ANIMAL, PLANT & SOIL SCIENCE

D3-2

SOIL CHEMISTRY

Interest Approach

- **Approach One:** Show students different soil samples. Ask what makes one soil better than another. Encourage discussion that focuses on reasons why one soil is better than another. Guide the group discussion toward soil fertility.

Interest Approach

- **Approach Two:** Using a magnet and pieces of metal, demonstrate the attraction the magnet has for the metal pieces. Explain to the students that soil, plant roots, and plant nutrients are very similar to the magnet and metal, in that there is an attraction between soil and plant roots for plant nutrients. Lead a class discussion on the exchange of nutrients in the soil solution.

Objectives

- 1 **Describe the meaning and importance of soil fertility.**
- 2 **Define pH and discuss its role in plant nutrition.**
- 3 **Explain the role of soil reaction (pH) and liming in soil chemistry.**
- 4 **Explain the role of soil colloids, ions, and the cation exchange capacity (CEC) in soil chemistry.**
- 5 **Explain the role of organic matter, soil depth, surface slope, soil organisms, and nutrient balance in soil productivity.**
- 6 **Describe environmental conditions that influence nutrient deficiencies.**

Terms

- acid
- anion
- cation
- cation exchange capacity
- colloids
- ion
- lime requirement
- pH
- soil depth
- soil fertility
- soil organic matter
- soil pH

What is the meaning and importance of soil fertility?

- I. ***Soil fertility*** is the ability of a soil to provide nutrients for plant growth.

- A. Soil fertility involves the storage of nutrients and refers to the availability of those nutrients for plants. Soil fertility is vital to a productive soil. A fertile soil is not necessarily a productive soil. Poor drainage, insects, drought, and other factors can limit production, even when fertility is adequate.

What is the meaning and importance of soil fertility?

- B. Existing soil-plant relationships affect soil productivity. External factors control plant growth: air, heat (temperature), light, mechanical support, nutrients, and water. The plant depends on the soil, at least partly, for all these factors, except light. Each directly affects plant growth and is linked to the others.

What is the meaning and importance of soil fertility?

- C. Since water and air occupy the pore spaces in the soil, factors that affect water relationships necessarily influence soil air. Moisture change affects soil temperature.

What is the meaning and importance of soil fertility?

- D. Nutrient availability is influenced by soil and water balance as well as by soil temperature. Root growth is influenced by soil temperature as well as by soil, water, and air.

SIXTEEN ESSENTIAL PLANT ELEMENTS

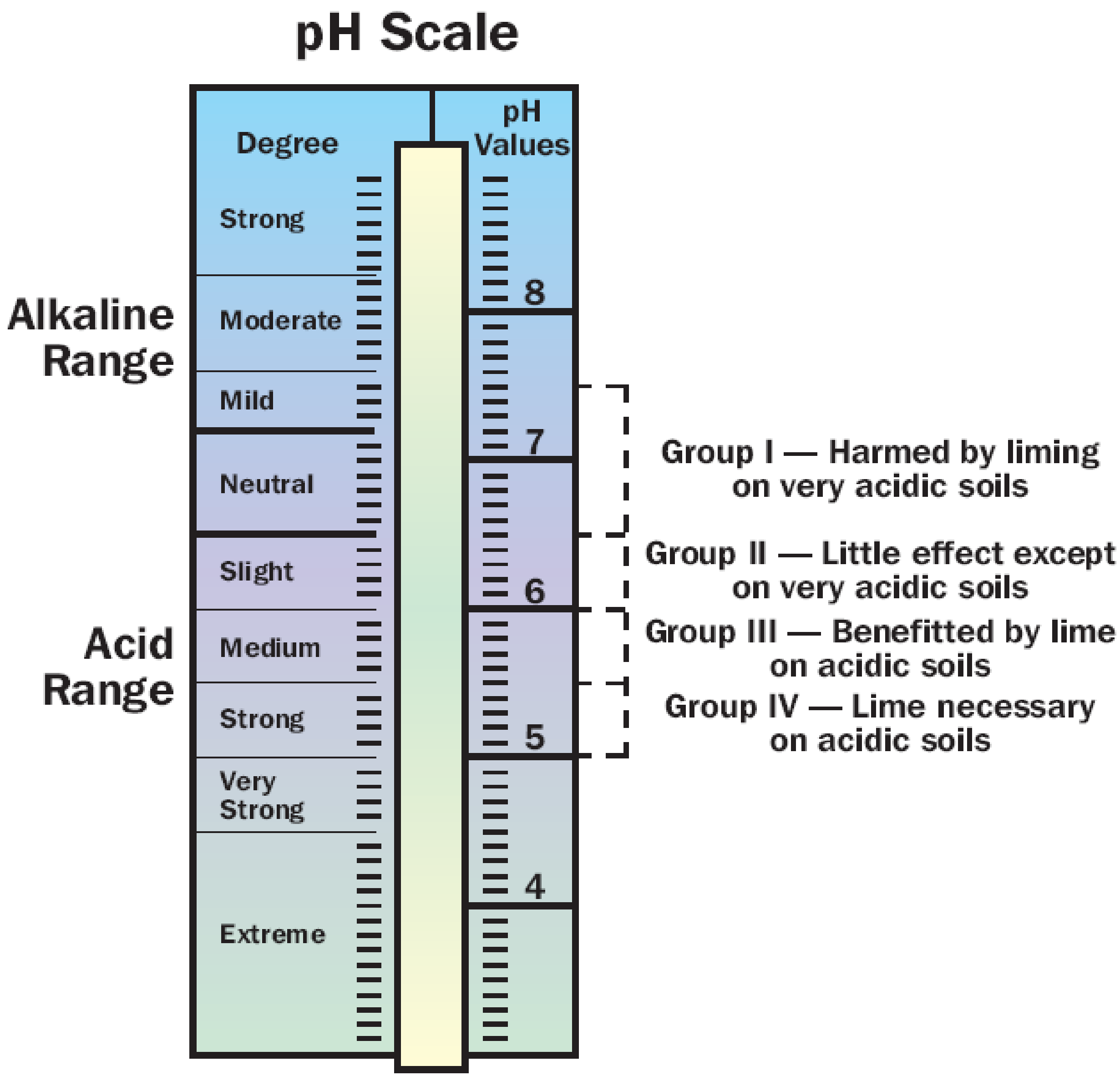
Periodic Table of the Elements

1a	2a	3a	4a	5a	6a	7a	8a			1b	2b	3b	4b	5b	6b	7b	8b
1 H																	2 He
3 Li	4 Be											**5 B**	**6 C**	**7 N**	**8 O**	9 F	10 Ne
11 Na	**12 Mg**					Transition Elements						13 Al	14 Si	**15 P**	**16 S**	**17 Cl**	18 Ar
19 K	**20 Ca**	21 Sc	22 Ti	23 V	24 Cr	**25 Mn**	**26 Fe**	27 Co	28 Ni	**29 Cu**	**30 Zn**	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	**42 Mo**	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 X
55 Ca	56 Ba	57-71 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89 Ac	90 Th	91 Pa	92 U												

What is pH and what role does it play in plant nutrition?

- II. ***Soil pH*** is the measure of acidity or alkalinity of the soil.
- A. A 14-point scale is used to measure pH. A neutral pH is 7.0.
- 1. Any reading between 0.0 and 7.0 indicates an acid. A pH of 1.0 indicates a very acidic solution, and 6.0 is considered slightly acidic.
- 2. A solution with a pH between 7.0 and 14.0 is alkaline, or basic. A pH of 8.0 is slightly basic, whereas a reading of 14 indicates a strong base.
- 3. Most productive soils range from 4.0 to 9.0 in pH.

SOIL pH


pH Scale
Degree
pH Values
Alkaline Range
Strong
Moderate
Mild
Neutral
Acid Range
Slight
Medium
Strong
Very Strong
Extreme
8
7
6
5
4
Group I — Harmed by liming on very acidic soils
Group II — Little effect except on very acidic soils
Group III — Benefitted by lime on acidic soils
Group IV — Lime necessary on acidic soils

What is pH and what role does it play in plant nutrition?

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

- 1. A sample of pure water has an equal number of H+ and OH- and is neutral.
- 2. 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 soil's acidity.

What is pH and what role does it play in plant nutrition?

- 3. Soil pH measures H+ activity and is expressed in logarithmic terms.
- 4. The practical significance of the logarithmic relationship is that each unit change in soil pH means a 10-fold change in the amount of acidity or alkalinity.
- 5. A soil with a pH of 6.0 has 10 times as much active H+ as one with a pH of 7.0.

What is pH and what role does it play in plant nutrition?

- C. Several factors influence soil pH.

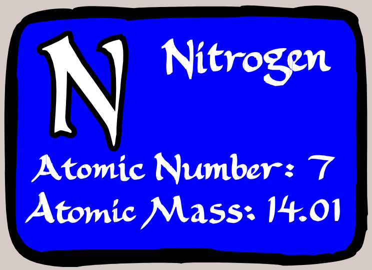
- 1. Soil organic matter is continuously being decomposed by microorganisms into organic acids, carbon dioxide, and water, forming carbonic acid. Carbonic acid reacts with calcium (Ca) and magnesium (Mg) carbonates in the soil to form more soluble bicarbonates that are leached away, leaving the soil more acidic.
- 2. Soils developed from parent material of basic rocks generally have higher pHs than those formed from acid rocks.

What is pH and what role does it play in plant nutrition?

- 3. As water from rainfall passes through the soil, basic nutrients, such as Ca and Mg, 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.

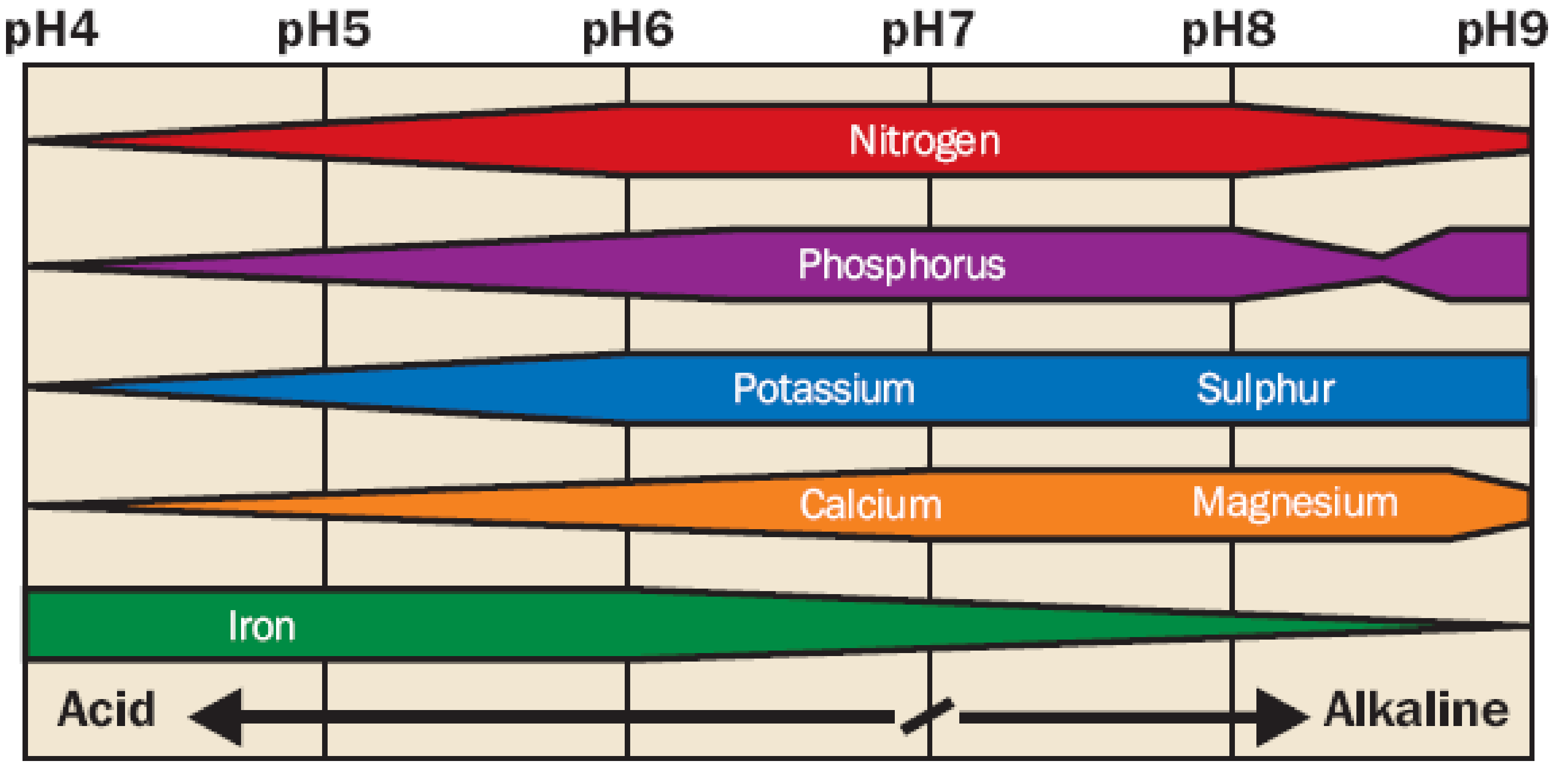
- 4. Soils formed under forest vegetation tend to be more acidic than those developed under grasslands.

What is pH and what role does it play in plant nutrition?



- 7. 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.
- 8. The overall effect of submergence is an increase of pH in acidic soils and a 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.

SOIL PH AND PLANT NUTRIENTS



Availability of plant nutrients to plants increases as the width of the bar increases.

What is the role of soil reaction (pH) and liming in soil chemistry?

- III. Soil pH is a critical aspect of crop production. As such, it should be measured. A determination of lime requirements is also necessary.

- A. The two most commonly accepted methods of measuring soil pH are indicator dyes and the pH meter.

- 1. 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.
- 2. The more accurate and widely used method is the pH meter used in soil-testing laboratories.

What is the role of soil reaction (pH) and liming in soil chemistry?

- B. Soil pH is an excellent single indicator of soil acidity, but it does not determine lime requirement.

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

What is the role of soil reaction (pH) and liming in soil chemistry?

- 2. When pH is measured, only active acidity in the soil water is determined. Potential acidity or that held by the soil, clay, and organic matter must also be considered.
- 3. Lime requirement of a soil is not only related to the pH but also to its buffer capacity or cation exchange capacity (CEC).

What is the role of soil reaction (pH) and liming in soil chemistry?

- C. Total amounts of clay and organic matter in a soil, as well as the kind of clay, will determine how strongly soils are buffered or how strongly they resist a pH change.
- 1. Buffering capacity increases with the amounts of clay and organic matter.
- 2. These types of soils require more lime to increase pH than soils with a lower buffer capacity.

What is the role of soil reaction (pH) and liming in soil chemistry?

- 3. The process and reactions by which lime reduces soil acidity are very complex.
- 4. The principal source of H^+ in most soils of a pH below 5.5 is the reaction of aluminum (Al) with water, as shown by the following equation:

$$Al^{+3} + H_2O \quad Al(OH)^{+2} + H^+$$

This reaction releases H^+ (acidification) which in turn increases the amount of Al^{+3} ready to react again.

What is the role of soil reaction (pH) and liming in soil chemistry?

- D. Lime reduces soil acidity (increases pH) by converting some of the H^+ into water. Above pH 5.5, Al precipitates as $Al(OH)_3$. Thus, its toxic action and the main source of H^+ are eliminated.

- 1. Ca^{+2} ions from the lime replace Al^{+3} at the exchange sites and the carbonic ion (CO_3^{-2}) reacts in the soil solution, creating an excess of OH^- ions that react with the H^+ (excess acidity), forming water.
- 2. The reverse of the process can also occur. An acidic soil can become more acidic if a liming program is not followed.

What is the role of soil reaction (pH) and liming in soil chemistry?

- E. General statements concerning the frequency of liming are probably unwise because of the many factors involved. The best way to determine liming is to soil test. The following factors will influence frequency of liming.

- 1. Soil texture—Sandy soils must be limed more often than clay soils.
- 2. Rate of N fertilization—High rates of ammonium N generate considerable acidity.

What is the role of soil reaction (pH) and liming in soil chemistry?

- 3. Rate of crop removal—Legumes remove more Ca and Mg than non-legumes.
- 4. Amount of lime applied—Higher application rates usually mean the soil need not be limed as often. Do not overlime.
- 5. pH range desired—Maintenance of a high pH usually means that lime must be applied more frequently than when an intermediate pH is satisfactory. Often, the desired pH range is not reached because of underliming, poor quality lime (coarse particles), or incomplete mixing.

What is the role of soil reaction (pH) and liming in soil chemistry?

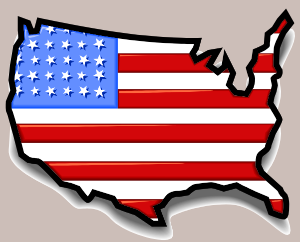
- F. When selecting a liming material, check its neutralizing value, its degree of fineness, and its reactivity.

- 1. Neutralizing values of all liming materials are determined by comparing them to the neutralizing value of pure calcium carbonate ($CaCO_3$).
- 2. Setting the neutralizing value of $CaCO_3$ at 100, a value for other materials can be assigned. This value is called a relative neutralizing value or calcium carbonate equivalent.

What is the role of soil reaction (pH) and liming in soil chemistry?

- 3. When a given quantity of lime is mixed with the soil, its reaction rate and degree of reactivity are affected by particle size. Coarse lime particles react more slowly and less fully. Fine lime particles react more rapidly and much more completely.
- 4. Cost of lime increases with the fineness of grind. The goal is a material that requires a minimum of grinding, yet contains enough fine material to cause a rapid pH change.
- 5. Agricultural liming materials contain both coarse and fine particles.

What is the role of soil reaction (pH) and liming in soil chemistry?



- G. Some states require a certain percentage of lime to pass through certain mesh sizes to guarantee the lime will be of sufficient quality to neutralize acidity.

- 1. Although lime reaction rate depends on particle size, initial pH, and degree of mixing with the soil, the chemical nature of the liming material itself is an important consideration.
- 2. Calcium oxide and calcium hydroxide react more quickly than calcium carbonate. Hydrated lime can react so quickly it can partially sterilize the soil.

What is the role of soil reaction (pH) and liming in soil chemistry?

- H. Another important factor determining the effectiveness of lime is placement. Placement for maximum contact with the soil in the tilled layer is essential.

- 1. Most common liming materials are only slightly soluble in water, so distribution in the soil is a must for lime reaction.
- 2. Even when properly mixed with the soil, lime will have little effect on pH if the soil is dry. Moisture is essential for lime-soil reaction to occur.

What is the role of soil reaction (pH) and liming in soil chemistry?

- I. Types of liming materials

- 1. Calcium oxide (CaO)—Also known as unslaked lime, burned lime, or quicklime, CaO is a caustic white powder, disagreeable to handle. It is manufactured by roasting calcitic limestone in an oven or furnace. When added to the soil, it reacts almost immediately. Thus, when rapid results are required, CaO is ideal.

What is the role of soil reaction (pH) and liming in soil chemistry?

- 2. Calcium hydroxide [Ca(OH)2]—Frequently referred to as slaked lime, hydrated lime, or builder's lime, Ca(OH)2 is a caustic, white, powdery substance, difficult and unpleasant to handle. It is prepared by hydrating CaO. Acid neutralization occurs rapidly when it is added to the soil.
- 3. Calcitic limestone (CaCo3) and dolomitic limestone [CaMg(CO3)2]—These materials are mined by open-pit methods that are widespread throughout the United States. Quality depends on the impurities, such as clay, that they contain.

What is the role of soil reaction (pH) and liming in soil chemistry?

- 4. Marl—Marls are soft, unconsolidated deposits of CaCO3, occurring in many areas. They are mined by dragline or power shovel after the overburden has been removed. Marls are almost always low in Mg, and their liming value is inversely related to the amount of clay they contain.

What is the role of soil reaction (pH) and liming in soil chemistry?

- 5. Slags—Several types of materials are classified as slags.
  - a. Blast-furnace slag is a byproduct of the manufacture of pig iron.
  - b. Basic slag is a product of the basic open-hearth method of making steel from pig iron and is generally applied for its phosphorus (P) content rather than for its value as a liming material.

What is the role of soil reaction (pH) and liming in soil chemistry?

- c. Electric-furnace slag results from the reduction of phosphate rock in the preparation of elemental P. It is a waste product, usually marketed at a low price within a limited radius of production point.
- d. Stack dust is a byproduct of cement production and contains a mixture of compounds, including CaO, CaCO3, potassium oxide (K2O), potassium carbonate (K2CO3), and other materials. The material is very finely divided and difficult to handle. Small particle size makes this an ideal product for use in fluid suspensions.
- e. Water-softening sludge is a byproduct of municipal water softening plants or industrial boiler feedwater treatments. It is largely calcium carbonate, very finely divided, usually wet, and often discarded as a waste.

What is the role of soil reaction (pH) and liming in soil chemistry?

- J. High pH soils: calcareous, saline, and alkali (sodic)

- 1. Many soils in arid climates have high pHs that can affect their properties and influence productivity. They do not require lime, but their high pHs do affect nutrient availability, soil fertility, and fertilizer management.
- 2. Calcareous soils contain free calcium carbonate and undissolved lime, with pHs generally ranging from 7.3 to 8.4.

What is the role of soil reaction (pH) and liming in soil chemistry?

- K. The presence of free lime influences some management practices, such as herbicide use, P placement (because of fixation), and micronutrient availability.

- 1. Lowering the pH is not usually economical.
- 2. With proper management, these are some of our most productive soils.
- 3. Saline soils contain salts in quantities high enough to limit crop growth because plants cannot take up sufficient water to function properly.

What is the role of soil reaction (pH) and liming in soil chemistry?

- 4. Crops differ in their salt tolerance. A good management practice is to select those crops known to be salt-tolerant. These soils usually have a pH of less than 8.5.
- 5. Sodic (alkali) soils contain excessive amounts of sodium (Na) on the soil CEC sites.
- 6. Soils are usually classified as alkali if Na saturation exceeds 15 percent of the CEC and usually have pH values of 8.5 and above. Excess Na disperses the soil, limiting movement of air and water because of poor physical properties.

What is the role of soil colloids, ions, and the cation exchange capacity (CEC) in soil chemistry?

- IV. As soils are formed during the weathering process, some minerals and organic matter are broken down to extremely small particles.

- A. Chemical changes further reduce these particles until they cannot be seen with the naked eye. The very smallest are called ***colloids.***

- 1. Colloids are primarily responsible for the chemical reactivity in soils.
- 2. Mineral clay colloids are plate-like in structure and crystalline in nature. In most soils, clay colloids exceed organic colloids in amount.

What is the role of soil colloids, ions, and the cation exchange capacity (CEC) in soil chemistry?

- 3. The kind of parent material and the degree of weathering determine the kinds of clays present in the soil.
- 4. Each colloid, clay and organic, has a negative (-) charge, developed during the formation process. It can attract and hold positively (+) charged particles, as unlike poles of a magnet attract each other. Colloids repel other negatively charged particles, as like poles of a magnet repel each other.

What is the role of soil colloids, ions, and the cation exchange capacity (CEC) in soil chemistry?

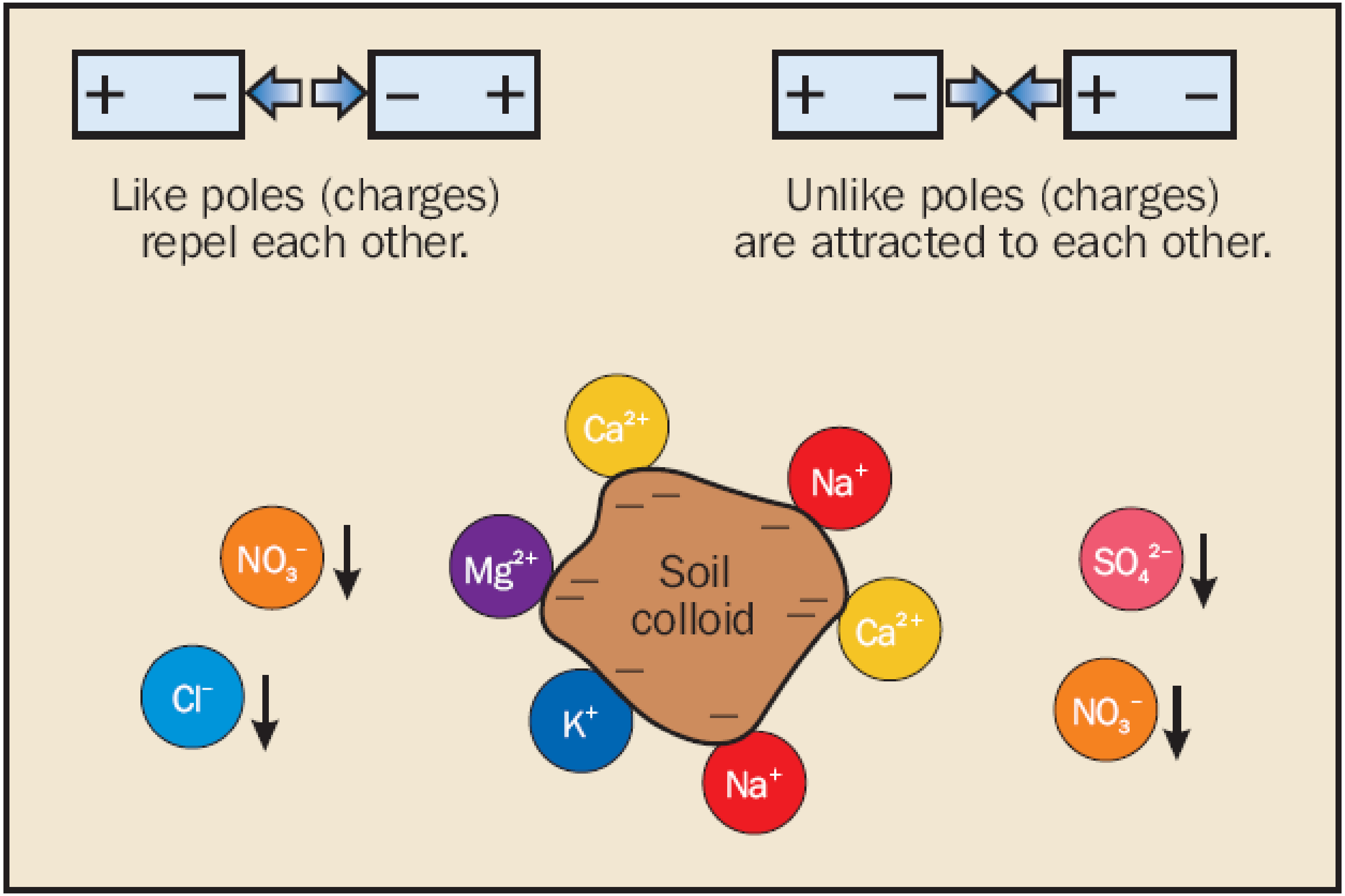
- B. An element with an electrical charge is called an ***ion.***

- 1. An ion with a positive charge is called a ***cation.*** It is written in the ionic form. Examples are potassium (K^{+}), sodium (Na^{+}), hydrogen (H^{+}), calcium (Ca^{+}), and magnesium (Mg^{++}).
- 2. An ion with a negative charge is called an ***anion.*** Examples are chlorine (Cl^{-}), nitrate (NO_3^{-}), sulfate (SO_4^{-2}), and phosphate ($H_2PO_4^{-}$).

What is the role of soil colloids, ions, and the cation exchange capacity (CEC) in soil chemistry?

- 3. Negatively charged colloids attract cations and hold them like a magnet holding small pieces of metal.
- 4. This characteristic explains why nitrate, which has a negative charge, is more easily leached from the soil than ammonium nitrate, which has a positive charge. Nitrate is not held by the soil but remains as a free ion in the soil water. It may be leached through the soil profile in some soils under certain rainfall conditions.

NEGATIVELY CHARGED COLLOIDS ATTRACT CATIONS



What is the role of soil colloids, ions, and the cation exchange capacity (CEC) in soil chemistry?

- C. Cations held by soils can be replaced by other cations. This means they are exchangeable. The total number of exchangeable cations a soil can hold (the amount of its negative charge) is called its ***cation exchange capacity***, or CEC.
- 1. The higher a soil's CEC, the more cations it can retain.
- 2. The CEC depends on amounts and kinds of clay and organic matter present. A high-clay soil can hold more exchangeable cations than a low-clay soil. CEC increases as organic matter increases.
- 3. The CEC of a soil is expressed in terms of milligram equivalents per 100 grams of soil and is written as meq/100g.

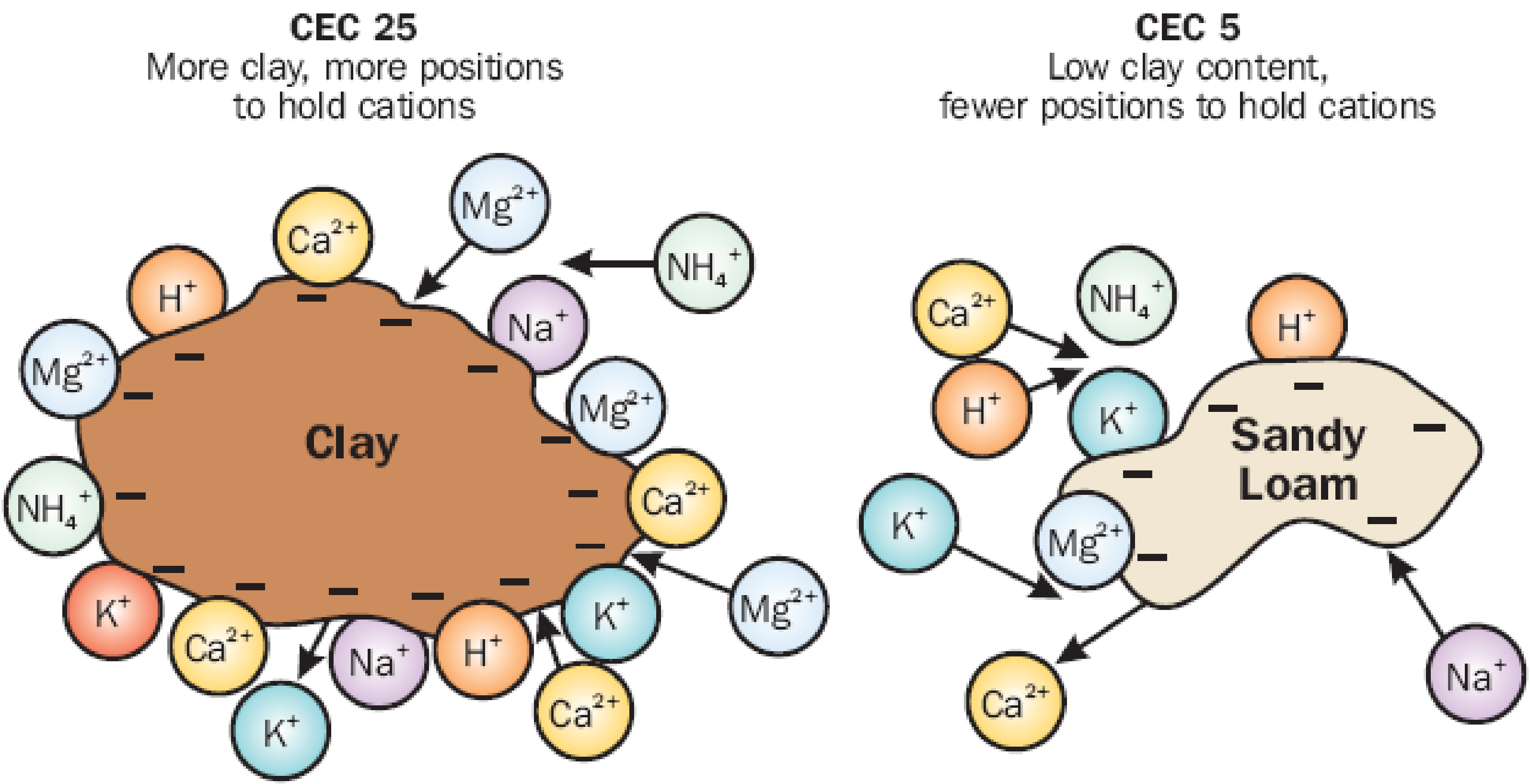
CLAY AND ORGANIC MATTER HAVE THE GREATEST INFLUENCE ON CEC

Clay	Organic Matter
10–150 cmol(+)/kg	200–400 cmol(+)/kg

Organic matter has a higher CEC

CATION EXCHANGE CAPACITY

A schematic look at cation exchange



What is the role of soil colloids, ions, and the cation exchange capacity (CEC) in soil chemistry?

- D. Clay minerals usually range from 10 to 150 meq/100g in CEC values.

- 1. Organic matter ranges from 200 to 400 meq/100g.
- 2. Clay soils with a high CEC can retain large amounts of cations against potential loss by leaching. Leaching is the loss or removal of materials from the soil.
- 3. Sandy soils with a low CEC retain smaller quantities.
- 4. Percent base saturation, the percent of the total CEC occupied by the major cations, has been used to develop fertilizer programs.

What is the role of soil colloids, ions, and the cation exchange capacity (CEC) in soil chemistry?

- E. The idea is that certain nutrient ratios or balances are needed to ensure proper uptake by the crop for optimum yields.

- 1. Research has shown that cation saturation ranges and ratios have little or no utility in a vast majority of agricultural soils.
- 2. Under field conditions, ranges of nutrients vary widely with no detrimental effects, as long as individual nutrients are present in sufficient levels in the soil to support optimum plant growth.

What is the role of organic matter, soil depth, surface slope, soil organisms, and nutrient balance in soil productivity?

- V. Soil productivity can be affected by organic matter, soil depth, surface slope, soil organisms, and nutrient balance.

- A. ***Soil organic matter*** consists of plant, animal, and microbial residues in various stages of decay.

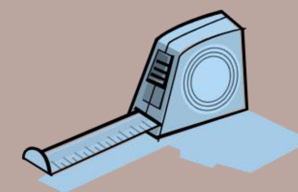
- 1. Adequate organic matter levels benefit soil in the following ways:
  - a. Improve the physical condition and tilth
  - b. Increase water infiltration
  - c. Decrease erosion losses
  - d. Supply plant nutrients

What is the role of organic matter, soil depth, surface slope, soil organisms, and nutrient balance in soil productivity?

- 2. Organic matter contains about 5 percent nitrogen and serves as a storehouse for reserve N. But the nitrogen in organic matter is in organic compounds and is not immediately available for plant use, since decomposition usually occurs slowly.
- 3. Fertilizer N is needed to assure non-legume crops an adequate source of readily available N.
- 4. Soil organic matter contains other essential plant elements. Plant and animal residues contain variable amounts of mineral elements, such as phosphorus, magnesium, calcium, sulfur, and the micronutrients.

What is the role of organic matter, soil depth, surface slope, soil organisms, and nutrient balance in soil productivity?

- B. ***Soil depth*** may be defined as that depth of soil material favorable for plant root penetration.



- 1. Deep, well-drained soils of desirable texture and structure are favorable to crop production.
- 2. Plants need plenty of depth for roots to grow and secure nutrients and water.
- 3. Roots will extend 3 to 6 feet or more when soil permits. Rooting depth can be limited by physical and chemical barriers as well as by high water tables.
- 4. Hardpans, shade beds, gravelly layers, and accumulations of soluble salts are extremely difficult to correct.

What is the role of organic matter, soil depth, surface slope, soil organisms, and nutrient balance in soil productivity?

- C. Land topography or surface slope largely determines the amount of runoff and erosion.

- 1. It also dictates irrigation methods, drainage, conservation measures, and other best management practices (BMPs) needed to conserve soil and water.
- 2. The steeper the land, the more management is needed, increasing labor and equipment costs.
- 3. At certain slopes, soil becomes unsatisfactory for row crop production.
- 4. The ease with which surface soils erode, along with percent slope, are determining factors in a soil's potential productivity.

What is the role of organic matter, soil depth, surface slope, soil organisms, and nutrient balance in soil productivity?

- D. Many groups of organisms live in the soil. Soil organisms range in size from microscopic (bacteria, fungi, and nematodes) to those readily visible to the naked eye (earthworms and insect larvae).

- 1. Most soil organisms depend on organic matter for food and energy and are usually found in the upper foot of soil.
- 2. Factors that affect the abundance of soil organisms include moisture, temperature, aeration, nutrient supply, soil pH, and the crop being grown.
- 3. Some of the microscopic organisms cause many favorable soil reactions, such as the decay of plant and animal residues. They help to speed nutrient cycling.
- 4. Other reactions can be injurious, such as the development of organisms that cause plant and animal diseases.

What is the role of organic matter, soil depth, surface slope, soil organisms, and nutrient balance in soil productivity?

- E. Nutrient balance is a vital concept in soil fertility and crop production.

- 1. Nitrogen may be the first limiting nutrient in non-legumes. But without adequate amounts of the other nutrients, N cannot do its best.
- 2. As nitrogen fertilization raises yields, the crop demands more of the other nutrients.

How do environmental conditions influence nutrient deficiencies?

- VI. Understanding environmental conditions and their effects on a crop can help pinpoint a problem that is developing. All factors that influence crop growth, response to fertilization, and yield should be evaluated.

- A. Both water and oxygen are essential for the uptake of nutrients.

- 1. Nutrient absorption may be restricted in wet soil due to a low level of oxygen.
- 2. Under drought conditions, water absorption is greatly reduced. Nutrient absorption drops as less water enters the plant. Dry soil conditions may create deficiencies in boron, copper, and potassium.

How do environmental conditions influence nutrient deficiencies?

- B. Many conditions that reduce the rate of photosynthesis and the production of sugars can lower nutrient absorption. Stress caused from low light or extremes in temperature may lead to nutrient deficiency problems.

- C. Diseased roots, roots damaged from cultivation, and plantings that are too deep often result in poor nutrient absorption.

How do environmental conditions influence nutrient deficiencies?

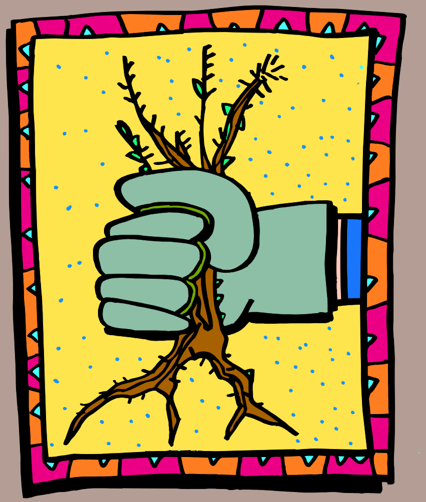
- D. The measure of alkalinity or acidity of a substance is known as ***pH***. The pH scale runs from 0 to 14, with 0 being extremely acidic, 7 neutral, and 14 extremely basic.
- 1. Changes in pH can be made by adding sulfur or gypsum to lower pH (make more acidic) and by adding limestone to increase pH (make more basic). Generally, plants grow best within the pH range of 5.5 to 8.0.

How do environmental conditions influence nutrient deficiencies?

- 2. The pH value of soil is important to agriculturists because certain nutrients become unavailable to plants if the pH value is too high or too low. The amount of nitrogen, phosphorus, and potassium available is dependent upon soil pH.
- 3. Acidic soil conditions reduce the availability of calcium, magnesium, sulfur, potassium, phosphorus, and molybdenum and increase the availability of iron, manganese, boron, copper, and zinc.

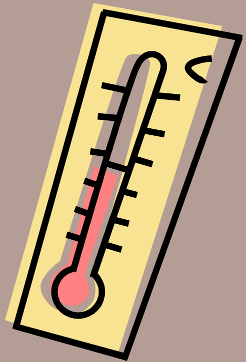
How do environmental conditions influence nutrient deficiencies?

- E. The soil must be of good tilth and permeable enough for roots to expand and feed extensively. A crop will develop a root system 6 feet or more in depth in some soils to get water and nutrients. A shallow or compacted soil does not offer this root-feeding zone. Wet or poorly drained soils result in shallow root systems.



How do environmental conditions influence nutrient deficiencies?

- F. Cool soil temperature slows organic matter decomposition. This lessens the release of nitrogen, sulfur, and other nutrients. Nutrients are less soluble in cool soils, and that increases deficiency potential. Phosphorus and potassium diffuse more slowly in cool soils. Root activity is decreased.



How do environmental conditions influence nutrient deficiencies?

- G. Soluble salts and alkali are problems in some areas. They may cover only part of the field. They are usually present where a high water table exists, where saltwater contamination has occurred, or where poor quality water has been used for irrigation.

How do environmental conditions influence nutrient deficiencies?

- H. Herbicides and mechanical controls are more important today than ever before. Weeds rob crop plants of water, air, light, and nutrients. Some weeds may even release substances that inhibit crop growth.

- I. Some soils develop hardpans (compaction) and require deep tillage. This requires more phosphorus and potassium to build up fertility.

How do environmental conditions influence nutrient deficiencies?

- J. Irrigation water can contain nitrate, sulfate, boron, potassium, bicarbonate, chlorine, and other salts. A water analysis should be used to modify production practices for utilization of various water sources.

- K. Other pollutants can also cause nutrient deficiencies as well as other problems.

REVIEW

- 1. What is the meaning and importance of soil fertility?
- 2. What is pH and what role does it play in plant nutrition?
- 3. What is the role of soil reaction (pH) and liming in soil chemistry?
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