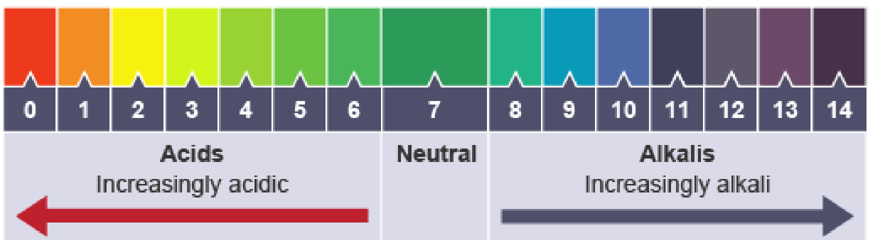
Smart Farming: Using data to make on-farm decisions

The Importance of Soil pH (I.B.i.)

How is pH measured? What affects soil pH? What can be done to adjust soil pH?

One of the pieces of data farmers can use to determine their planting decisions is a soil test. Soil tests are usually performed every two to four years. Many factors are measured, including phosphorus, potassium, calcium, magnesium and soil pH. Soil chemistry determines the amount of root growth, the amount of nutrients that can be held in the soil and the ability of plants to take in and use those nutrients. But why is pH important and what are the consequences of different levels of pH?

The measurement of pH is measured on a scale of 1-14, where the lower numbers represent acids, which have more hydrogen ions (H^+), and the higher numbers represent bases, which have more hydroxide ions (OH^-). A measure of 7 is neutral. The scale is logarithmic, meaning that the difference between a pH of 5 is ten times more acidic than a measure of 6, a measure of 9 is ten times more basic than a measure of 8, and so on.

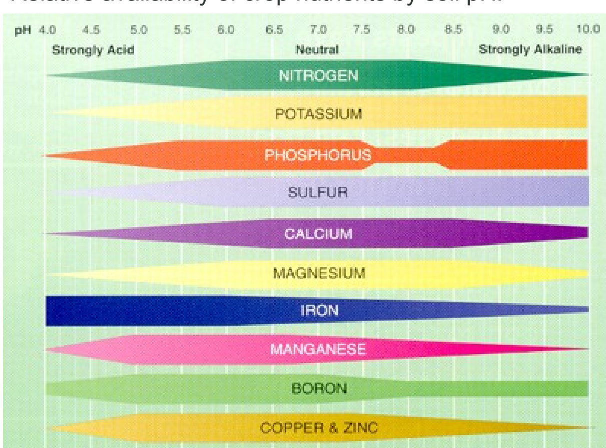


Taken from: http://www.bbc.co.uk/education/guides/z89jq6f/revision

Why is pH important to crops?

The level of pH will affect the availability of nutrients. Some nutrients are less available when the pH is too low or too high. In addition, if certain nutrients are too abundant, they may inhibit the availability of other nutrients.

Relative availability of crop nutrients by soil pH.



http://articles.extension.org/pages/13064/soil-ph-modification

Nutrient in excess	Induced deficiency
Nitrogen (N)	K
Phosphorus (P)	Cu
Potassium (K)	N, Ca, Mg
Sodium (Na)	K, Ca, Mg
Calcium (Ca)	Mg, Boron (B)
Magnesium (Mg)	Ca
Iron (Fe)	Mn
Manganese (Mn)	Fe
Copper (Cu)	Fe

http://ipm.uconn.edu/documents/raw2/html/546.php?aid=546

The recommended pH for soybean growth is 6.6-7.0. For crop production in general, pH for optimal uptake of phosphorus and potassium should be in the 6.0-6.6 range. When nitrogen is assimilated (taken into a plant), the pH will be reduced, making the soil more acidic. These interactions are complex and make determining an adjustment to pH difficult. In addition, readings across a field can vary widely. That is why it is important to have soil test data to help in making a decision.

Measuring pH

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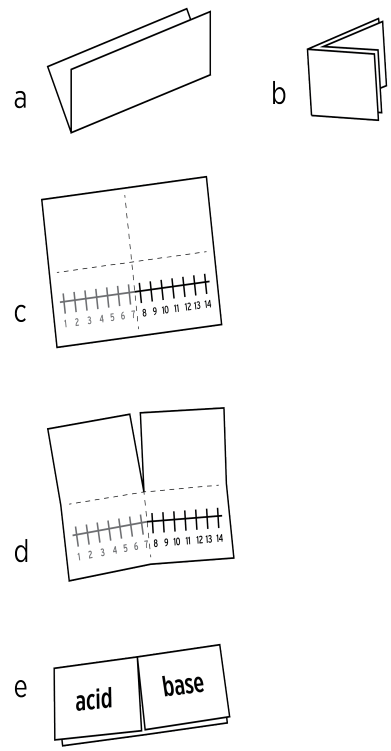
Materials

colored pencils: red, yellow, blue, green
1 sheet of blank paper for each student
Universal Indicator (label from bottle for color coding of pH numbers on the scale)
Lab AIDS trays for testing substances
Various substances to test: citrus juices, white vinegar, detergent, diluted bleach, ammonia cleaners, liquid fertilizers, soil solution, etc.
Soils from various locations

Procedure

1. Make a “foldable' graphic organizer: Follow steps a-e
   a) Fold the blank sheet of paper in half like a hot dog.
   b) Fold the hot dog in half lengthwise.
   c) Unfold. On the inside bottom half of the hotdog, draw a number line and number it from 1-14 using the following key: 1-6 should be red, 8-14 should be blue. (7 should be on the center fold of the hot dog.) As an extension, use the color scale on Universal Indicator to color code numbers.
   d) Cut the top half of the hotdog along the center fold. Only cut up to the long fold line.
   e) On the half of the flap over the numbers 1-7, label the flap ACID. On the half of the flap over the numbers 7-14, label the flap BASE.



2. Test various substances by adding one drop of the substance plus one drop of Universal Indicator in the Lab AIDS tray. Use the scale from the Universal Indicator bottle to assign a pH number. Add notes or pictures of the substances on the inside of the flap near the pH number indicated when they are tested.
3. Collect soil samples from various areas around the school. Allow each sample to soak in water overnight in a mixture at a ratio of 1 part soil to 5 parts water. Test the soil sample by using one drop of the soil solution and adding one drop of Universal Indicator. Compare the samples.

Reflection

1. Compare readings obtained by multiple groups for the same substances. How accurate are the readings obtained for each substance?
2. What is a limitation of this method of testing pH?
3. How might pH readings affect what decisions a farmer makes? Look up the pH recommendations for various crops.

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How does soil become acidic or basic? How does rainfall make soils acidic?

Nutrients, macronutrients and micronutrients are needed in differing amounts throughout a plant's growth. The pH of the soil can affect whether the nutrients are available to the plant when needed. The proportion of cations (charged particles) determines soil pH. If there are more acidic cations present than basic cations, the soil will be acidic with a lower pH.

Pure water (H_2O) is neutral because the H^+ and OH^- ions are each equivalent to 10^{-7}M (M=molarity or moles/liter). As rain falls through the atmosphere, carbon dioxide dissolves in the water, resulting in this reaction: $H_2O + CO_2$ Nj $H^+ + HCO_3^-$ The resulting pH of rain water is ~5.7, creating a source of acidic solution that will weather rock materials to help in soil formation. Burning fossil fuels add more acidic compounds such as sulfur dioxide and various nitrogen dioxides that make rain even more acidic.

Acidic cations	Basic cations
AL^{+3}	Ca^{+2}
H^+	Mg^{+2}
Fe^{+3}	Na^+
	K^+

1. Describe how the soil would become basic (or have a higher pH).

2. If soil pH is not between 6.5 and 7, plants may have trouble absorbing the nutrients they need. How did your soil samples (tested above) compare in terms of providing plants with the best chance to absorb nutrients?

How do farmers correct soil pH?

Farmers do soil testing within a field every 2-4 years. This data helps them to make decisions about how to manage soil pH. Soil pH is not a stand-alone measurement. The pH needs to be reviewed with regard to the buffer pH measure (how much potential acidity needs to be neutralized), the amount of nutrients in the soil, and the crop to be planted. This data is contained in a soil test report. Liming is a regular practice farmers use to adjust the pH of the soil. Lime is made from crushed limestone, a rock formed from precipitates or sediment that has a basic pH. (See “Soil Acidity and Liming for Agronomic Production,” an OSU Extension Newsletter for more information.)

1. Read “Soil Acidity and Liming for Agronomic Production,” (https://ohioline.osu.edu/factsheet/AGF-505-07) an OSU Extension Newsletter.
2. Divide the fields between student groups and assume fields 6 and 11 will be planted next year with corn while fields 7, 8A and 12B will be planted next with soybeans.
3. Look at the data for each field. Notice the range of pH measures. Look at the Buffer pH. Is there a need to add lime to any of these fields? If so, what type (look at Magnesium levels) and how much?

Go to the Decision Tracker (row I.B.i.) to determine what action you will take [1-yes (variable rate), 0.5 (same rate across the field), 0-none]