Soil pH

Water (1:1) pH

After HACH Company (1992a) and Soil Survey Staff (2014b)

Application

The 1:1 soil:water is a mixture by weight of one part to one part distilled water. It is the most commonly used method in the field because of the availability of water. Seasonal variations in soil pH can be detected with the 1:1 soil:water method, i.e., it is not used to determine family reaction classes in soil taxonomy (Soil Survey Staff, 2014a). If pH varies widely, knowledge of this variability is important because of the effect of pH on crop performance and on some other aspects of land use. Soil pH is commonly used in conjunction with EC measurements to assess salinity and sodicity. The 1:1 water pH is also a widely used criterion in soil classification (Soil Survey Staff, 2014a).

The 1:2 0.01 *M* $CaCl_2$ solution is a mixture, by weight, of one part soil to two parts 0.01 *M* $CaCl_2$ solution. The 0.01 *M* $CaCl_2$ solution dampens the seasonal variation in soil pH by providing Ca^{2+} ions that displace the hydronium and aluminum ions from the colloid surfaces. The result is a pH measurement that remains somewhat invariable to the seasonable changes in pH. Use of the $CaCl_2$ solution also diminishes the seasonal effect of soluble salt concentration. The $CaCl_2$ soil pH is generally lower than the 1:1 water pH. The combination of exchange and hydrolysis in salt solutions (0.1 to 1 *M*) can lower the measured pH from 0.5 to 1.5 units, compared to the pH measured in distilled water (Foth and Ellis, 1988). The methods described herein are after the Soil Survey Staff (2014b, methods 4C1a2a1 and 4C1a2a2, respectively) and as applied by HACH Co. (1992a).

Summary of Method

An aqueous extract (1:1) is prepared. Contents are stirred for 1 min at 10-min intervals over a 30-min period. The 1:1 pH is measured. The 0.02 *M* $CaCl_2$ (20 mL) is added to soil suspension, the sample is stirred, and the 1:2 0.01 *M* $CaCl_2$ pH is measured.

Interferences

The difference betwen the sediment pH and the supernatant pH is called the suspension effect (McLean, 1982). To maintain uniformity in pH determination, measure the pH just above the soil sediment. Clays may cause clogging and slow the electrode response.

Atmospheric CO_2 affects the pH of the soil:water mixture. Closed containers and nonporous materials will not allow equilibration with CO_2. At the time of pH determination, the partial pressure of CO_2 and the equilibrium point must be considered if critical work is being done. Refer to Appendix 9.3.1 for information about limitations and advantages of pH meters.

1:1 soil:water pH

Equipment

1. Scoop
2. Balance (portable)
3. Beakers, polypropylene, 50-mL
4. pH meter, pocket-type or handheld.
5. Gloves, disposable, chemical-resistant (e.g., NSK-24™ Chemical Resistant Nitrile Glove)
6. First-aid kit

Reagents

1. Distilled water

Procedure

1. Measure 25 g of soil sample into the 50-mL beaker. Measure 25 mL of distilled water into 25-mL graduated cylinder and transfer into the 50-mL beaker.
2. Stir contents of beaker
3. Wait 1 minute, immerse tip of calibrated pH meter 1 inch (2.5 cm) below the surface of aqueous solution extract and stir gently until soil is completely suspended. Refer to Appendix 9.3.1 on calibration of pH meter.
4. Allow readings to stabilize. Read and record 1:1 soil:water pH.

Cleanup

5. Rinse electrode with distilled water. Remove excess water by patting it dry with tissue. Allow electrode to dry. Recap and store.

Answer these questions:

Report the 1:1 soil:water to the nearest 0.1 unit:_____

Use the tables below to answer the following questions:

1. What descriptive term can be used to describe the pH of your soil sample? *Hint: see Table 1.*

   _____

2. Is your soil at an ideal pH? If not, why? *Hint: see table 2*

   _____
   _____
   _____

3. Is your soil a suitable pH for growing the following crops? *Hint: use table 3*
   Corn? _____
   Lettuce? _____
   Potatos (Sweet)? _____

Table 1.—Descriptive Terms Commonly Associated With Certain 1:1 pH Ranges (Soil Survey Division Staff, 1993).

Term	pH
Extremely acid	<4.5
Very strongly acid	4.5–5.0
Strongly acid	5.1–5.5
Moderately acid	5.6–6.0
Slightly acid	6.1–6.5
Neutral	6.6–7.3
Slightly alkaline	7.4–7.8
Moderately alkaline	7.9–8.4
Strongly alkaline	8.5–9.0
Very strongly alkaline	>9.1

Table 2.—Agronomic Interpretations (Indications and Associated Conditions) of pH Ranges (HACH Co, 1993; Ryan et al., 2001).

pH	Interpretation
pH <5.5	Soil is deficient in Ca and Mg and should be limed. Poor root growth due to low cation-exchange capacity (CEC) and possible Al^{3+} toxicity. Phosphorus deficiency is likely.
pH 5.5–6.5	Soil is low in carbonate but should be monitored. Satisfactory for many crops.
pH 6.5–7.5	Ideal range for most crops. Soil CEC is near 100%.
pH 7.5–8.4	Free carbonate present in soil. Usually excellent infiltration and percolation of water related to high Ca saturation of clays. Typically P and micronutrients less available.
pH >8.4	Typically, indicative of sodic soil. Poor soil physical conditions. Low infiltration and percolation. Possible root deterioration and organic matter dissolution.

Table 3.—Suitable Soil pH (1:1) Ranges for Selected Crops (after Whittaker et al., 1959).

Crops	Soil pH Ranges																	
	4.5		5.0		5.5		6.0		6.5		7.0			7.5				
Alfalfa																		
Alsike clover																		
Apples																		
Asparagus																		
Barley																		
Beans, lima																		
Beans, snap																		
Beans, velvet																		
Blueberries																		
Buckwheat																		
Cabbage																		
Carrots																		
Clover, crimson																		
Clover, red																		
Clover, sweet																		
Clover, white																		
Corn																		
Cotton																		
Cowpeas																		
Cucumber																		
Grasses																		
Kale																		
Lettuce																		
Mustard																		
Oats																		
Onions																		
Parsnips																		
Peas																		
Peppers																		
Potatoes, sweet																		
Potatoes, white																		
Radishes																		
Rye																		
Sorghum																		
Soybeans																		
Spinach																		
Squash																		
Strawberries																		
Sudan grass																		
Timothy																		
Tobacco																		
Tomatoes																		
Trefoil, birdsfoot																		
Vetch																		
Wheat																***10***		