseth (1987) tried to sound the alarm that an acidic soil problem in the Pacific Northwest was developing, but little attention was given them since crop yields continued to be good.

Soil Acidity

Soil acidity is a major limitation to soil productivity in much of the world and is considered the master variable by soil chemists (McBride 1994). This acidity has a direct impact on many of the chemical and biological processes causing yield reductions in many crops (Koenig et al. 2011).

Soil pH (power of hydrogen) is the result of the buildup of hydrogen (H^+) ions in the soil solution (acid soils) or hydroxide (OH^-) ions (alkaline soils), and determines the acidity or alkalinity of soil (Horneck et al. 2007). The breadth and depth of the concentration of the H^+ ions in these layers is due to large amounts of N applications, plant nutrient uptake, and rainfall (Mahler et al. 1985).

The presence of ammonia NH_4 or ammonium NH_3 in the soil contributes to the H^+ ions from the result of the conversion to nitrate by the bacteria in the soil. This process releases H^+ ions into the soil solution. If the H^+ ions are not neutralized or bound to soil particles they remain in the soil solution creating the active acid soil environment.

Sampling Soils for Acidification

Standard soil sampling methodologies tend to overlook the problem of stratified acid soil layers that have developed in once neutral pH soils. Reduced tillage intensifies and narrows the layer of stratification compared to inversion tillage systems where more soil mixing occurs.

Inversion tillage systems experience the same rate of acidification, but the soil is mixed in a larger volume and is not as noticeable. New methods of sampling the layers or increments have been adopted to try to identify possible stratification of acidity and nutrients that may have developed.

Traditionally, determining the pH of soil samples has been a laborious and time-consuming process requiring laboratory equipment and technicians. McLean (1982) stated that soil pH is usually determined potentiometrically in a slurry system using an electronic pH meter.

Recently, the development of new technology pH meters has reduced or eliminated much of the time and expense of collecting samples and sending them to a lab to be tested. Some meters have been tested previously for accuracy in checking for soil pH, as well as some other nutrient values (Davenport and Jabro 2001), and reported that pH values were quite accurate for the soils tested. Although most of these meters are limited to pH values only, they make it possible to quickly assess the soil pH condition in the field using a pH meter probe or sensor.

Soil Testing with a pH Meter

There are many “sensors” on the market today, however most of the devices perform the same functions with few differences between them and the technology each uses. Although, there are differences in how the units are used to get good results.

When selecting a pH meter to test soil samples directly in the field, it is important to read the meter description and ask questions of the manufacturer to determine if the meter will work directly on soils in the solid state (paste-like soil samples) from a soil probe.

Only one meter was found to be suitable for direct measurement on the soil core samples; others require making a liquid solution using distilled water with the soil using equal amounts of each by volume (a ratio of 1 to 1, water and soil).

Selecting and Using a Soil Core Sample pH Meter

The price range for pH meters starts at around \$20 and can go to over \$1,000. Most meters have been developed for greenhouse use in monitoring the acidity of potted plants, where irrigation can be applied. Under these conditions managers have the potential to quickly change the acidity to maximize plant growth and development. Other low cost units are for homeowner and gardener use and are often found to not be very reliable.

A handheld sampling meter (Soil Stik) has been utilized for in-field checking of the soil pH with good results. Within a few minutes of arriving at a field location it is possible to collect a soil sample, test the soil, and record the pH values. An additional value of the Soil Stik is that samples can be checked at various depths without mixing or stirring the soil. This allows for the possible identification of layers within the soil column.

Through traditional sampling, a soil core would be collected up to 5 feet deep and the core would be separated into 1-foot increments. The top foot would be collected as one sample, as would each subsequent foot, and be sent to a lab for analysis. Each sample would be mixed thoroughly and tested as one value, losing the potential to isolate layers within the sample column.

With the aid of the pH meter it is possible to check the soil core intact and evaluate each inch or less (Figure 1). With the aid of GPS, the field sample location can be recorded for future sampling to evaluate soil pH changes.



Figure 1. Example of checking soil core at 1-inch increments using a soil pH meter. Photo: Paul Carter.

When determining where to sample within the field, carefully observe the field for abnormal plant development, plant discolorations, or areas of concern. It is best to sample soils within the same time frame each year for comparison of sample results. Spring is usually the best time as the soil is moist and easier to collect the soil sample.

Before sampling, be sure to read and follow sensor instructions for cleaning, calibration, and storage of the meter. All meters should be calibrated routinely with specific reference solutions at two points before making measurements. The first point of calibration should be at pH 7, while the other should be chosen based on the range of soil pH normally observed, either pH 4 or pH 10. A helpful [video](#) provides guidance on the setup and calibration of the ExTech Soil ExStik 110 pH meter.

After sensor calibration is complete, collect a sample and try to keep the core intact as much as possible. Moistening the soil core will help the sensor to make better contact and should produce reasonable results. Between sample readings, record results and rinse the sensor with distilled water to avoid possible contamination between readings. It may be necessary to lightly brush the sensor tip if the soil sticks and does not easily remove. A plastic toothbrush is a useful tool for this purpose and will not damage the sensor tip.

Tools and equipment needed for sample collection and soil testing include (Figure 2):

1. Water bottle
2. Paper towels
3. Yard stick, tape measure, or ruler
4. Soil probe or shovel
5. pH meter
6. Calibration liquids
7. Distilled or de-ionized water
8. Small soft brush or toothbrush for gently cleaning sensor tip
9. GPS unit
10. Paper and pencil for recording values
11. Bucket or tub (if desired)

After each reading record the numbers on a data record sheet. A sample of a data sheet is provided and can be copied for use (Figure 3).



Figure 2. Items helpful for a successful sampling event. Photo: Paul Carter.

Farm: _____

Field: _____

Sample Date: _____

Sample #	1	2	3	4	5
Depth	pH	pH	pH	pH	pH
1 inch					
2 inch					
3 inch					
4 inch					
5 inch					
6 inch					
7 inch					
8 inch					
Coordinates:					

Notes:

Figure 3. Sample data recording sheet. Developed by Paul Carter.

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