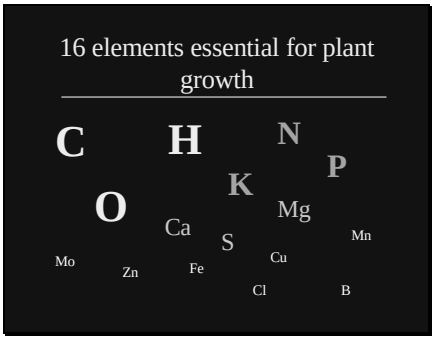
Part 5. Essential Plant Nutrients

Slide 1

1. Not all plant nutrients come in a fertilizer bag.

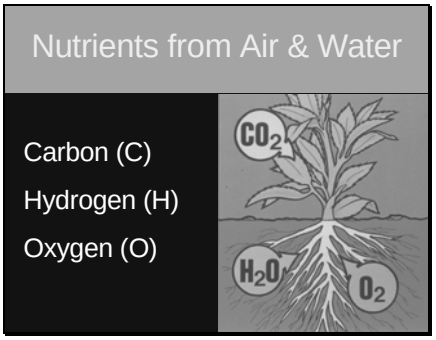
This is the fifth of six slide sets on "Soils, Plant Nutrition and Fertilizer". Each slide set is independent and does not have to be viewed in sequence.
PART 1, "Dirt is a Four-letter Word - AN INTRODUCTION TO SOILS" (25 slides with text; presentation time is approximately 30 minutes; file: *MG1-intro.ppt*)
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 Earth Beneath Our Feet - SOILS OF ALABAMA" (41 slide 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. "ESSENTIAL PLANT NUTRIENTS - The ABCs and NPKs for Healthy Plants - " (48 slides with text; presentation time is approximately 40 minutes; file: *MG5-nutrients.ppt*)
PART 6. "SOIL TESTING FOR HOME GROUNDS"

Slide 2



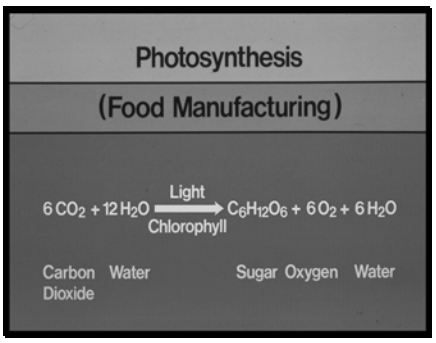
2. In fact, sixteen elements have been found to be essential for green plants to complete their life cycle. Three of these come from the air and water.

Slide 3



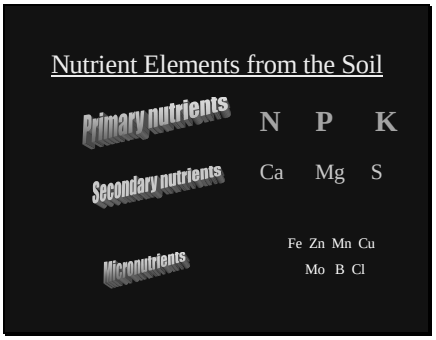
3. Since over 80 percent of a succulent, green plant is water, it stands to reason that HYDROGEN AND OXYGEN, the components of water (H_2O) are needed in the absolute largest quantity. Without water, life processes couldn't get started and without water, all the other elements are not needed. That's why the first deficiency you are likely to see in your garden is an H_2O deficiency.

Slide 4



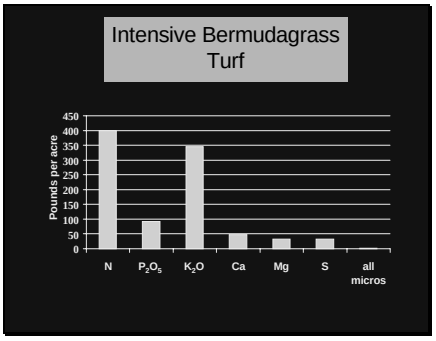
4. About half of the dry weight of a plant is carbon (C). A plant takes water and carbon dioxide (CO_2) from the air and energy from sunlight to store energy in the form of carbohydrates (*Glucose, $C_6H_{12}O_6$, is the simplest sugar. Note that it is just a mixture of carbon, hydrogen, and oxygen*). The plant gives off oxygen. This, as you may recall, is photosynthesis. (*You may also wish to discuss respiration at this point.)* The other 13 elements come primarily from the soil and serve to support photosynthesis.

Slide 5



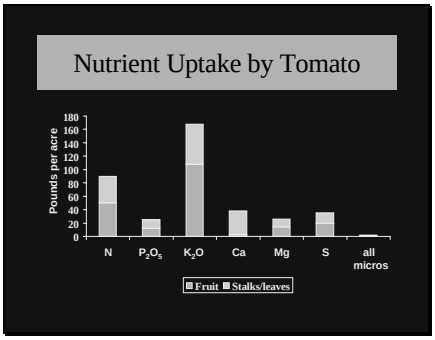
5. The other 13 elements are called essential nutrients. They are generally listed in the order they are needed by crops or the order in which they are most likely to be deficient in soils from around the world.

Slide 6



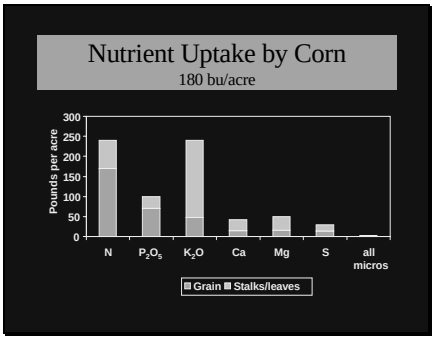
6. To put the nutrients into perspective, this slide shows the relative uptake of primary, secondary, and micronutrients in an acre of bermudagrass turf. Note that the total micronutrient uptake barely shows up on the graph (less than 1 pound per acre) whereas the uptake of nitrogen (N) and potassium (as K_2O) can be almost 400 pounds per acre. In general, we see fertilizers sold for turfgrass that have high nitrogen (the first number on the fertilizer bag) and high potassium (the third number on the fertilizer bag).

Slide 7



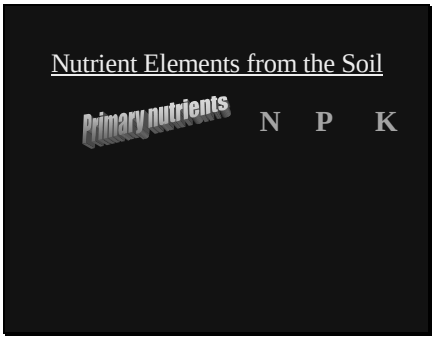
7. The same general trend is seen with an acre of tomatoes. However, note that tomatoes actually take up more potassium (K_2O) than N. Should this affect how companies mix nutrients to make fertilizers? Some fertilizers sold as "tomato" fertilizer may actually contain more potassium (the third number on the bag) than nitrogen or phosphorus.

Slide 8



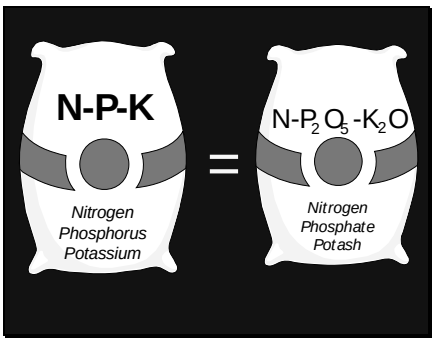
8. Corn is actually a grass and as such has a high nitrogen and high potassium uptake. Note that in all these crops, the relative amounts of secondary nutrients (Ca, Mg, and S) needed are much less than the primary nutrients. All the micronutrients added together barely show up on this graph.

Slide 9



9. Primary nutrients are NITROGEN, PHOSPHORUS, AND POTASSIUM.

Slide 10

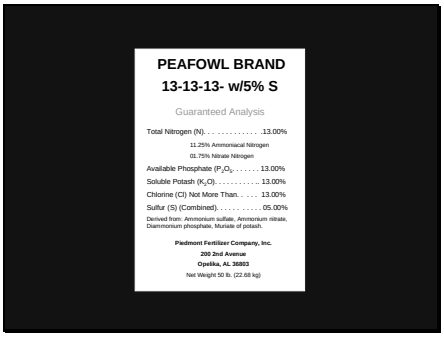


10. These are the three that are always, by law, listed on the fertilizer bag or box. The numbers refer to the percentage, by weight, of nitrogen (N), phosphate (P_2O_5), and potash (K_2O) in the fertilizer. The terms phosphate and potash are an old, chemical way of expressing phosphorus and potassium. For all practical purposes, think of the values as representing the percentage of nitrogen (N), phosphorus (P) and potassium (K) in the fertilizer.

Slide 11

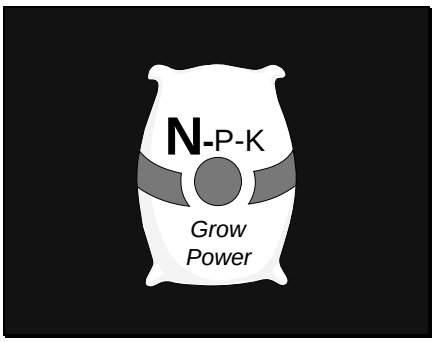
11. For example, 100 pounds of a 10-10-10 would contain 10 pounds of nitrogen, 10 pounds of phosphate and 10 pounds of potash for a total of 30 pounds of plant nutrients.

Slide 12



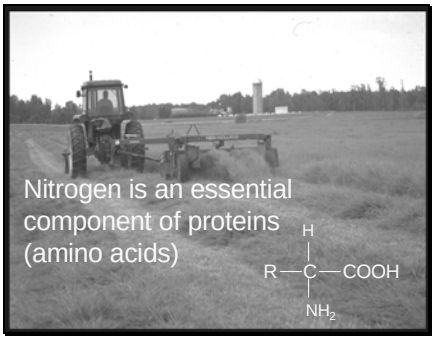
12. This is an example of a label from an actual bag of 13-13-13 fertilizer manufactured in Alabama. It gives you thepercentages of all primary, secondary, and micronutrients (if any) in the bag as well as the source of these nutrients. The Alabama Department of Agriculture and Industries regularly tests fertilizers to assure customers that the fertilizer contains the nutrients stated on the label.

Slide 13



13. Consider nitrogen the growth element. The first number on the fertilizer bag represents green, leafy growth. Nitrogen promotes protein formation and proteins result in more green, leafy growth.

Slide 14

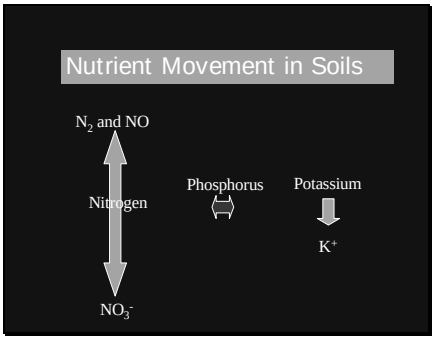


14. Farmers use lots of nitrogen on hayfields because they want lots of green leafy growth high in protein.

Slide 15

15. This comment is printed on all soil test reports from Auburn University's Soil Testing Laboratory when the crop to be grown is bermuda, zoysia, or St. Augustine lawn.

Slide 16



16. Yet nitrogen is very mobile in the soil. It's present in the soil as plant protein, but once the organic matter decomposes, most of the soil N is lost. For this reason, most soil testing labs in the humid eastern U.S. don't bother to test for nitrogen. One good rain and you could lose most of what was applied as inorganic fertilizer.

Slide 17

17. Because it is mobile in the soil, recommendations often suggest multiple applications of N, such as every 2 months on bermudagrass lawns. Golf courses may apply it weekly. You "sidedress" your garden vegetables primarily to give them extra nitrogen once they are up and growing (*Explain what "sidedressing" means.)*

Slide 18

18. Yet, the air is 78 percent nitrogen gas! It's N_2 gas, not a form that plants can convert to protein.

Slide 19

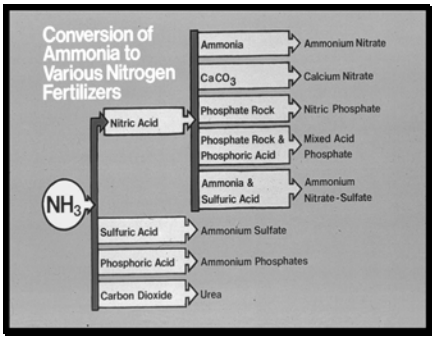
19. But there is a group of plants, called legumes, that can use nitrogen gas from the air. Specially adapted bacteria, called *Rhizobia*, live on their roots. These bacteria can take N_2 from the air, convert it into ammonium, use some of it for their own protein and give the rest to the plant. In return, the plant provides carbohydrates for the bacteria and a place for them to live. The little round, white balls with pink centers on the roots of legumes are called nodules and is home for the bacteria.
Name some common legumes in the landscape? Some are trees. (*peas, beans, soybeans, peanuts, clover, vetch, alfalfa, lespedeza, mimosa, locust, redbud, kudzu, etc.*)

Slide 20

20. Legumes rarely need nitrogen fertilizers. In fact, some such as clover and vetch are planted as a winter cover crop to protect the soil from erosion during the winter and to add organic matter and nitrogen to the soil.

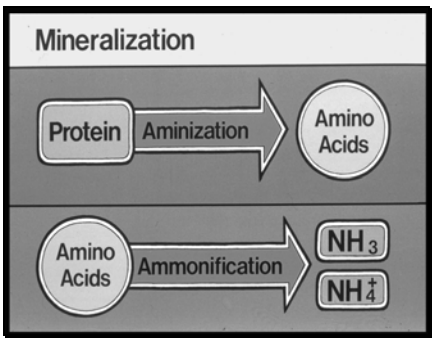
This corn is on an organic farm in Alabama. The corn is yellow and is not getting all the nitrogen it needs in spite of the fact that it is growing in a stand of white clover. Why? (*The clover is still green and growing. Nitrogen is still tied up as protein in the clover leaves, stems, and roots. It has to be killed or plowed under in order for the nitrogen to mineralize into a form that corn can take up.)*

Slide 21



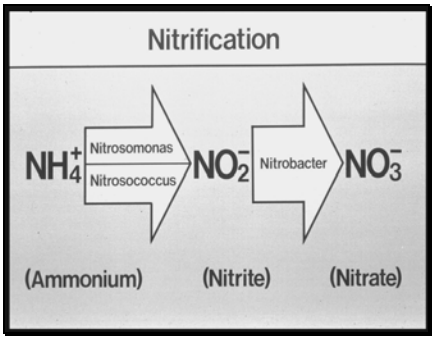
21. From ammonia gas, the following nitrogen fertilizers can be made:
anhydrous ammonia, NH_3 82-0-0
urea, $CO(NH_2)_2$ 45-0-0
ammonium nitrate, NH_4NO_3 34-0-0
ammonium sulfate, $(NH_4)_2SO_4$ 21-0-0
diammonium phosphate, $(NH_4)_2HPO_4$ 18-46-0
potassium nitrate, KNO3 13-0-44

Slide 22



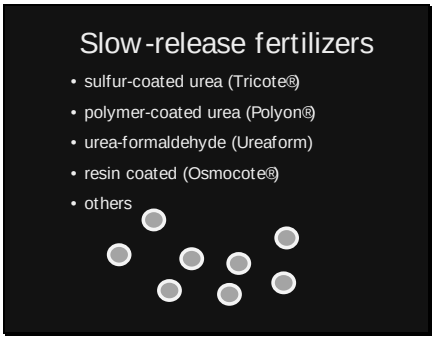
22. Anything high in protein will be high in N. Cottonseed meal is a 6-1-1 fertilizer. Blood meal is a 15-0-0 fertilizer. Alfalfa meal is a 3-1-1 fertilizer. Chicken litter is a 3-3-2 fertilizer. Dead animals are rich in protein. When these forms of nitrogen are added to the soil or buried in the soil, the protein is decomposed into amino acids by the microorganisms in the soil. They use some of the nitrogen for protein in their microscopic bodies. Amino acids are broken down into ammonia gas. (*Note the strong ammonia odor of chicken manure and the strong odor of escaping ammonia from a dead animal.)*

Slide 23



23. But, in a warm moist soil, there are ammonium-loving bacteria (called nitrifying bacteria) that convert ammonium to the negatively charge anion, nitrate (NO_3^-) . Since nitrate is negatively charged, it is repelled by the soil particles. This is the form of nitrogen which plants prefer to take up. Nitrate forms of nitrogen, such as ammonium nitrate which is half nitrate and half ammonium, promotes rapid green-up and rapid vegetative growth. The nitrate is also free to flow with the soil water. This is the form that can leach into groundwater.

Slide 24

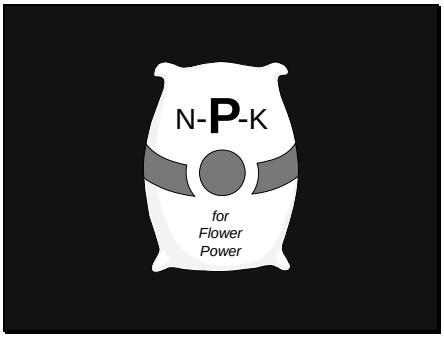


24. The idea behind slow-release or time-release fertilizers is to coat the fertilizer granule with a substance that will keep it in the soil longer and prevent the bacteria from mineralizing it to nitrate. While these fertilizers are much more expensive, they save the homeowner time because you don't have to apply them as often. They are popular for use on nurseries, landscapes, golf courses, athletics fields, and high-value crops. When properly used, they may also help to prevent excess nitrate leaching into surface and ground water.

Slide 25

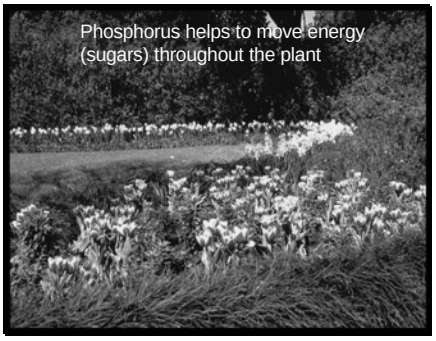
25. The objective of any environmentally conscientious fertilizer program is to apply enough N for the crop when the crop needs it in order to minimize the potential for excess nitrate polluting our water.

Slide 26



26. The middle value on a fertilizer bag is the percentage of P_2O_5 in the fertilizer. The fertilizer industry calls it, "phosphate" and sometimes "phosphoric acid", but for all practical purposes, gardeners can think of it as phosphorus. Fertilizers high in phosphorus are often used on blooming plants and root crops such as potatoes.

Slide 27



27. Phosphorus is always associated with flowers, fruiting, and carbohydrate storage in roots, tubers, and bulbs. Phosphorus is essential in energy transformations in the plant. Without adequate P, carbohydrates manufactured in the leaves could not be transported to the flower, developing fruit, or stored in the root or bulb. It takes a lot of energy for a rose to blossom. Energy must be stored in a daffodil or tulip bulb in order for it to bloom next spring.

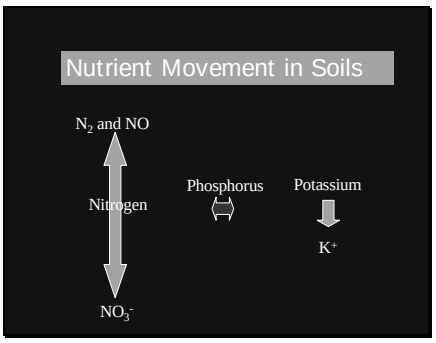
Slide 28

28. Bone meal is often recommended for bulbs and flower such as hyacinths, daffodils, and irises. Bones are rich in phosphorus and bone meal is about a 0-10-0 fertilizer. If you were to apply a high nitrogen fertilizer to a flowering plant, you may get all green, leafy growth and no flower and little energy stored in the root or bulb for next year's flowers. This is why most fertilizers sold in garden centers for roots, bulbs, and flowering plants are always low in N and high in P.

Slide 29

29. However, when phosphorus builds up to extremely high levels in soils or when too much phosphorus is applied to the land, or phosphorus from manures and septic tanks gets into our streams, we have a problem with water quality. High phosphorus in runoff water can lead to excessive algae growth in our streams and lakes. This could result in oxygen depletion and fish kills. It can also give the water an undesirable taste which urban water treatment plants cannot remove.

Slide 30



30. Fortunately, phosphorus doesn't leach in most soil like nitrogen. It builds up in the surface.

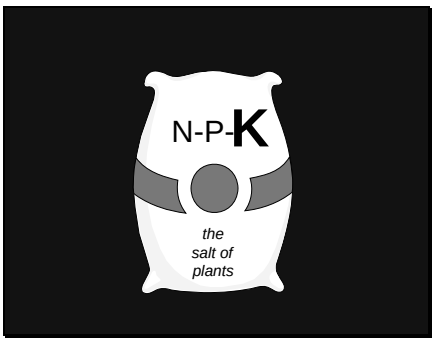
Slide 31

31. This makes soil testing a very convenient way to determine how much phosphorus is in your soil. Fortunately, excessive levels of soil phosphorus won't hurt most plants, but it is an environmental concern.

Slide 32

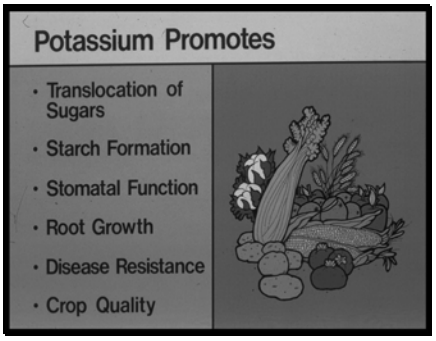
32. If your soils are already "high" or "very high" in phosphorus, then you don't need to apply more. Add just a little nitrogen to maintain satisfactory green growth. On the other hand, plants growing in pots or in confined areas such as these roses, do not present an environmental runoff threat. Therefore, any convenient flowering plant fertilizer will do.

Slide 33



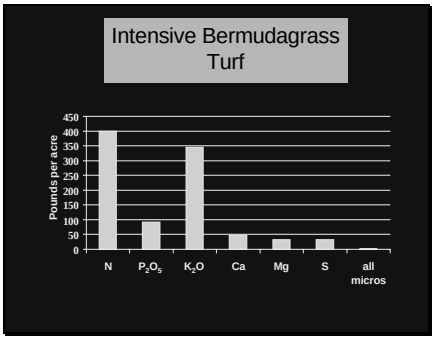
33. Potassium, the third number on the fertilizer bag, is the salt of plants. It regulates the rigidity or turgidity of plant cells.

Slide 34



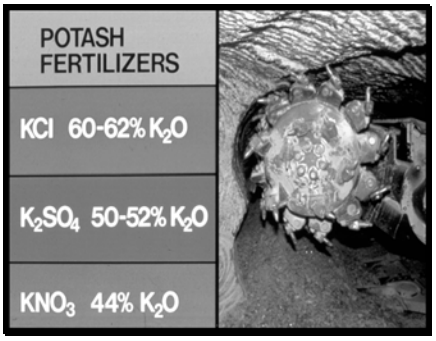
34. It helps plants to take up water and other nutrients, transpire, avoid drought stress during hot weather, and fight diseases. The opening and closing of the stomata are a function of K nutrition. Adequate K nutrition helps plants survive cold weather by acting as a type of anti-freeze.

Slide 35



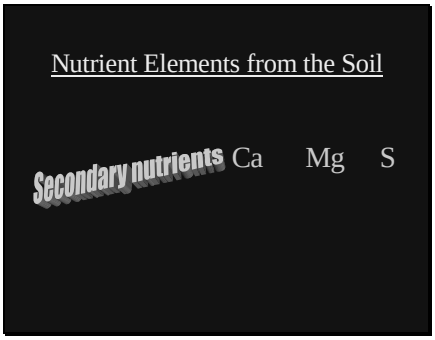
35. Note that bermudagrass uses almost as much potassium as K_2O as nitrogen (N). In general, we see fertilizers sold for turfgrass that have high nitrogen (the first number on the fertilizer bag) and high potassium (the third number on the fertilizer bag).

Slide 36



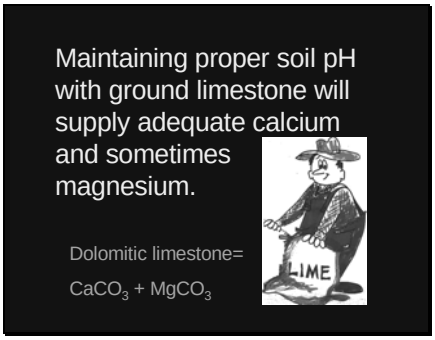
36. Potassium is mined as a salt in arid regions. These salts are simply blended with other fertilizer materials to make a complete fertilizer. The most widely used potassium salt is muriate of potash (KCl) or potassium chloride.

Slide 37



37. The secondary nutrients are calcium, magnesium, and sulfur. Calcium is an essential part of the cell wall structure, giving strength and rigidity to cells. Magnesium is part of the chlorophyll molecule; sulfur is a component of some proteins and imparts pungency and a strong odor to some plants such as broccoli, cauliflower, onions, and garlic.

Slide 38



38. Adequate calcium and magnesium is applied if the soils are limed with dolomitic limestone. Gypsum (calcium sulfate) is sometimes applied to add extra calcium to peanuts, peppers, and tomatoes

Slide 39

39. Few vegetable gardeners have escaped an encounter with the dreaded “blossom end rot” of tomatoes. This is a calcium deficiency causing the growing end of the fruit to turn black. Calcium doesn't move in the plant so it has to be taken up by the roots as needed. If the soil dries out while the tomato fruit is rapidly growing, the plant cannot take up enough calcium even though it's high in the soil. Sometimes a foliar spray with a calcium chloride solution will help, but the real solution lies in liming the soil, mulching the plants and watering the garden regularly and uniformly. Too much nitrogen fertilizer may also aggravate blossom end rot.

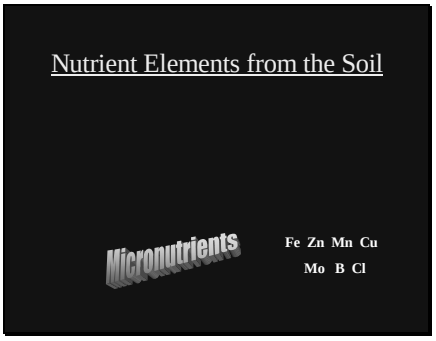
Slide 40

40. Some gardeners swear that Epsom salts can work miracles in the garden. Epsom salts is magnesium sulfate, a good source of both magnesium and sulfur. It seems to be most effective on acid-loving plants such as ferns which may be growing in very acid, low magnesium soils. Again, for most landscape plants, dolomitic limestone will provide adequate magnesium.

Slide 41

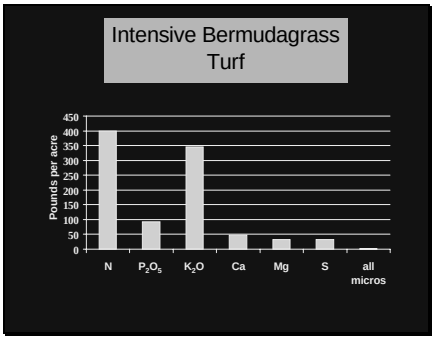
41. If you live downwind from Birmingham, Mobile, a paper mill, or a coal-fired steam plant, chances are you are getting lots of free sulfur from the air. It is the sulfur from air pollution that creates sulfuric acid in the atmosphere and falls back to earth as "acid rain." In spite of the problems with acid rain, in some ways it is free fertilizer sulfur. You also add sulfur if you use organic soil amendments. But just in case you are still concerned, read the fertilizer label. Many super or premium fertilizers today contain added sulfur just in case you live in a clean-air region.

Slide 42



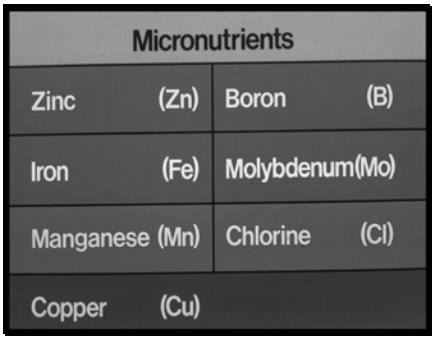
42. Micronutrients are so called because they are needed in micro amounts. Sometimes you still hear them called minor elements or trace elements. Most mineral soils in Alabama contain adequate levels of these elements. Even if you had a deficiency, it's not likely to be devastating. Toxicities are more likely than deficiencies. Recall that manganese can be toxic in very acid soils. Most micronutrients are part of plant enzymes.

Slide 43



43. Recall this figure showing the relative uptake of primary, secondary, and micronutrients in bermudagrass turf. Note that the total micronutrient uptake barely shows up on the graph (less than 1 pound per acre) whereas the uptake of nitrogen alone can be almost 400 pounds per acre.

Slide 44

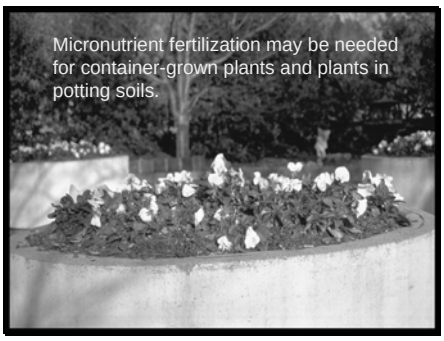


44. The availability of these nutrients are more a function of soil chemistry such as pH than the absolute amounts present. The most common micronutrient deficiency is an iron deficiency. It is often encountered when acid-loving plants (gardenias, azaleas, blueberries, etc.) are inadvertently overlimed or planted on a high pH soil.

Slide 45

45. These gardenias are healthy but iron deficiency typically shows up as a yellowing of the new leaves. Veins in the leaves remain dark green . Iron deficiency can be temporarily corrected using a foliar spray of an iron solution. Sometimes, foliar iron sprays are used by nurserymen and sod producers to green up plants for market.

Slide 46

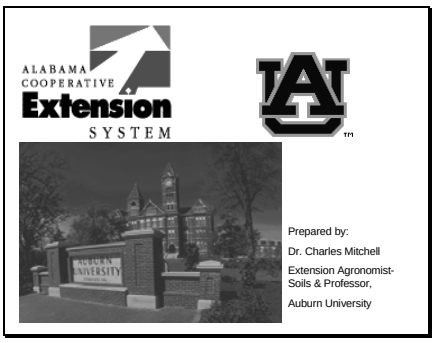


46. Plants grown in potting mixes or containers with a confined root system are most susceptible to micronutrient deficiencies. In these cases, it's probably good insurance to occasionally use a fertilizer that contains a mix of micronutrients. These are always listed on the fertilizer bag, box, or container.

Slide 47

47. Remember, not all plant nutrients come in a fertilizer bag. Providing your garden with adequate nutrients is important to healthy plants, but there are many other factors which can affect nutrient uptake by plants. (temperature, moisture, insects, diseases, type of plant, etc.).

Slide 48



48. End of slide set

The next slide set in this series is:

PART 6. “SOIL TESTING FOR HOME GROUNDS” (49 slides with text; presentation time is approximately 20 minutes.)