Unit D: pH of Soil

Lesson : Identifying the pH Changes in Soil

KEY TERMS

Soil pH

Acid

Lime Requirement

I. The pH scale measures how acidic or basic a substance is.

A. It ranges from 0 to 14.

1. A pH of 7 is neutral.

a. A pH less than 7 is acidic.

b. A pH greater than 7 is basic.

2. Each whole pH value below 7 is ten times more acidic than the next higher value.

a. For example a pH of 4 is ten times more acidic than a pH of 5 and 100 times (10 times 10) more acidic than a pH of 6.

3. The same holds true for pH values above 7, each of which is ten times more alkaline—another way to say basic—than the next lower whole value.
    a. For example a pH of 10 is ten times more alkaline than a pH of 9.
4. Pure water is neutral, with a pH of 7.0.
    a. When chemicals are mixed with water, the mixture can become either acidic or basic.
    b. Vinegar and lemon juice are acidic substances, while laundry detergents and ammonia are basic.

B. **Soil pH** is a measure of the acidity or alkalinity in the soil. It is also called soil reaction.
   1. It indicates whether a soil could contain toxic levels of aluminum and manganese, whether it may be low in bases such as calcium and magnesium, and therefore if lime is needed.
   2. The availability of other essential plant nutrients is also affected by pH.
      a. Therefore, knowing a soil's pH may help in diagnosing nutritional problems of agricultural crops and other plants.
      b. Soil pH is one of the most important measurements of soil fertility.

3. The most common classes of soil pH are:

Extremely acid	3.5 – 4.4
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

4. Soil pH influences the solubility of nutrients.
    a. It also affects the activity of micro-organisms responsible for breaking down organic matter and most chemical transformations in the soil
    b. Soil pH thus affects the availability of several plant nutrients.
5. A pH range of 6 to 7 is generally most favorable for plant growth because most plant nutrients are readily available in this range.
    a. However, some plants have soil pH requirements above or below this range.

6. Soils that have a pH below 5.5 generally have a low availability of calcium, magnesium, and phosphorus. At these low pH's the solubility of aluminum, iron, and boron is high; and low for molybdenum.

7. At pH 7.8 or more, calcium and magnesium are abundant. Molybdenum is also available if it is present in the soil minerals. High pH soils may have an inadequate availability of iron, manganese, copper, zinc, and especially of phosphorus and boron.

8. The pH of a soil should always be tested before making management decisions that depend on the soil pH.

II. pH is determined by the concentration of hydrogen (H+) ions and hydroxyl ions (OH–) in the soil solution.

A. A sample of pure water has an equal number of H+ and OH– and is neutral.

B. An ***acid*** is a substance that releases hydrogen ions. When saturated with H+, a soil behaves as a weak acid. The more H+ held on the exchange complex, the greater the soils acidity.

C. Soil pH measures H+ activity and is expressed in logarithmic terms.

D. The practical significance of the logarithmic relationship is that each unit change in soil pH means a ten-fold change in the amount of acidity or alkalinity.

E. A soil with a pH of 6.0 has 10 times as much active H+ as one with a pH of 7.0.

III. Several factors influence soil pH.

A. Soil organic matter is continuously being decomposed by microorganisms into organic acids, carbon dioxide, and water, forming carbonic acid. Carbonic acid reacts with Ca and Mg carbonates in the soil to form more soluble bicarbonates, which are leached away, leaving the soil more acid.

B. Soils developed from parent material of basic rocks generally have higher pHs than those formed from acid rocks.

C. As water from rainfall passes through the soil, basic nutrients such as calcium and magnesium are leached. They are replaced by acidic elements including aluminum, hydrogen, and manganese. Soils formed under high rainfall conditions are more acidic than those formed under arid conditions.

D. Soils formed under forest vegetation tend to be more acidic than those developed under grasslands.

E. Soils often become more acidic when crops are harvested because bases are removed. Legumes generally contain higher levels of bases than grasses. Legumes also release H+ ions into their rhizosphere when actively fixing atmospheric N.

F. Except in low rainfall areas, acidity generally increases with depth, so the loss of topsoil by erosion can lead to a more acid pH in the plow layer. The reason is that more subsoil is included in the plow layer.

G. Nitrogen from fertilizer, organic matter, manure, and legume N fixation produces acidity. Nitrogen fertilization speeds up the rate at which acidity develops. At lower N rates, acidification rate is slow, but is accelerated as N fertilizer rates increase.

H. The overall effect of submergence is an increase of pH in acid soils and decrease in basic soils. Regardless of the their original pH values, most soils reach pHs of 6.5 to 7.2 within one month after flooding, and remain at that level until dried.

IV. Soil pH Determination

A. One method to determine soil pH is by using a pH indicator dye. It is easy to use and gives a suitable pH value for most soils.

1. The indicator dye is added to the soil in the spot plate until it is saturated. The solution is stirred using a small spatula.
    a. The solution will change color depending on the soil pH.
    b. The solution color is compared to a color card that has been calibrated to various pH readings.
    c. Indicators are frequently used in the field to make a rapid pH determination and must be used by a trained hand to avoid major error.


Wide Range of pH Test Paper - pH 1 to 14
Compare color within 30 seconds
pH1 2 3 4 5 6 7
pH8 9
WIDE RANGE INDIC
FOR LABORATORY USE ONLY

B. The more accurate and widely used method is the pH meter used in soil testing laboratories.
   1. The soil pH meter is an electronic device that can be hooked to a pH sensitive electrode. When the electrode is immersed in a soil solution the pH meter will indicate the pH of the soil.
   2. Measurement of soil pH is very important - but in no way it is easy.
      a. Soil can be dry, and the pH electrode needs to be immersed to work.
      b. pH electrodes are very fragile so they can't be hammered into the ground.

3. A widely accepted method is to take a sample of the soil, crush any clumps, and close it in a jar filled with distilled water.
    a. After some vigorous shaking sample should be left for 5 to 10 minutes to let all soluble substances to dissolve and to let all hard parts to sediment.
    b. Then pH of the solution above sediment is measured in a standard way and called "soil pH".
    c. When pH is measured, only active acidity in the soil water is determined. Potential acidity not found in soil water, which can be held by the soil, clay, and organic matter, must also be considered.

Close up picture of the soil pH meter.

V. ***Lime requirement*** is the amount of agricultural limestone needed to establish the desired pH range for the cropping system being used.

A. Lime raises the pH of soil, i.e. makes it less acidic.

1. Lime is added to "sweeten" the soil.
2. In areas where the soil is sandy, lime is often added to make the soil less acidic for crops like corn and beans.

B. **T**he most common liming materials are calcitic or dolomitic agricultural limestone.

1. These are natural products made by finely grinding natural limestone.
2. Since natural limestone is relatively insoluble in water, agricultural limestone must be very finely ground so it can be thoroughly mixed with the soil and allowed to react with the soil's acidity.

3. Other soil liming materials that may be used but are not as effective include:
    a. Wood Stove ashes
    b. Fire Place ashes
    c. Boiler Wood ashes

C. Do NOT over-lime!
    1. Lime adjusts soil chemistry, it is not a fertilizer.
    2. A little too much can raise pH to undesirable levels and keep it there, causing serious management problems.
    3. Make certain you know how much lime is needed, then apply it over a number of seasons until your soil is back in balance.

VI. Aluminum Sulfate can be used to lower the pH, to make it more acidic.
    1. This would be used in soils that are basic and you are trying to grow Azaleas, Rhododendrons, Junipers, Hydrangeas, Pines and other acid loving plants.

REVIEW/SUMMARY

1. What does soil pH mean?
2. Explain how to determine the pH level in a soil?
3. What are some of the factors that determine the pH level in a soil?
4. How can we measure the pH level in a soil?