

Unit E: Organic Matter

Lesson 2: Organic Matter in Soil

Student Learning Objectives: Instruction in this lesson should result in the students achieving the following objectives:

1. Explain where organic matter is found in the soil.
2. Describe how organic matter is formed in soil.
3. Explain the use of organic matter by plants.

Recommended Teaching Time: 2 Hours

Recommended Resources: The following resources may be useful in teaching this lesson

- A PowerPoint has been provided
- <http://www.noble.org/ag/soils/OrganicMatter/Index.htm>
- http://soils.usda.gov/sqi/concepts/soil_biology/earthworms.html
- <ftp://ftp.fao.org/agl/agll/docs/sb80e.pdf>

List of Equipment, Tools, Supplies, and Facilities:

Writing surface
PowerPoint Projector
PowerPoint Slides
Copies of Student Worksheets
Earthworms
Paper to shred
Boxes of different sizes
Plant Pots with holes in bottom
Sand
Water
Seeds to plant

Terms: The following terms are presented in this lesson (shown in italics and on PowerPoint Slide 2)

- Organic Matter
- Decomposition
- Humus
- Water Holding Capacity

Interest Approach: Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

Split students into pairs. Have them answer the following questions.

- 1. What makes one soil better than the other?**
- 2. What texture is best for plant growth?**
- 3. What things in soil hold water?**
- 4. What is the smallest section of soil that isn't water, air, and soil minerals?**
- 5. Where does the majority of soil nutrients come from?**

After they answer these five questions, have each pair compare answers with the group next to them. Then give them the correct answers and see which groups have the most correct answers.

Summary of Content and Teaching Strategies

Objective 1: Explain where organic matter is found in the soil.

(PowerPoint Slide 3)

- I. Healthy soil consists of 5% *organic matter*.
 - A. 90% of all organic matter is found in the top 25 centimeters. The majority of that is in the top 15, where the animal and plant material begin to decompose. The *decomposition* of the material causes the soil to appear very dark. The healthier the soils, the deeper and darker the organic material will be.
 1. More organic matter is found in grassland and forest areas. Bare soil, mountainous areas, and arid areas do not have the same organic matter as forests and grasslands.
 2. Any part of the soil that is considered to be "weathered" will have some sort of organic matter in the soil.

Have students go outside in groups of 3. Each group should go to different parts of the school grounds and start to dig. They should measure when the soil changes colors from a darker color to a lighter color. They should record their place and measurements on handout WS: 1E-1. Have the groups come back to class and share their findings. Use TM: 1E-1 as a reminder to the students of the Soil Profile lesson and how they are now going to be specifically looking at the A horizon.

Objective 2: Describe how organic matter is formed in soil.

(PowerPoint Slide 4)

- II. Organic matter is composed of plant and animal material that is in the process of decomposing.
 - A. Decomposing is to separate into simple components or basic elements.
 - B. Organic Matter has several functions:
 1. Stabilizes soil structure.
 2. Increases water retention and availability.
 3. Increases drainage and aeration.
 4. Increases cation exchange capacity.

5. Supplies nutrients upon decay (only if low C:N ratio).
6. Stabilizes pH7.
7. Food source for microorganisms.

(PowerPoint Slide 5)

- C. Organic matter that is fully decomposed is called *Humus*.
 1. All soil contains varying percentages of decaying matter.
 2. Humus, or the remnants of decaying matter, is long lasting, stable and vital for soil health and plant growth.
 3. Humus absorbs moisture, serving as a reserve for plant roots during times of drought.
 - a. It also shrinks and expands during dry or wet stages, providing air movement for plant roots.
 4. Humus provides several important organic acids and trace elements plants need but does not contain nitrogen or phosphorus.
 5. Desert sand contains very little humus.
 6. Desert or rocky/gravel soils have little or no organic matter and also do not support plant life.
 7. Soil that is all decaying matter or humus is called peat and is infertile.

(PowerPoint Slide 6)

- D. Of all the members of the soil food web, earthworms are the major decomposers of dead and decomposing organic matter, and derive their nutrition from the bacteria and fungi that grow upon these materials.
 1. They fragment organic matter and make major contributions to recycling the nutrients it contains.
 2. Earthworms occur in most temperate soils and many tropical soils.
 - a. They are divided into 23 families, more than 700 genera, and more than 7,000 species.
 - b. They range from an inch to two yards in length and are found seasonally at all depths in the soil.
 3. In terms of biomass and overall activity, earthworms dominate the world of soil invertebrates, including arthropods.

(PowerPoint Slide 7)

4. Earthworms dramatically alter soil structure, water movement, nutrient dynamics, and plant growth.
 - a. They are not essential to all healthy soil systems, but their presence is usually an indicator of a healthy system.

Set up a collection of earthworms in a box with small air holes in it. In this box of worms, place some soil and some shredded paper into the box. Have this box set up 2 weeks in advance of this lesson. Then a week before the lesson, do the same thing with a second box. Then when this part of the lesson comes up, have the students look at each box. Describe to them that earthworms help decompose things into soil. Then have small boxes for groups of 5 students. These students should collect some paper, shred it and place it into the box.

Then they should go to the boxes of earthworms that you have set up and take some for their own boxes. WS: E1-2 explains how to make and use a worm bin.

Objective 3: Explain the use of organic matter by plants.
(PowerPoint Slide 6)

- III. There are many ways that plants use organic matter found in soil.
 - A. Adding organic matter to sandy soil adds more water holding capacity to that soil.
 - 1. *Water holding capacity* helps the plants by providing extra water for the plant roots to uptake for growth.
 - 2. Sandy soil does not hold very much water naturally so anything that can be added to the soil to increase that is beneficial.
 - B. Organic matter has important nutrients that are needed for plants to grow including nitrogen and other important elements.
 - 1. Nitrogen, phosphorous, and potassium are most beneficial for plants and are greatly increased with more organic matter.
 - C. Organic matter helps break soil up as well as helping prevent soil compaction.

Have students take a plant pot that has a hole in the bottom and fill it with a mixture of sand and some of the left over “material” from the earthworm boxes. They should mix everything up thoroughly. Have them pour some water into the plant pot. Then they should take another plant pot that has a hole in the bottom and fill it with just regular sand and add the same amount of water. Have the students make observations and see the difference in water holding capacity. Have the students record their findings and share their information with the other members of the class.

Review/Summary: Use the student learning objectives to summarize the lesson. There are also review questions on PowerPoint Slide 10. Have students explain the content associated with each objective.

Application: Have the students plant a seed in the plant pots filled with a mixture of sand and with just sand used earlier in this lesson. Over the next two weeks they should take care of each pot by watering them. After two weeks they should be able to see the difference in growth of the plants in each pot. If everything works properly the seed in the cup with the sand and organic matter mix should be healthier. If students have access to the internet they can also do a report on earthworms. The students could also make presentations to the members of the class on what they have learned. Two websites on earthworms are provided under recommended resources.

Evaluation: Evaluation should focus on student achievement of this lesson’s objectives. A sample test has been provided.

Answers to Sample Test:

Part One: Matching

1=d, 2=b, 3=c, 4=a

Part Two: Completion

1. Sandy soil
2. Earthworms, humus
3. Organic Matter
4. Decomposed

Test

Unit E Lesson 1: Organic Matter in Soil

Part One: Matching

Instructions. Match the term with the correct response. Write the letter of the term by the definition.

a. organic matter

c. decomposition

b. humus

d. water holding capacity

_____ 1. The ability for soil to retain water.

_____ 2. Completely decomposed organic matter.

_____ 3. The act of breaking down organic matter into specific elements.

_____ 4. Decaying plant and animal material.

Part Two: Completion

Instructions. Complete the following statements.

1. _____ has organic matter added to it to help increase water holding capacity.

2. Soil uses _____ to help decompose organic matter into _____.

3. _____ helps add important nutrients to soil.

4. Humus is simply completely _____ organic matter.

WS: E1-1

Organic Matter Measurements

Names:

Place measurements and locations of random organic matter measurements on this page. Make sure you complete all 5 places for the information to be recorded.

1. Location:

Measurement:

2. Location:

Measurement:

3. Location:

Measurement:

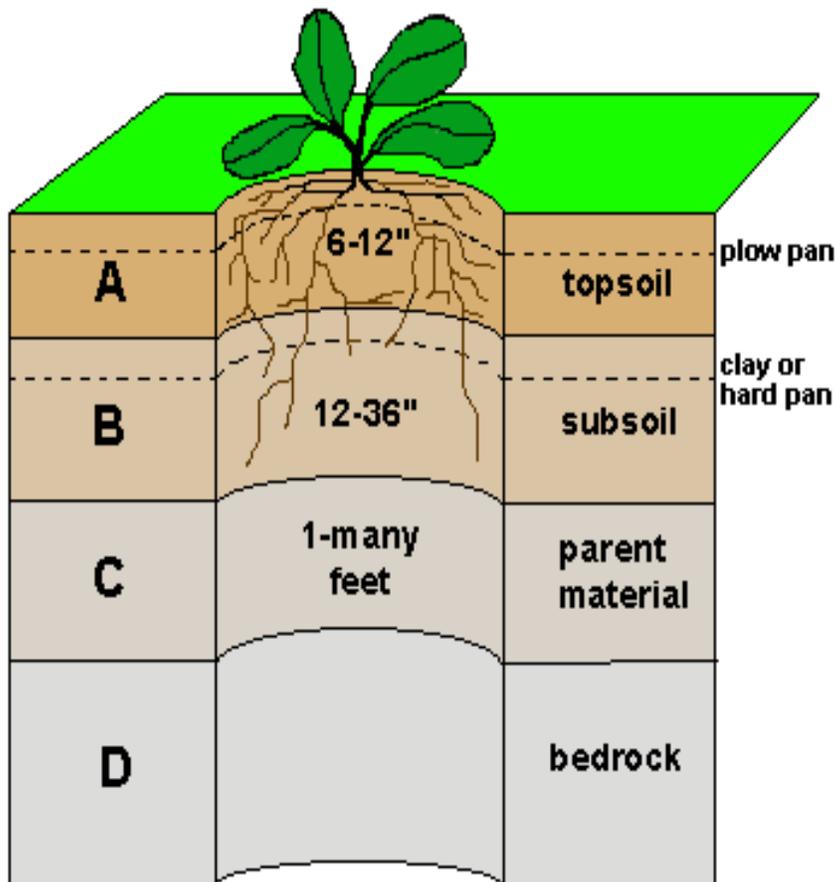
4. Location:

Measurement:

5. Location:

Measurement:

SOIL PROFILE



A Horizon or topsoil

- highly weathered
- abundant life, therefore, high in organic matter
- dark colored

plow pan - a compacted impermeable layer in the A horizon due to repeated plowing or tilling (approx. 6" deep)

B Horizon or subsoil

- less weathered; higher in clay
- less life, therefore, low in organic matter
- lighter colored

clay pan - impermeable layer high in clay

hard pan - impermeable layer high in iron

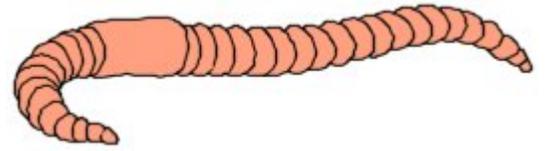
C Horizon or parent material

- little weathered
- little life, except deep rooted plants and
- little to no organic matter

D Horizon or bedrock

- rock base

How to Build a Worm Bin



- Reduces waste disposal costs.
- Raises worms for fishing.
- Has no foul smell or pests.
- Provides a convenient method for converting kitchen vegetable wastes into a rich organic fertilizer for house and garden plants.

A worm composting system can be easily started by following these five steps:

1. MAKE WORM BIN

Wooden, plastic or metal boxes or tubs may be used. The container should be 8"-12" deep and of a size to accommodate the amount of garbage you produce. Approximately one square foot of surface area is needed for each pound of kitchen vegetable wastes per week. For example, a 1'x2' x 3' box will serve a family of 4 to 6.

2. ADD BEDDING

Bedding is the living medium and also a food source for the worms. Bedding holds moisture and provides a medium in which the worms can work and the garbage can be buried. It is material high in carbon and made to mimic decaying dried leaves on the forest floor, the worms' natural habitat. The bedding should be moist (often similar to the consistency of a wrung-out sponge) and loose to enable the worms to breathe and to facilitate aerobic decomposition of the food that is buried in it. It must be light and fluffy enough to allow air exchange.

Bedding must be well soaked in water and wrung out before adding to the bin. You may add a handful of dirt every time the bedding is changed although it is not necessary.

Worms actually consume bedding as well as the kitchen vegetable wastes.

A wide variety of bedding materials can be used, including shredded newspaper, sawdust, hay, cardboard, burlap coffee sacks, peat moss, pre-composted (aged) manure, and dried leaves. Cat litter, and pet and human waste should not be used.

Bedding must be well soaked in water and wrung out before adding to the bin. You may add a handful of dirt every time the bedding is changed although it is not necessary.

Most vermicomposters avoid using glossy paper from newspapers and magazines, junk mail, and shredded paper from offices, because they may contain toxins which may disrupt the system. Also, coated cardboard that contains wax or plastic, such as milk boxes, cannot be used. Newspaper and phone books printed on regular, non-glossy paper with non-toxic soy ink are safe for use, and decompose relatively quickly. Some bedding is easier to use and add food scraps to than others.

3. **ADD WORMS**

Red worms are the most satisfactory and efficient type of worm to use for composting. The worms need adequate temperature, moisture and ventilation. The optimum temperature is from 55-77 degrees. Remember, an active worm bin must be kept in a heated garage or basement during the winter to prevent freezing. The worm population increases (or decreases) according to how well they are fed. To determine the number of worms needed to populate a bin, figure one pound of worms for each pound of kitchen vegetable wastes produced per day. Worms process their own body weight of organic matter each day.

4. **BURY GARBAGE**

Kitchen vegetable waste which can be composted includes vegetable and fruit scraps, egg shells, bread products, coffee grounds and tea leaves. Meat, bones, fats, and dairy products should not be composted. It may be helpful to keep a plastic container near the kitchen sink to collect scraps. Keeping the container uncovered will prevent odors but may attract fruit flies. About twice a week, the contents may be buried in the worm bedding, rotating around the box utilizing a different area each time. Be sure to cover all of the worm food with bedding. If your bedding dries out a sheet of black plastic can be laid over the surface to retain moisture.

5. **HARVEST COMPOST**

While there are several methods of harvesting compost and adding new bedding, the most convenient is to move the compost to one side of the bin and add new bedding and garbage to the other. Replacing the plastic sheet on only the half of the bin containing the new bedding will allow the compost to dry out some. The worms will migrate to the fresh material and the compost may be removed and replaced with new bedding. This migration may take several weeks.

Note: Kitchen vegetable wastes compost well in a worm bin and yield valuable worm castings compost. When adding kitchen vegetable waste to your outdoor compost pile you can create odors and attract vermin and other unwanted visitors if the wastes are not buried in the middle of the compost bin. Be especially careful if you add kitchen vegetable waste to a compost bin. Burying kitchen waste in the ground causes similar problems