GECAC Garden Lesson

Topic: Soil

Learning Points:

- Soil is the naturally occurring, loose materials at the surface of the earth. Soil has minerals from rocks and nutients from dead plants and animals.
- Soil is capable of supporting plant and animal life. Soil is very important for plant growth. We have learned that plant growth is very important for human survival.
- Organisms and microorganisms (fungus, bacteria and invertebrate, including worms) in the soil are very important for plant growth. They take in oxygen to survive and give off carbon dioxide. Plants take in carbon dioxide to produce the plant's food and give off oxygen, which humans need. (See Oxygen Cycle graphic)
- There needs to be an adequate amount of soil pores (pockets of space) in soil to hold the air and water that both plants and soil organisms need to survive and thrive.
- Mineral particles (from rocks), organic matter (from once living organisms such as trees, leaves, flowers, and animals) and soil organisms together create pores or spaces in the soil where air and water can pass and roots can grow.
- Some soil types are better at creating soil pores (spaces) than others.
- There are primarily three types of soil: clay, sand and silt. They can be blended in several different porportions to create different mixtures of soil, some being very porous (a lot of pore space) and others having very little.
- Good quality soil (referred to as Loam) has the ideal mix of sand, silt, and clay along with lots of humus (decomposed organic matter). Loam has a variety of nutrients and the ability to hold air and water for the plant roots and the organisms that live in the soil. (see Soil Type Chart)
- Soil having too many smaller particles such as sand and clay can block soil pores making it more difficult for roots to grow and soil organisms to survive. Clay can become very hard to dig when it gets too wet or too dry.
- We must protect our soil and its creatures by adding materials and nutrients that improve the soil's quality. Note: This is a lead-in to composting (decomposition) and mulching which will be introduced later.

Key Terms:

Soil: The upper layer of earth in which plants grow. Soil can be a few inches to more than 100 feet deep. Soil is created over thousands of years, primarily from disintegrated and decomposed rocks and organic matter.
Nutrients: substances that provide nourishment, e.g. minerals and organic matter.
Organic Matter: anything that was once alive (leaves, flowers, fruits, branches, animals, etc)
Minerals: rocks broken down into particles
Decomposition (verb: decompose): to break down organic matter from a complex to a simpler form, mainly through the action of fungi, bacteria, and invertebrates.
Invertebrate: an animal that does not have a backbone, e.g. an insect or worm
Fertility(adjective: fertile): describes soil that is rich in the nutrients needed to sustain the growth of healthy plants
Clay: a fine-grained material consisting mainly of hydrated aluminum silicates that occurs naturally in soil and sedimentary rock. Use: in making bricks, ceramics, and cement.
Sand: a substance consisting of fine loose grains of rock or minerals, usually quartz fragments, found on beaches, in deserts, and in soil, sometimes used as a building material. Sand is finer than gravel but coarser than silt, with particle sizes between 0.06 mm and 2 mm
Silt: a fine-grained sediment, especially of mud or clay particles at the bottom of a river or lake. Silt also found in soils where rivers or lakes once existed or overflowed. Note: Manteca has history of being a lake and having river overflows.
Gravel: The largest particle of soil. Gravel looks like small, smooth rocks. The large size and uneven surfaces create large pore spaces.
Humus: The decomposed organic matter of soil, which normally ranges from 1-5 percent by volume in an average soil. It is derived mainly from dead plants and animal remains.
Loam: A name given to soils that have the ideal mix of sand, silt, and clay along with lots of humus. Loam contains more silt or sand than clay. (See Soil Type Chart)

Common Core Standards:
Science: K-LS1-1: Use observations to describe patterns of what plants and animals need to survive.
Science: K-ESS3-3 Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.
Science 2-LS4-1: Make observations of plants and animals to compare the diversity of life in different habitats. (Use different types of soil mineral particles, eg. clay, sand, silt as examples of different habitats, therefore plants must adapt as do humans when building structures)
Science 3-LS3-2: Use evidence to support the explanation that traits can be influenced by the environment. (Apply to the different types of soil and their impact on plant development)
Speaking and Listening K-SL3 thru 3-SL3: Ask and answer questions…….for understanding.

Items Needed:

- Gravel – at least 36 ounces (volume)
- Sand - at least 36 ounces (volume)
- Seed Starting Soil (used in Unit 2) - at least 36 ounces (volume)
- Your school garden top soil (used in Unit 2) - at least 36 ounces (volume)
- Potting Soil - at least 36 ounces (volume)
- 5 each non-breakable containers or buckets that will hold at least 36 ounces of the above dry soil materials
- 5 clear one quart jars with lids* (*lids will only be needed if you choose to store the soil or do optional activity)
- 5 funnels with mouths about 6 inches in diameter to fit coffee filters
- 20 coffee filters (1 each/group x 5 groups x 3 classes plus 5 extra) basket style (circular with flat bottoms – not pointed at bottom)
- 5 each measuring cups that can measure milliliters (could get by with one – see Preparation)
- 5 each water containers with at least a quart of water in each (could use one larger container –see Preparation)
- Cleanup materials (including storage of wet soils at end of each class). Soils are reusable so should not mix.
- One blank chart (see attached) to record water levels of the five soil materials.

Preparation: (Based on 3 classes (total of 120 students), each with 40 students with 5 groups of 8 students)

1. Place at least 36 ounces of soil material in each of the 5 non-breakable containers or buckets as follows:
   Group 1: Gravel
   Group 2: Sand
   Group 3: Seed starting soil (mix)
   Group 4: Native top soil from school garden
   Group 5: Potting soil (mix)
2. Place all items at the designated location for each group.
3. If each group does not have a measuring cup you could pre-measure the soil and water, but will need additional containers. Note: it would likely take too long to individually measure out each group during activity with one measuring cup.
4. Label the soil material containers with material type.
5. Label the quart jars with soil material type (place the label near the top of the quart jar).
6. Have a timing device available (could use a classroom clock if indoors –timing doesn't have to be exact).
7. Have containers handy to empty wetted soil materials after activity. Do not mix different soils together.
8. Have cleaning materials handy to rinse out jars between classes and wash dirty hands and spilled soil and water.
9. Preselect your 5 groups of students for each class (Use Student List and Water Log form).
10. Have your Student List and Water Log form available to note the measuring cup results for water drained and water retained.

Begin Class Lesson:

Statements: (3 minutes)

- One of the important factors for a healthy garden is the soil.
- Soil is the naturally occurring, loose materials at the surface of the earth. Soil has minerals from rocks and nutients from dead plants and animals. Soil may be called dirt, especially by children who play in it or parents who have to clean their children's dirty clothes.
- Soil is very important for plant growth. Soil is capable of supporting plant and animal life. Plant growth is very important for human survival. Therefore good soil is important for human survival.
- Good quality soil has billions of organisms and microorganisms (fungus, bacteria and invertebrate, including worms) living in it. They take in oxygen to survive and give off carbon dioxide. Plants take in carbon dioxide to produce the plant's food and give off oxygen, which humans need. (See Oxygen Cycle graphic)
- There needs to be an adequate amount of soil pores (pockets of space) in soil to hold the air and water that both plants and soil organisms need to survive and thrive.
- Mineral particles (from rocks), organic matter (from once living organisms such as trees, leaves, flowers, and animals) and soil organisms together create pores or spaces in the soil where air and water can pass and roots can grow.
- Some soil types are better at creating soil pores (spaces) than others.
- There are primarily three types of soil: clay, sand and silt. They can be blended in several different porportions to create different mixtures of soil, some being very porous (a lot of pore space) and others having very little.

Activity Explanation: (2 minutes)

- For you to better understand why one type of soil may be better for plants than another we are going to conduct an experiment to see which of these soil materials drains water the quickest and which soil materials holds the most water.
- Some of the soil materials we are using are only one type of material (gravel and sand) and others are a mixture of materials (starter soil, school garden soil, school raised bed soil or potting soil). Note: students can identify which soil material they have from the label on the soil container or jar.
    - Note: If student(s) ask about what is in the soil mixes you can respond as follows:
        - Gravel: broken up rocks
        - Sand: Better broken up rocks
        - Seed Starting soil: Primarily (70-80%)Peat Moss (organic matter/forest product) and perlite(volcanic glass used for water and heat retention)
        - School native soil: Not totally sure, but in Manteca likely a goodly amount of sand; some silt
        - School raised bed soil: Not sure, but if purchased likely has Peat Moss; other forest products and possible some sand or perlite.
        - Potting Mix: Similar to Seed starting mix, but has some larger particles of forest products
- You will decide which soil or combination of soils would be best in a garden.
- Lastly, you will decide (time permitting) if your school garden soil (native soil) is good or will need something added to make it better. Note: This is a lead-in to composting (decomposition) and mulching which will be introduced later.

Activity Instructions: (8 minutes)
Have students trade off in doing the following steps:

1. Have each group fill their measuring cup with exactly one cup of their soil material (unless you pre-measured). Note: They can lightly press down on the soil material in the measuring cup to make sure that it is an accurate measurement.
2. Using a clear quart jar, a coffee filter, and funnel, place funnel over opening in quart jar; place filter in funnel
3. Carefully pour the cup of soil into the paper filter being careful that the soil doesn't fall into the jar.
4. Fill the measuring cup with exactly one cup of water (unless you pre-measured). Do not pour the water onto the soil until told to do so.
5. When all five groups have placed their soil in the paper filters, state the following:

Prediction
Statements: (4 minutes)

- Raise your hand if you think your water will move through the soil material faster than the rest. Why?
- Raise your hand if you think your water will move through the soil material slower than the rest. Why?
- Raise your hand if you think your soil material will hold the greatest amount of water. Why?
- Raise your hand if you think your soil will hold the least amount of water. Why?

Note: At this point the 5 jars with funnels, etc. could be placed next to each other in a highly viewable location so all students can easily watch the flow of water. A designated person from each group will pour on your command. Ask those students to move out of the view of the jars so all students can observe what happens.
Instructions: (3 minutes)

- When I tell you, all groups will **carefully** pour your cup of water into the soil.
- We will let the soil drain for 2 minutes and then we will remove the funnel and place it down carefully (in pre-designated location) making sure we don't spill the soil material. It may still be dripping a little, but that's OK. Any questions?

Statement: Start pouring – (time for 2 minutes).
Note which soil drained the fastest and slowest
After 2 minutes:
Statement: Remove the funnel and carefully place it (designate a location)* without spilling the soil. (*decide where to place funnel and wetted soil materials)
Statement: Let's see how much of the cup of water that you poured into the soil made it through to your jar.
Instructions: (6 minutes)

1. Empty each quart jar into the measuring cup and note on the Student List and Water Log form the amount of water that drained into the measuring cup (probably in milliliters would be most accurate).
2. After measuring the amount of drained water, pour each group's water back into their quart jar.
3. Determine the amount of water that was retained in the soil by subtracting the amount of water in the measuring cup from the initial 1 cup (250 milliliters) of water (See Student List and Water Log Sample Form).
4. Announce the numbers for each group.

Questions: (3 minutes)

- Which soil(s) drained the fastest?
- Which soil(s) drained the slowest?
- Which soil(s) kept (retained) the greatest amount of water? Why do you think this happened?
- Which soil(s) retained the least amount of water? Why do you think this happened?

Explanation/Discussion: (3 minutes)
You may get a variety of answers and questions, but most importantly is the fact that larger particles create greater pore space in soil therefore allowing more water and air to pass through the soil. Therefore the water in the gravel and/or the potting soil should have been the fastest to move through the soil material. Another factor can be the nature of the material and how absorbent it is (rock vs. wood).
Also gravel and sand are not organic matter; therefore they do not have many of the most important nutrients (Nitrogen, Phosphorous, Potassium, and others) that allow plants to grow healthy.

Optional Questions (Time Permitting): (5 minutes)

- Which soil do you think did the best at creating soil pores (spaces) for water and oxygen as well as provided needed nutrients for plants? (The best answer would be the mixed soils (seed starting mix and potting mix) followed possibly by the school's native soil which has some organic materials).
- What can you say about the school's native soil? Is it on the sandy (mineral) side or more on the organic matter side? (It likely is more on the sandy side)
- What would you need to add to the school's native garden soil to make it better for plants?
  (Add more organic matter (composted soil) which would, create more soil pores (hold more water and oxygen), attract more organisms, and add more nutrients to the soil.

Wrap Up

Statements: (1 minute)

- Good quality soil (referred to as Loam) has the ideal mix of sand, silt, and clay along with lots of humus (decomposed organic matter). Loam has a variety of nutrients and the ability to hold air and water for the plant roots and the organisms that live in the soil. (see Soil Type Chart)
- Soil having too many smaller particles such as sand and clay can block soil pores making it more difficult for roots to grow and soil organisms to survive. Clay can become very hard to dig when it gets too wet or too dry.
- We can/must protect our soil and its creatures by adding materials and nutrients that improve the soil's quality.

Optional Activity

If you are teaching younger students and want to simplify the lesson or you don't have the time or the supplies needed to conduct the above lesson you might consider something as simple as this.

Preparation

Get the following:

- large rock (such as a cobblestone)
- large sponge (preferably one with easily observable air pockets)
- 2 large bowls
- One pint of water
- One or two measuring cup(s)

Content

Introduce the key points of the content from the above lesson (modify as needed)

Activity

Replace above lesson activity with this one.

1. Show students the rock and sponge (you might want to select other materials that are less obvious than these).
2. Talk about how they are similar and different.
3. Ask students which one (rock or sponge) has more of the qualities that we find in good soil. (refer back to content)
4. Ask why (students should restate importance of soil pores that hold water and air for the plants roots).
5. State: Let's find out by pouring a cup of water over the rock and the sponge to see which one holds the most amount of water.
6. Pour a cup of water over each of the items as you hold them over separate bowls. Then pour the water from each bowl back into the measuring cup to see how much water was not retained by the rock and sponge.
7. Ask why the sponge held more water than the rock. (The sponge has many pores that held the water and the rock didn't).
8. State: That is why most plants grow healthier when they are in a soil that has pores to allow their roots to get oxygen and water.