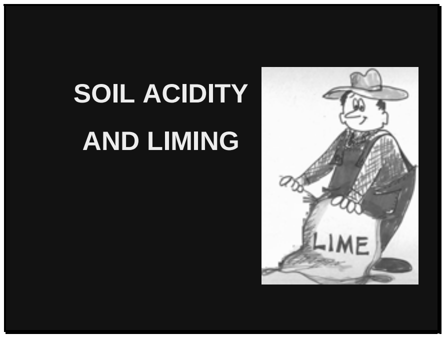
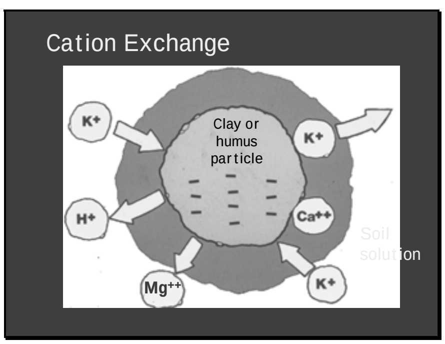
Part 4. SOIL ACIDITY AND LIMING



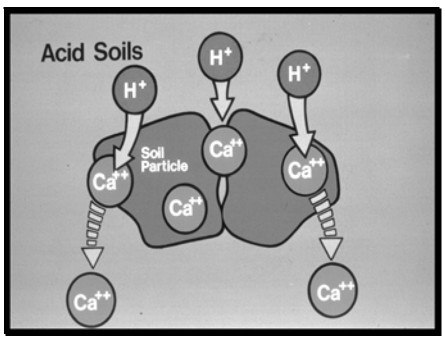
1. We can't talk about soils and plant nutrition without discussing a little chemistry. Understanding some fundamental soil chemistry is important toward understanding why we lime and fertilize.

This is the forth of six slide sets on “Soils, Plant Nutrition and Fertilizer”.
Each slide set is independent and does not have to be viewed in sequence.
PART 1, “Dirt is a Four-letter Word - AN INTRODUCTION TO SOILS” (25 slides with text; presentation time is approximately 30 minutes; file: *MG1-intro.ppt*)
PART 2. “Getting to the Root of the Problem - SOIL PHYSICAL COMPONENTS” (17 slides with text; presentation time is approximately 40 minutes; file: *MG2-components.ppt*)
PART 3. “The
arth Beneath Our Feet - SOILS OF ALABAMA” (41 slides/no text; presentation time is approximately 60 minutes; file: *MG3-alasoils.ppt*)
PART 4. “SOIL ACIDITY AND LIMING” (16 slides with text; presentation time is approximately 20 minutes; file: *MG4-pH.ppt*)
PART 5. “The ABCs and NPKs for Healthy Plants - ESSENTIAL PLANT NUTRIENTS” (46 slides with text; presentation time is approximately 40 minutes; file: *MG5-nutrients.ppt*)
PART 6. “SOIL TESTING FOR HOME GROUNDS” (under development; available only as a conventional slide set)

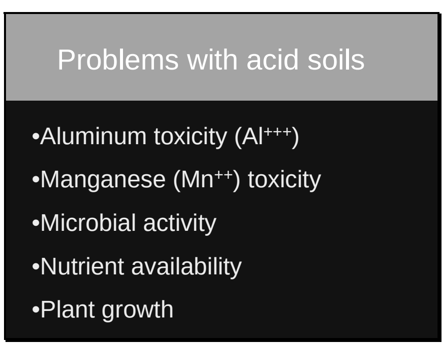


2. The microscopic clay particles and humus in soil are so tiny that they can develop an electrical charge. Just like the dust that is attracted to your TV or computer monitor, the tiny clay and humus particles in the soil attract oppositely charged minerals dissolved in the water that surrounds them. Clay and humus has a net negative charge. Therefore, it attracts positively charged minerals called cations which are dissolved in the water. *(Note that any charged particle is an ion. A negatively charged particle is an anion. Since the soil attracts mostly positive charged cations, we are mostly concerned with these.)* Some of these cations may be essential plant nutrients such as potassium (K^+), calcium (Ca^{++}). magnesium (Mg^{++}), and ammonium (NH_4^+). Although sodium (Na^+) is not an essential plant nutrient, it can be high in soils of the arid western U.S. We have an abundance of hydrogen (H^+) and aluminum (Al^{+++}) in our soils. These cations can exchange for one another on the surface of clay and humus, a process known as cation exchange The more clay and the more organic matter (humus) in the soil, the more of these cations the soil can hold, and the higher the soil's cation exchange capacity. This is why soils high in clay and high in organic matter are generally more fertile than sandy soils. They have a higher cation exchange capacity.

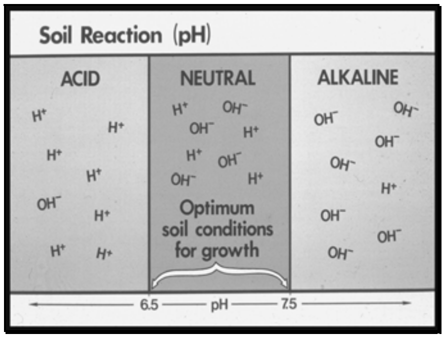
3. Early settlers moving into Alabama 200 years ago didn't know about cation exchange, but they must have known that dark, clayey soils were more productive. This is why most of the antebellum cotton plantations were in the Black Belt and Limestone Valley regions of the State. They avoided the less fertile, sandier soils of the Wiregrass and Sand Mountain.



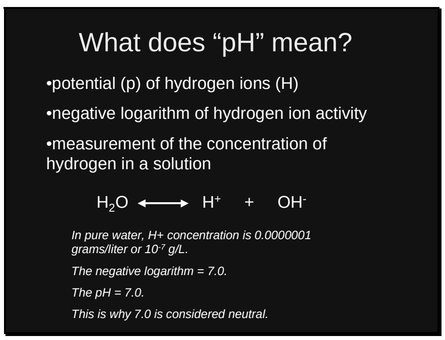
4. As water moves through a well drained soil over time, some basic cations such as potassium, calcium, and magnesium may be leached downward. Every positive charge that moves down has to be replaced by some other positive charge from another cation. The replacing cation is hydrogen which comes from H_2O. Gradually, this makes the soil more acid.



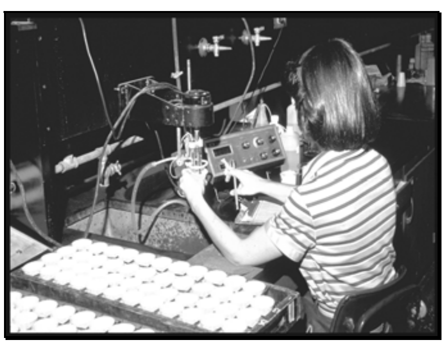
5. Most garden crops, lawns, shrubs and ornamentals grow best in a slightly acid soil. If the soil becomes too acid, problems can develop. The number one problem with acid soils in Alabama is aluminum toxicity. Aluminum is NOT a plant nutrient. Some plants will tolerate aluminum, but no plant needs it to grow. Excessive aluminum has even been implicated in human health problems. Nevertheless, aluminum is abundant in all mineral soils. When soils become very acid, the acidity dissolves some aluminum. Plant roots try to take it up, and it kills the root tips. Many, non-native crops are particularly sensitive to aluminum toxicity. These include alfalfa, cotton, beans, peas, tomatoes, spinach, most annual flowers, lilacs, roses, and many other annuals and perennials. Those tolerant to aluminum are our acid-loving plants: azaleas, gardenias, hydrangeas, pine trees, centipedegrass, and broom sedge. Unlike aluminum, manganese is an essential plant micronutrient, but it also is a metal and could become toxic in very acid soils. Many bacteria and other beneficial soil microorganisms cannot survive in very acid soils (*note that bacteria cannot survive pickles, tomatoes, and other acid fruits).* When soils become acid, the availability of other essential nutrients is reduced. All these problems with acid soils lead to poor plant growth



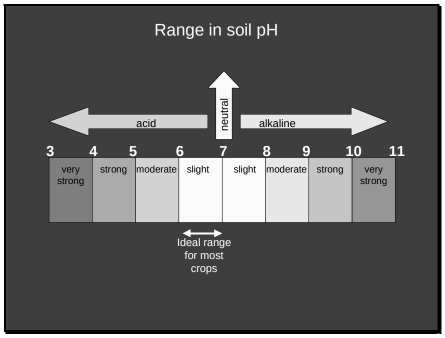
6. Pure water with no other mineral dissolved in it is neutral. It is a balance between H^+ cations and OH^- anions. If something were to be added to the water to make it more acid, for example, adding vinegar, lemon juice, or coffee, we would increase the proportion of H^+ cations to OH^- anions. On the other hand, if we added Alka-seltzer, baking soda, or lye to the water, we would have more OH^- anions than hydrogen and the water would now be alkaline. We use the pH scale to measure how acid or how alkaline water may be.



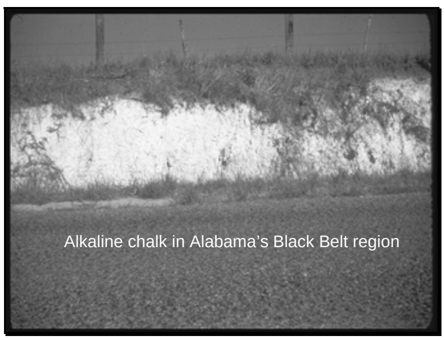
7. The "p" stands for "potential' and the "H" stand for "hydrogen". Therefore, pH is really a measurement of hydrogen cations in water. Because the pH value represents a negative logarithm, as the number gets smaller, the actual concentration of hydrogen increases (acidity increases).



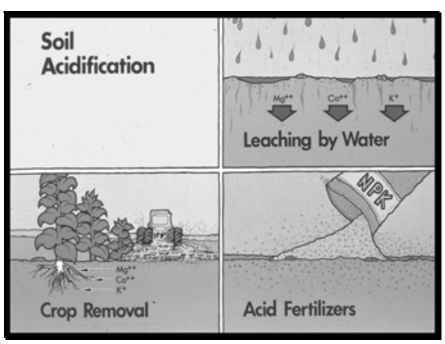
8. In the laboratory, we take about a tablespoon of soil and mix it with the same amount of distilled water. Using a hydrogen-measuring electrode, we check the pH of the soil-water suspension.



9. If the pH is less than 5.8 for most soils and crops, we'd then check the soils cation exchange capacity and recommend enough lime to raise the soil pH to around 6.5. The ideal range for most garden crops is around 6.0 to 7.0. Some plants, particularly many native plants, do well in acid soils. Name some acid-loving plants. (*Pine trees, broom sedge, azaleas, gardenias, camellias, centipedegrass, hydrangeas, etc.)*. They may grow well in a soil with a pH between 5.0 and 6.0.



10. Unless you live in the Black Belt region and have soils formed from Selma chalk, you shouldn't have a pH over 7.0. If you test your soils and find that it has a pH above 7.0, ask yourself, "Why?" (*over-limed? added wood ash at very high rates? builders lime from mortar mix or concrete mix spilled on the soil? limestone outcropping in North Alabama? etc.*)



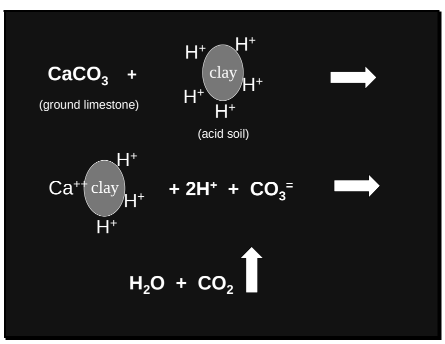
11. Most Alabama soils are naturally acid because we have well drained soils with over 55 inches of rainfall per year leaching out calcium, magnesium, and potassium. Plants also take up calcium, magnesium, and potassium replacing these with hydrogen. And, finally, some fertilizers add hydrogen to the soil, also making it more acid.

12. The only way to know for sure if you need lime is to soil test. Quick soil tests may help diagnose pH problems, but aren't accurate enough to use in recommending lime

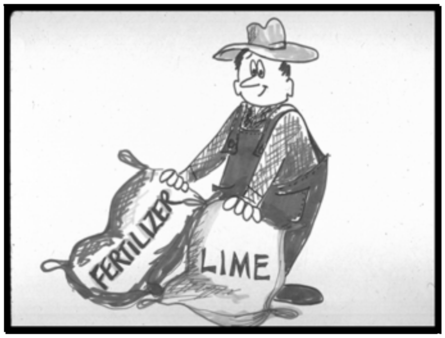
Common Liming Materials

Name	Chemical Formula	Equivalent % $CaCO_3$
Calcitic limestone	$CaCO_3$	90-100
Dolomitic limestone	$CaCO_3$+ $MgCO_3$	95-110
Oxide/burned lime	CaO	150-175
Hydrated lime	$Ca(OH)_2$	120-135
Ground shells	$CaCO_3$	80-95
Basic slag	$CaSiO_3$	50-80
Wood ashes	Oxides & hydroxides	30-70

13. Unless you're growing acid-loving plants, sooner or later, you may need to add lime to your garden, flower bed, or shrubs. Lots of materials are called lime and many can be bought for this purpose. But the recommendations from the Auburn University Soil Testing Laboratory are always for ground, agricultural limestone. This is the natural rock that ground to a fine powder for spreading. It can be pure calcium limestone (calcium carbonate, $CaCO_3$) or a mixture of calcium carbonate and magnesium carbonate ($CaCO_3$ + $MgCO_3$). The mixture is called dolomite and is usually more desirable because it contains two essential plant nutrients (calcium and magnesium) instead of just one. Some of the other products listed here are by-products or industrial products made from limestone (burned lime and hydrated (builders) lime. They can all be used to raise the pH of the soil, but some can "burn" living plants. To be safe, always use ground, agricultural limestone around living plants, AND, LIME ONLY WHEN THE SOIL TEST SHOWS YOU NEED IT



14. To be most effective, lime should be mixed with the soil well ahead of planting. Putting lime on the surface of a lawn or garden will prevent it from getting more acid, but it won't change the pH beyond an inch or so deep. The lime must react with the hydrogen cations attached to the surface of the clay and humus in the soil. Calcium and/or magnesium replaced the hydrogen on the clay. The hydrogen is then converted back into water and the carbonate becomes carbon dioxide which goes into the air as a gas. The same thing happens when you lime your acid stomach with a Tums



15. Remember, "Lime the soil, but fertilize the plant."

16. End of slide set

The next slide set in this series is:
PART 5. “The ABCs and NPKs for Healthy Plants - ESSENTIAL PLANT NUTRIENTS” (46 slides with text; presentation time is approximately 40 minutes; file: *MG5-nutrients.ppt*)