Module 3: Root Environment and Fertilization

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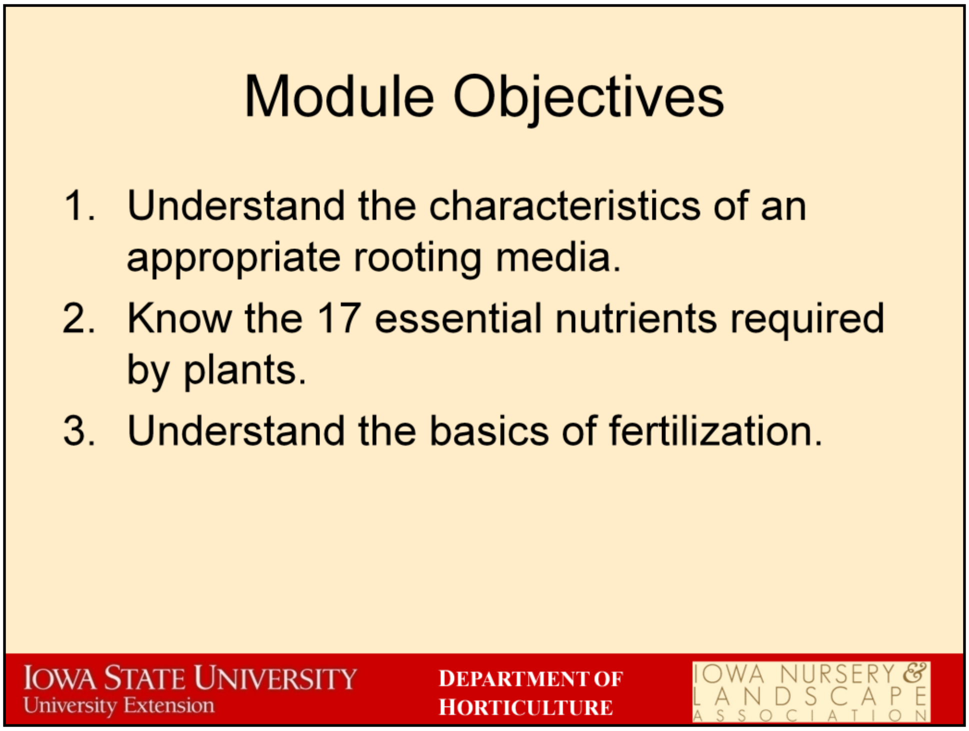
University Extension

DEPARTMENT OF HORTICULTURE

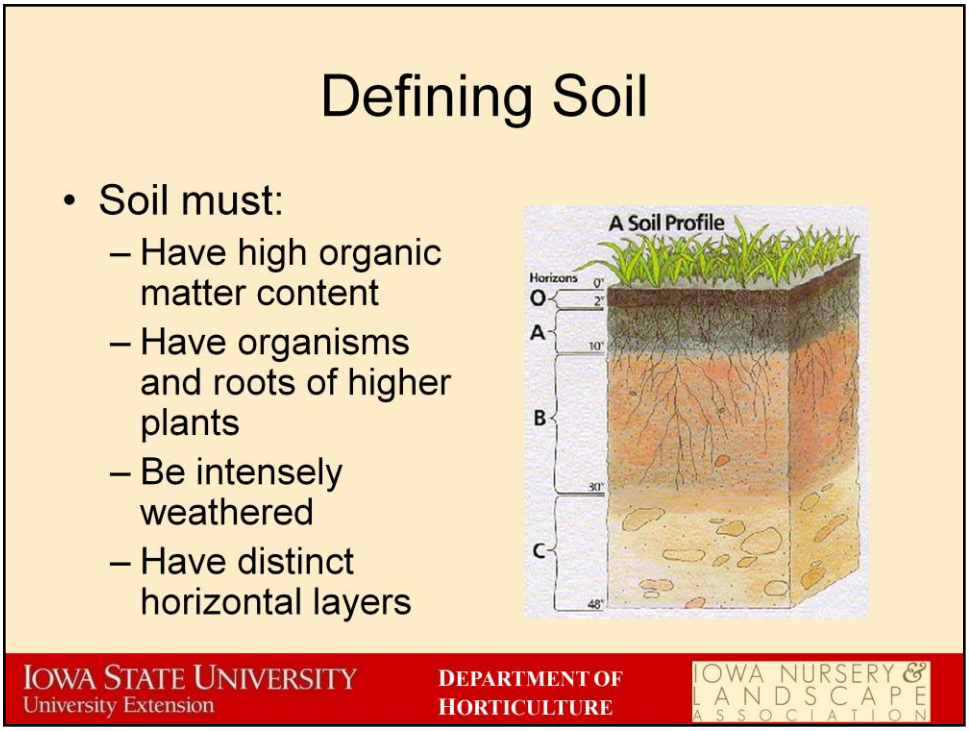
IOWA NURSERY & LANDSCAPE ASSOCIATION

Welcome to the Iowa Certified Nursery Professional Training program Module 3: Rooting Environment and Fertilization.



Upon completion of this module, you will be able to fulfill each of the objectives listed below.

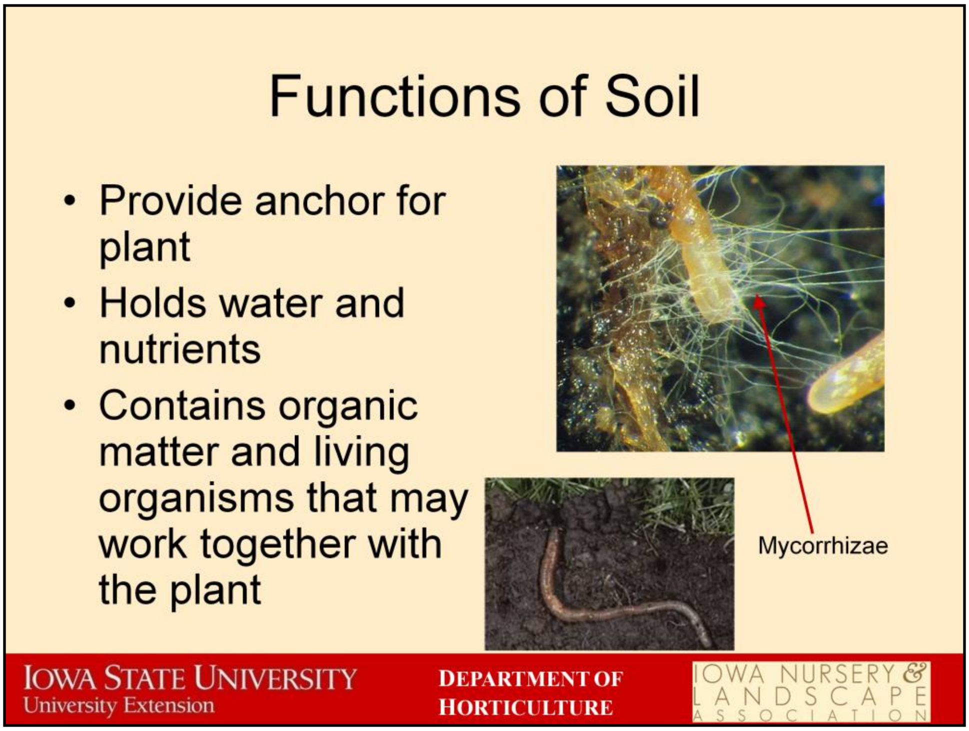
1. You will understand the characteristics of an appropriate rooting media.
2. You will know the 17 essential nutrients required by plants.
3. You will understand the basics of fertilization.



Let us begin by defining soil. Soil can be defined by the following four characteristics:

1. Contain relatively high levels of organic matter,
2. Contains organisms and roots of higher plants,
3. Intensely weathered,
4. Have distinct horizontal layers.

Soil comes from bed rock that is exposed to weathering and combined with organic matter. The soil profile shows the layers of soil in a particular location. The top most layer is top soil; it contains the highest amounts of organic matter, highest populations of organisms, and is the most weathered. Top soil is a highly valuable commodity. As you travel down a soil profile the particles become larger and the organic matter and living organism content decreases quickly. The lowest level of a soil profile is the parent bed rock.

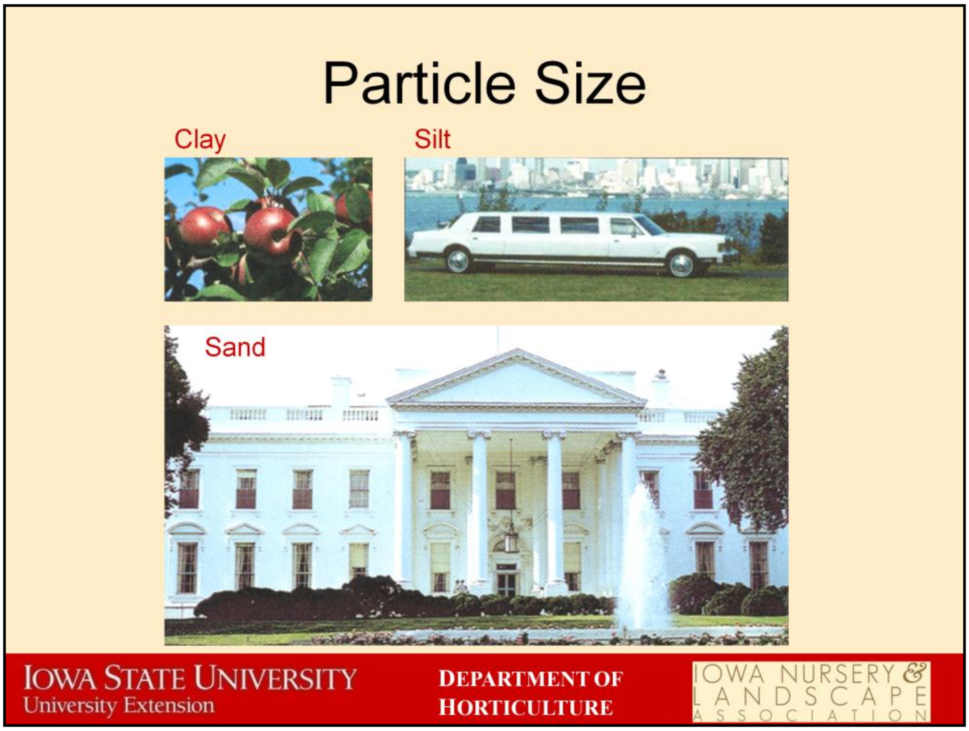


Soil, or rooting media, provide some basic, but essential functions for growing plants. The rooting media provides an anchorage for plant roots. *When a seed sprouts that first root knows to grow down into the soil because it is responding to gravity. This phenomenon is called geotropism.*

Soil also holds water and nutrients for the plant to use as it grows. As we learned in Module 1, root hairs are responsible for absorbing the water and dissolved nutrients. The water and nutrients are held in the soil. Some soils hold water and nutrients better than others.

To be classified as a soil, a rooting media must have living organisms. Earthworms, nematodes, bacteria, fungi and many other organisms call soil home. These organisms are both beneficial and harmful to plants.

Recent research has shown that some fungi, called mycorrhizae, work with plant roots to better absorb water and nutrients from the soil. The plant is helped because it gets the water and nutrients it needs and mycorrhizae is helped because it gets some nutrients too. This picture is of a mycorrhizae on the roots of a Scotch Pine.

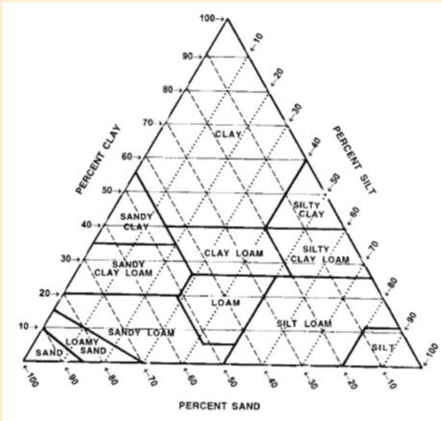


When talking about soil it is important to understand a few terms related to soils. **Particle size**, **soil texture** and **structure** are the three basic terms that are related to a basic understanding of soils. Let’s start with particle size.

Soil is made up of clay, silt, and sand particles. Clay is the smallest particle, silt in the middle, and sand the largest. In a relative size comparison clay is like an apple, silt like a limo, and sand like the White House. Having a mixture of all three particle sizes provides the best combination of pore spaces for oxygen and water.

The types of soil particles present in an area depends on the bed rock material being broken down.

Soil Texture



- Relative proportion of clay, silt, and sand
- Difficult to change
- Clay, loam, sandy loam

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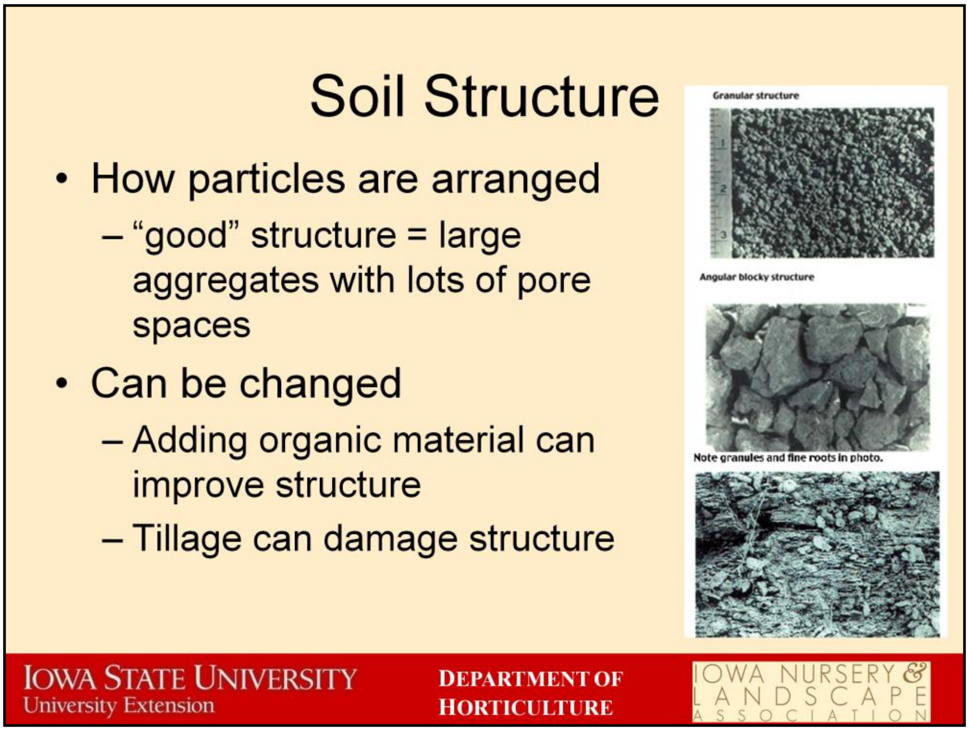
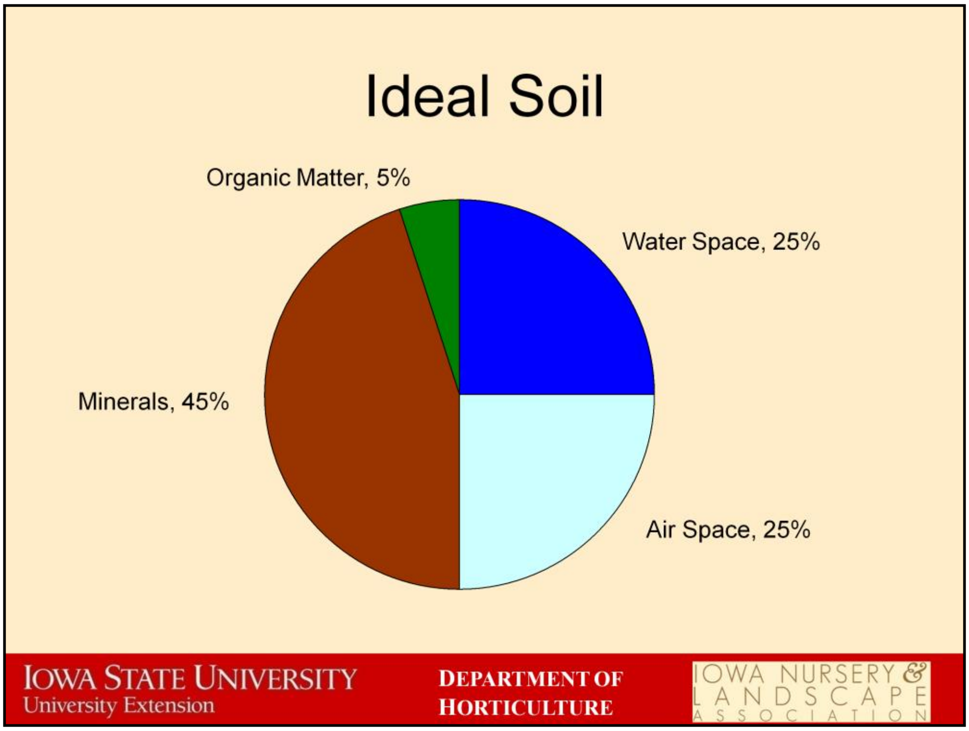
Soil texture is the relative proportion of the three soil particles. The proportion of sand, silt and clay in an area is determined by the bed rock material and the weathering that has occurred. Soil texture is very difficult to change. Adding sand to a heavy clay soil sounds like it might be a good corrective measure, but adding sand makes the sand-clay mixtures more like concrete.

Some soil texture types you may have heard of include, clay, loam, and sandy loam. Loam soils are those that have equal percentages of sand, silt and clay. Loam soils are ideal because they incorporate the best characteristics of each particle without being thrown out of balance.



Soil structure describes how the individual particles of sand, silt and clay are stuck to one another. Soil clods or clumps are types of soil aggregates. Unlike texture, structure can be changed over time. Some things that change soil structure include: freezing and thawing, wetting and drying, animal activity, and human activity (tillage). All of these activities can change soil structure for the better and worse. Tilling a field will decrease the aggregate size, while adding organic matter will act like glue sticking more particles together.

Different types of aggregates benefit plants in different ways. Some soil aggregates have more pore spaces to hold water and nutrients. While others provide open paths for root to grow through. Having "good" soil structure influences the availability of water, nutrients, air, and rooting space.



The percentage, in a volume of soil, that should be water space, air space, the clay, silt, or sand (minerals), and organic matter may not be what you would expect. When you dig up a shovel full of soil, you mostly see the minerals. What you don't see is that about half that space is empty! That empty space allows oxygen to reach the growing roots and water to be absorbed. The ideal soil is 25% air space, 25% water space, 45% minerals, and 5% organic material.

Soil pH

- Most plants grow in range 4.5 – 7.0
- pH very hard to change
- Small changes easier
  - Make more basic (higher pH), add dolomitic limestone
  - Make more acidic (lower pH), add sulfur products

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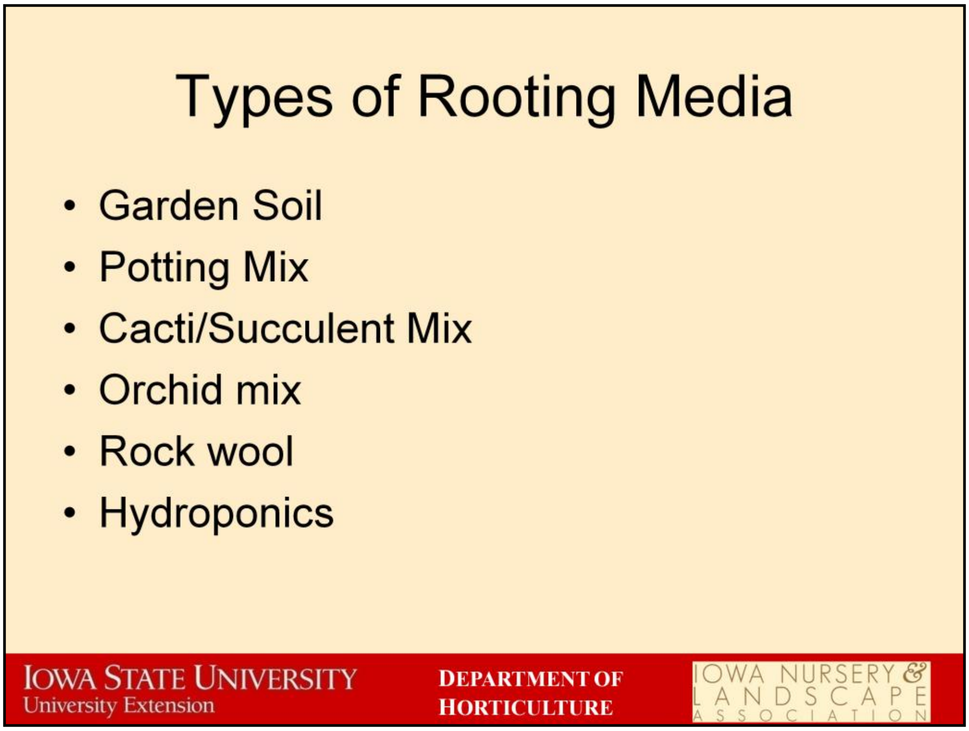
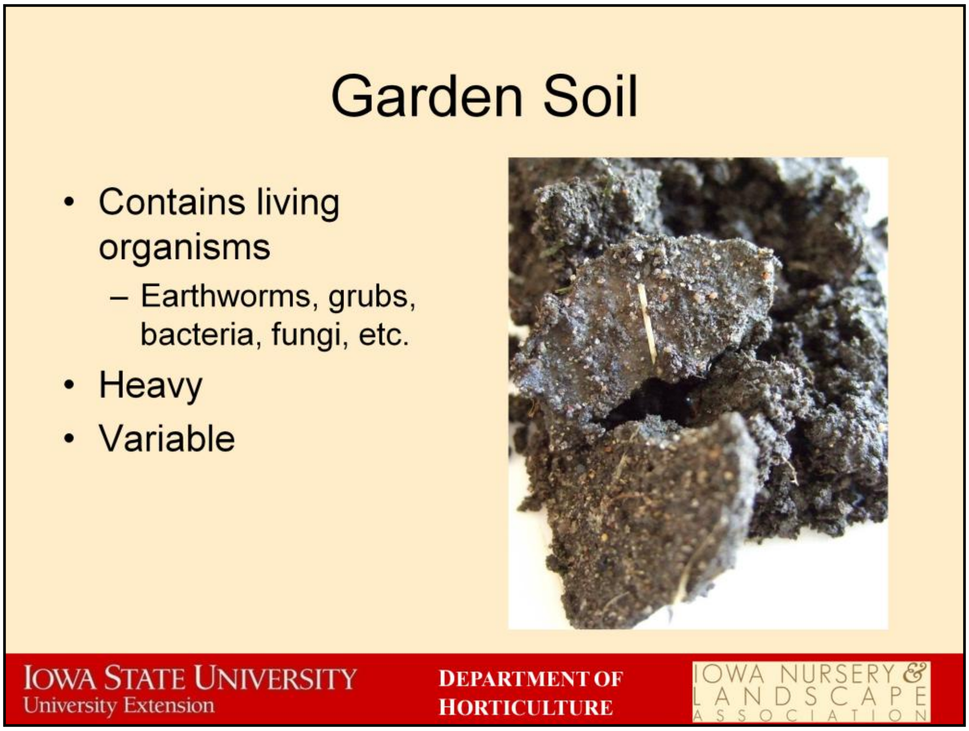
Soil pH is just as critical to plant success as any other feature of soil. Not having the proper pH level can limit what nutrients are available to the plant. The typical range of soil pH is 4.5 to 7.0.

Although raising or lowering pH seems like a simple process, it can be a difficult proposition because pH is measured on a logarithmic scale rather than a linear scale. For example, lowering a pH of 7.0 to a pH of 6.0 sounds like a relatively small amount (a difference of 1), but it is actually a difference of 10^1, or 10 times. A pH of 5.0 is 10^2 points lower, or 100 times lower than 7.0. To create that much change in pH, and keep the change from reverting back to natural conditions, on-going soil amendments may be required, and this may be difficult to do in an established landscape.

Small scale changes, like those required to grow certain acid-loving plants, can be done. For a more acidic soil sulfur products can be used to lower the pH. To make the soil more basic, add dolomitic limestone.



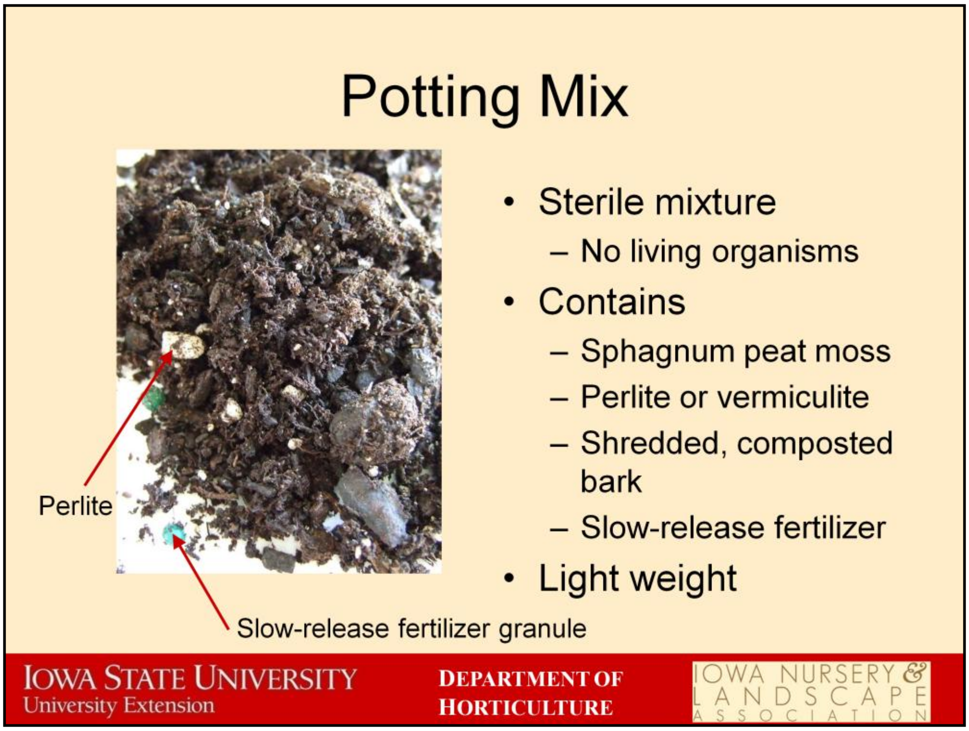
So those are the basics of soils. Now, within horticulture we use different types of rooting media for different purposes. We will discuss a few types of rooting media that are common in horticulture and couple that are more unusual.



Garden soil is what you would find if you dig up your yard. Garden soil is different from the other types of rooting media we will discuss because it has living organisms. Earthworms, grubs, bacteria, fungi, and many other organisms call garden soils home.

The quality of garden soil depends on the bed rock material that is beneath the soil, the organism activity, and on the nutrient levels.

Garden soils are best used where they are found. Nursery people do not use garden soils when they are growing their crops because garden soils are so variable it is difficult to generalize the care for a hundred pots. Garden soils are also heavy and therefore expensive to ship.

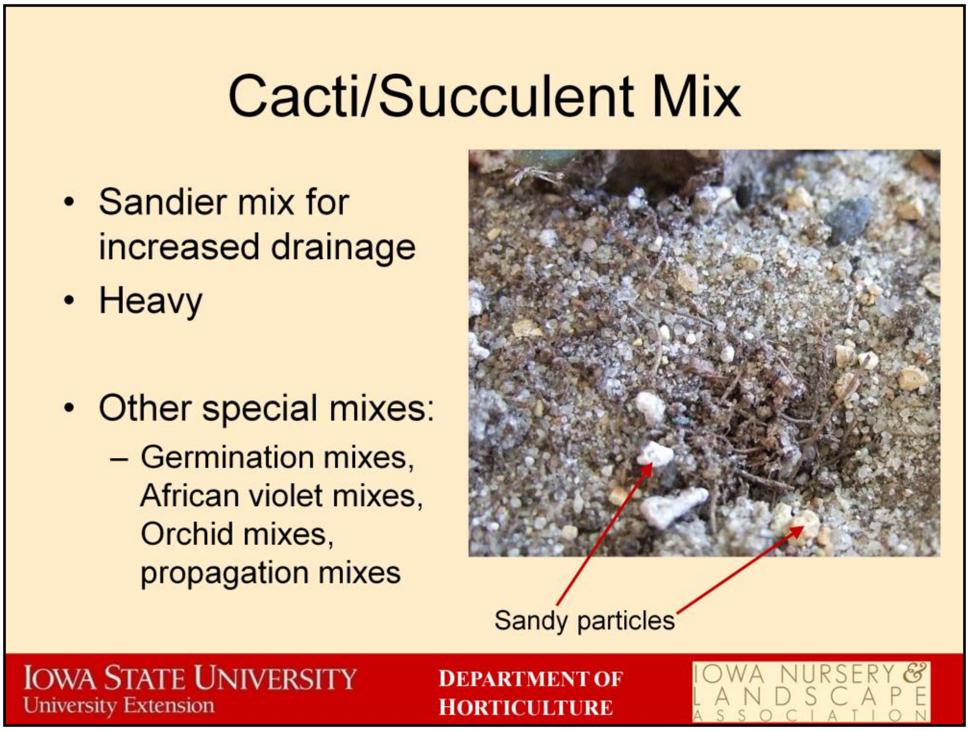


Instead of garden soils, nursery people use potting mixes or soilless mixes. Potting mixes are sterile, containing no living organisms at all. Most potting mixes are an equal-portion mixture of spaghnum peat moss, perlite, and shredded bark (or other organic material). Peat is used to make up the bulk of the mix and increases the water holding capacity of the mix. *Peat moss can hold up to 20 times its dry weight in water.*

Partially composted, shredded bark increases the water holding capacity even more. It also increases the nutrient holding capacity and lasts longer than the peat moss, so later becomes the major structural component.

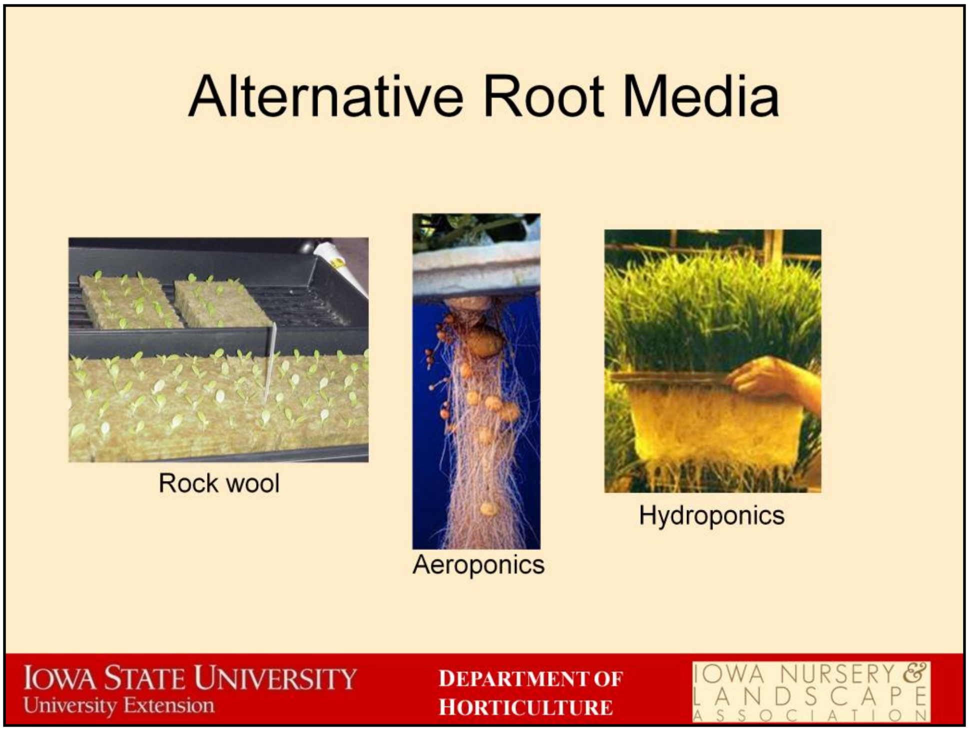
Perlite, expanded volcanic rock, is added to increase pore space and keep the mix light weight. Perlite is the white stuff in potting mixes.

Some potting or soilless mixes contain slow-release fertilizers.



Special mixes, like cacti and succulent mixes, have characteristics that make them particularly well suited for growing more unique plants. Cacti and succulent mixes have more sand then most other mixes because quick drainage is critical to growing cacti well. Also cacti tend to be a little more top heavy, so having the sandier mix provides a counter-weight to keep the plant up-right.

Other specialized mixes include: germination mixes, African violet mixes, Orchid mixes, and propagation mixes. Each mix is suited for the unique use it is intended for. Germination mixes have smaller particles and stay moist longer for the newly germinated seedling. Orchid mixes have large chunks of bark that replicate the tree bark orchids grow on naturally.



In situations where a rooting media we have already discussed would be inappropriate or cost prohibitive, new media have been developed. Many plant seedlings for commercial vegetable production are grown in rock wool blocks. Some plants, even for space exploration, are being grown in a water-nutrient solution with no solid material at all.

The growing of plants in water instead of soil is called hydroponics.

Some plants are being grown with their roots just hanging in the air!

That is called aeroponics.

Now on to fertilizers.

Essential Nutrients

- Essential for proper plant growth and development
- 17 of them
- Macronutrients
  - Required by the plant in larger amounts
  - May require supplementation
- Micronutrients
  - Required by the plant in smaller amounts

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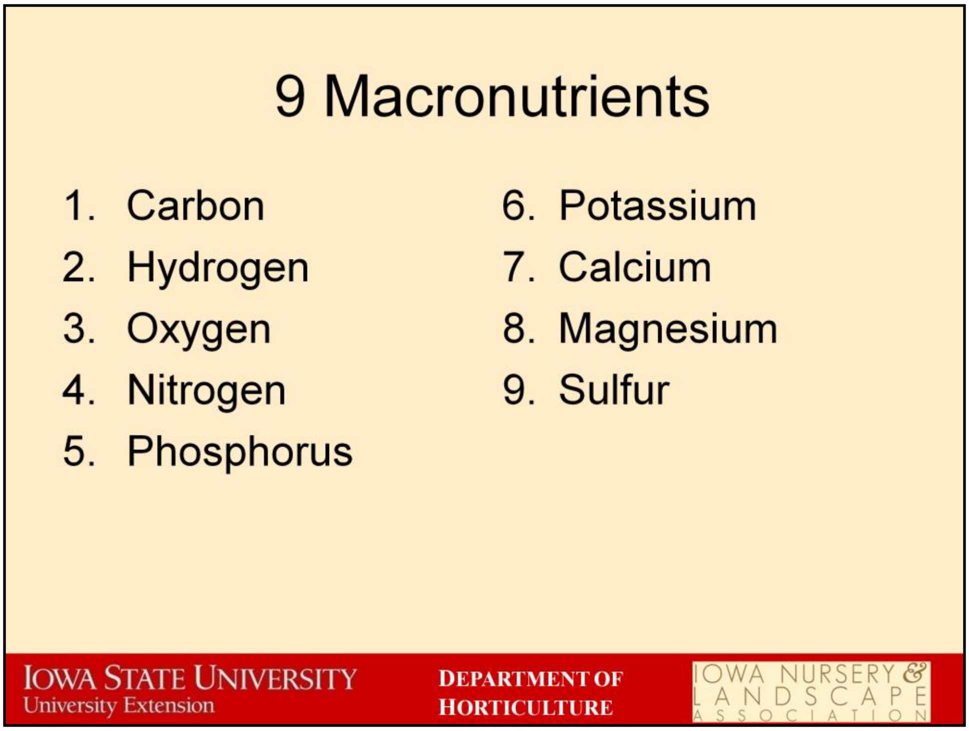
There are 17 essential mineral nutrients that plants require for proper growth and development. The group of 17 has been divided into two smaller groups. **Macro**nutrients are those nutrients that are required by nearly all plants in larger quantities. These nutrients are often those we add when we fertilize. **Micro**nutrients are those that are required in much smaller, trace amounts by the plant. These are typically not added in fertilizers because they exist in the soil in adequate amounts or can be found in irrigation water.



There are 9 macronutrients required by most plants for proper plant growth and development. They are: carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, calcium, magnesium and sulfur.

8 Micronutrients

10. Iron
11. Boron
12. Manganese
13. Zinc
14. Molybdenum
15. Copper
16. Chlorine
17. Nickel

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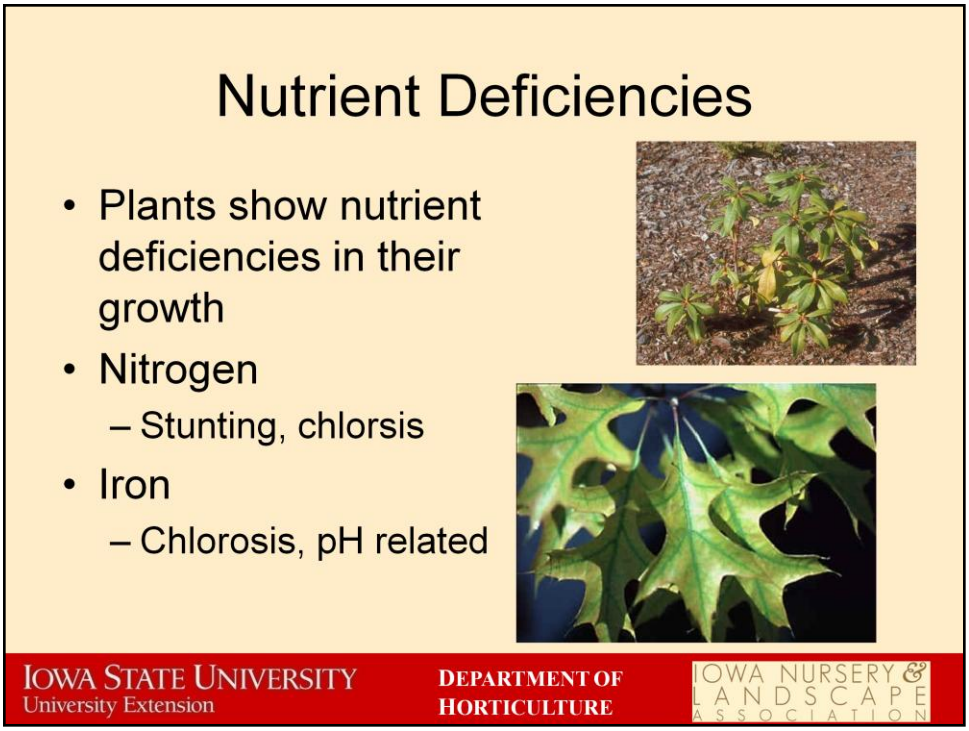
There are 8 micronutirents. They are: iron, boron, manganese, zinc, molybdenum, copper, chlorine, and nickel. We usually do not need to add any of these nutrients because they are required in such low levels, they are never depleted from the soil. If they are low and need replenishing, fertilizers can be found that can supplement them.

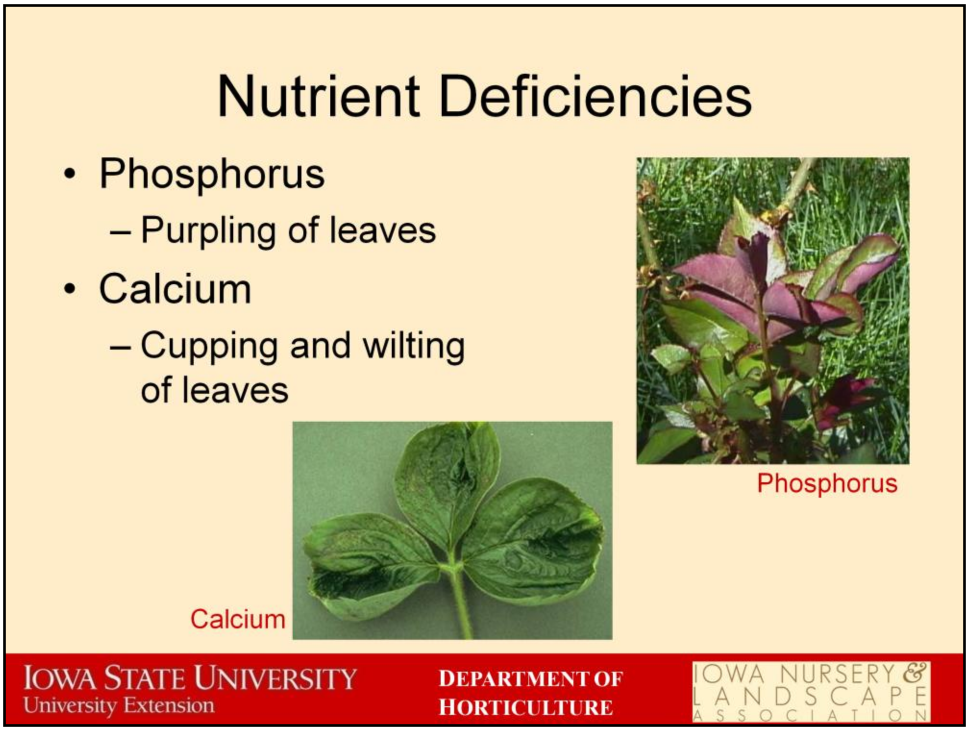


Nutrient deficiencies occur in growing plants that are lacking one or more of the 17 essential nutrients. The deficiencies are manifested in different ways in the growing plant depending on how that nutrient is used.

Most commonly, plants show stunted growth and chlorosis, or yellowing of the leaves, when they lack nitrogen. Nitrogen is short-lived in the soil because plants use so much of it during the growing season. Nitrogen deficiencies can be corrected by applying a nitrogen heavy fertilizer. Chlorosis is not only symptomatic of lower nitrogen levels.

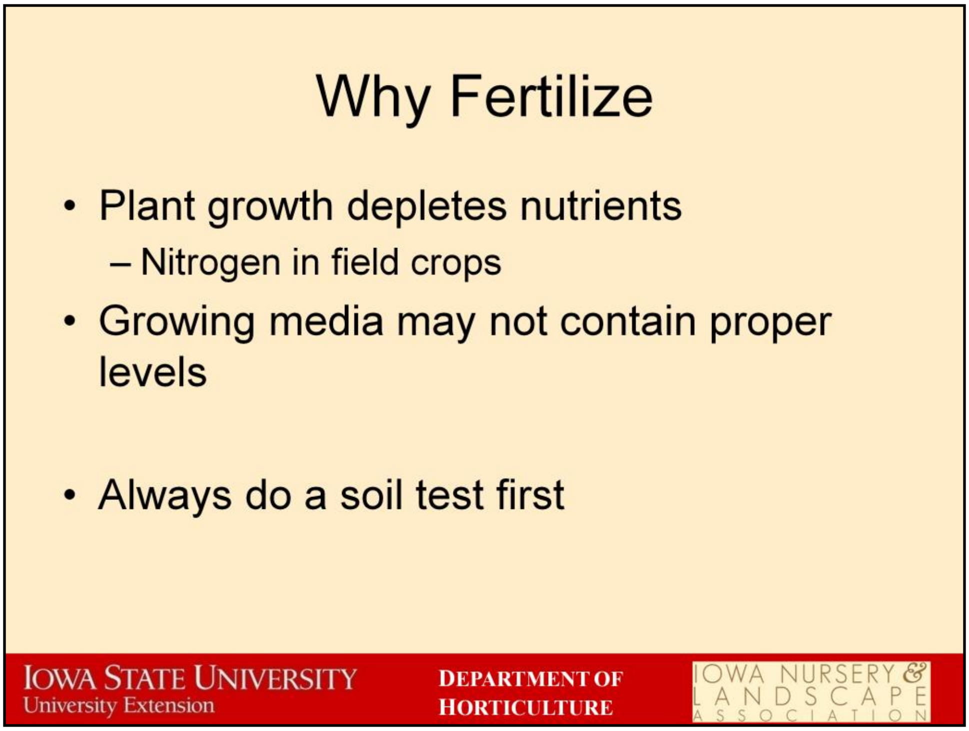
Other nutrient deficiencies like iron chlorosis are caused by the unavailability of iron. There is plenty of iron in the soil, but the soil pH makes it difficult for the plant to absorb the iron it needs. Treating this deficiency with iron will not correct the problem; the soil pH needs to be addressed. But, as we discussed earlier, soil pH is very difficult to change.

A common example of iron chlorosis is on Pin Oaks in some mid-western states.



To illustrate how different the symptoms of a nutrient deficiency can be, let's look at phosphorus and calcium. Phosphorus is important in releasing ATP and building chemicals necessary for normal development. A deficiency of phosphorus often shows up as purpling of leaf tissue. *If left untreated phosphorus deficiencies can lead to aborted flower buds and fruit and seed development.*

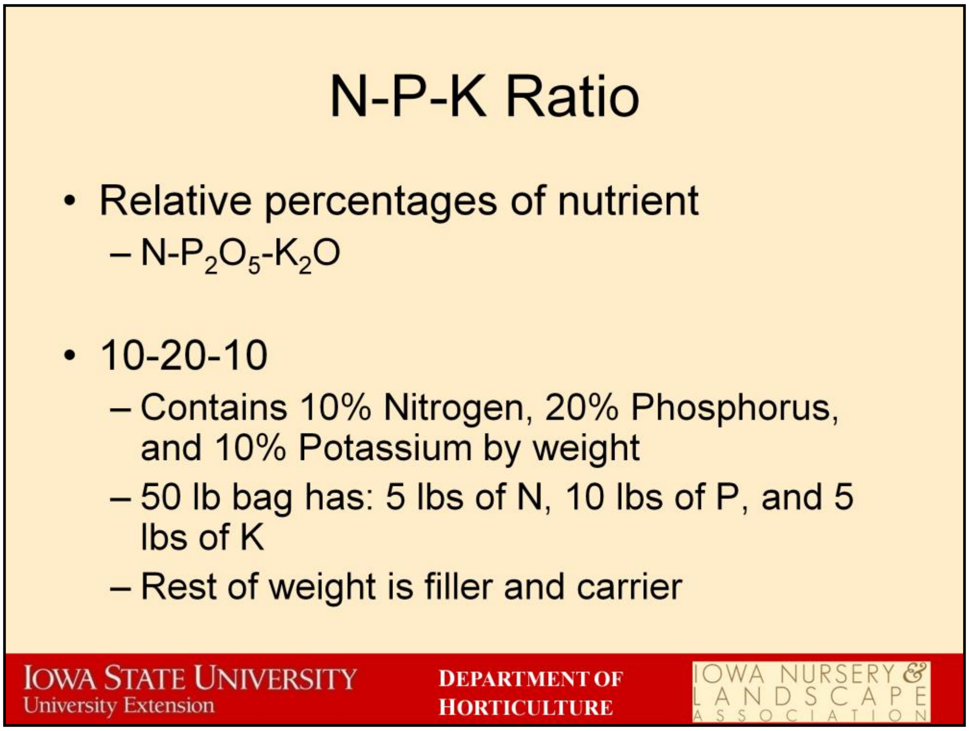
Calcium is used in the plant cell wall. *The plant cell wall helps give leaves their shape.* Without calcium, leaf tissues curl and wilt. Untreated, a calcium deficiency can lead to the death of the growing tip.



If a rooting medium contains these essential nutrients, why do we need to fertilize? We fertilize for a couple reasons: 1. plants growing in a soil or rooting media use up the nutrients that were there; 2. not all soils are created equal. Not all the essential nutrients are present in a soil in the amounts required by the plant.

Farmers who use a field every year place great demands on the soil for nutrients. Corn and soybeans use up a lot of nitrogen in the soil. In an uncultivated area, nitrogen is put back into the soil by decomposing plant material. But in a field situation that plant material is removed with harvest and so is that source of nitrogen. That is why we need to replenish the soil's nutrients in order to continue using that soil for plant production.

Before selecting and applying any fertilizer product, be sure that you have done a soil test to determine which nutrients are needed. *Applying chemical fertilizers when they are not needed contributes to run-off and pollution of local bodies of water. Also applying unneeded fertilizers can be an expensive waste of money.*



When selecting a chemical fertilizer product, you need to know the ratio of nitrogen, phosphorus and potassium in that product. The N-P-K analysis is the relative percentages of the nutrients.

For example a 50 pound bag of granular fertilizer with an analysis of 10-20-10 has 5 pounds of Nitrogen, 10 pounds of Phosphorus, and 5 pounds of Potassium. The remaining weight of the bag are the fillers and carriers to which the chemicals are attached making their application easier.

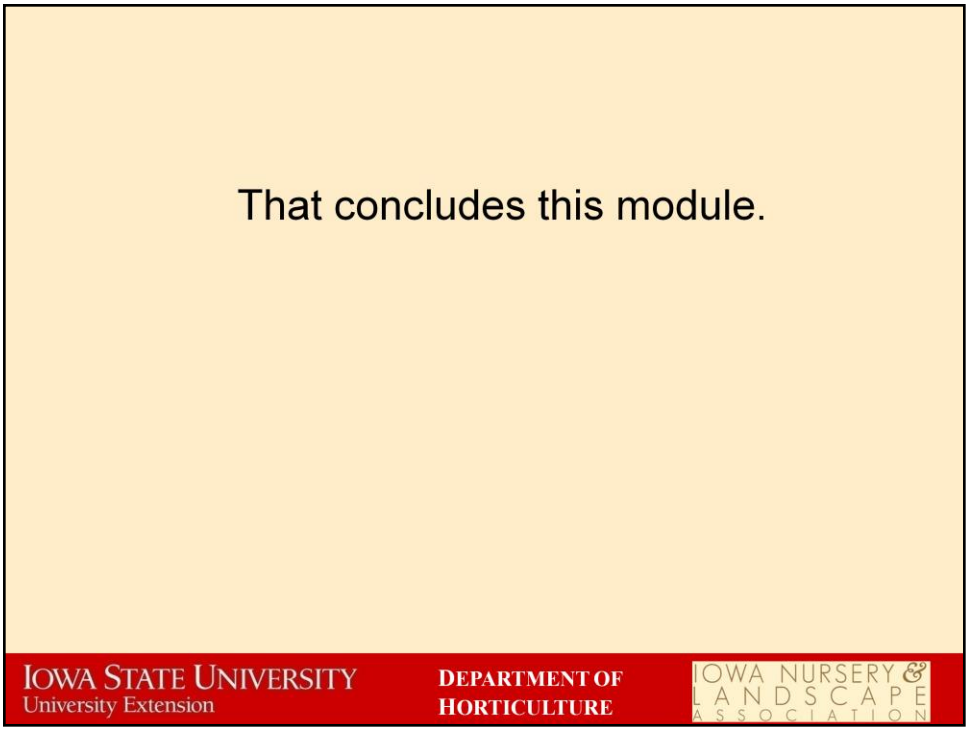
Perhaps what is more important is how sequences are related to one another. For example, 4-8-4, 5-10-5, 10-20-10 have the same relative amounts of the nutrients. They are all 1-2-1. Knowing that you could apply a 10-20-10 at half the rate and get the same result as apply the 5-10-5 at the recommended rate.

Different fertilizer analyses are appropriate for different uses. A starter fertilizer is typically higher in phosphorus. Phosphorus is used within the plant to release energy and build plant hormones. This directly relates to faster plant growth and establishment.

A complete fertilizer, on the other hand, has equal amounts of each N, P, and K. This equal proportion maintains plant growth.

A blossom booster fertilizer is extremely high in phosphorus because it is critical in flower production. A flowering plant that is given high levels of phosphorus, will bloom more profusely than one not given a blossom booster fertilizer.

Chemical fertilizers are not the only way to add nutrients to your soil. There are many organic options also. Things like composted animal and plant waste, bone meal, and alfalfa hay can all be added to the soil to increase the nutrients. There are benefits and disadvantages of using organic fertilizers. The benefits include: they are not chemicals and they are typically a waste product from another process. The disadvantages are: they do not have a set analysis and often require larger volumes for the same result. Large volumes of a product are difficult to incorporate into the soil of an established landscape.



That concludes this module.