Chapter 4 Mulching

Chapter Contents

Xeriscape Principle

Covering the soil with mulch reduces landscape water use. Mulch minimizes evaporation, stabilizes soil temperatures, reduces weed growth, and slows erosion.

Key Concepts

Evaporation, moisture retention, soil temperature, reflectivity.

Teacher's Notes

The primary benefit of covering the soil with a layer of mulch is water conservation. Adding a layer of mulch in landscaped areas will minimize evaporation, stabilize soil temperatures, reduce weed growth, and slow erosion. Mulches can also add visual interest and offer protective covering until plants mature.

A wide choice of mulches is available, both organic and inorganic. Organic mulches include bark chips, wood grindings, and pecan shells. Inorganic mulches include river rock and granite gravel.

The purpose of this mulching unit is to introduce the concept of landscape mulching and acquaint students with the options that exist for mulching materials. By the end of this unit, students will be able to evaluate a real-life landscape setting, pick the appropriate mulch, and explain their choices.

The **Problem to Solve** in this chapter involves providing Pete Tucker with a viable way to help retain soil moisture. The solution should focus on mulch, of course, and it can also include soil amendments, irrigation, or any other information learned from previous chapters. Just one level exists for the

Teacher's Notes, continued

Problem to Solve and **Project Cover Sheet** in this chapter. However, a more complex and detailed final project should be required for high school students (compared to the final project expected of mid-school students).

Assessment of Problem to Solve

In the **Problem to Solve: Pete Tucker's Mulch**, students are asked to choose mulching options for a hand-watered landscape with good soil in full sun. The landscape includes a section of native flowering shrubs and an area of more sensitive flowering annuals. Students should recognize that the landscape in full sun will heat up quickly and maintain high temperatures throughout the day. It will also lose moisture quickly to evaporation. Students should be able to tell Mr. Tucker that the addition of any mulch will slow the heating of the soil and the evaporation rate. They should also recognize that virtually any mulching material could be applied around the native plants. However, rock mulches should not be used around the more heat-sensitive annuals.

The work completed by the students in the **Problems to Solve** should be evaluated for accuracy, level of detail, and the skill in which the suggestions are communicated.

Teacher's Notes, continued

Notes on the Activities

Heat Beneath My Feet – Students will test soil temperatures at various depths and locations around the school. Be sure to include areas in full sun, partial sun, and shade. Also make sure to include areas with different types of vegetation, such as turf-grass, shrubs/trees/flowers, and barren ground. Perennial plants that shed leaves essentially provide their own mulch that cools the soil. By contrast, barren ground in full sun will provide the hottest temperatures and the largest temperature change. As an extension, students can try to stabilize soil temperatures by applying mulch. The type and depth of mulch influences how effective it is at keeping soil temperatures cool.

A Solar Still – Students will create a solar still to determine how much water soil contains. The amount of water collected in the solar still can be influenced by soil type, exposure to sun and wind, recent rainfalls, and proximity to irrigation systems. Even "dry" soil should yield some water.

A World of Mulches – Students will use books, the Internet, and other resources to research the different types of mulches. Then they will create a display or presentation to share their findings. In the **Background Information** section of this chapter is a table with information on a variety of mulches. This table is designed to be a guideline for the teacher, but it can also be handed out to students after they complete this activity. In completing the activity, students will undoubtedly come up with mulches that are not on the list, or they may develop a new list of advantages and disadvantages for different mulch types. Allow them to be creative!

Keeping the Water – Students test the rate of water loss for different types of soils and mulches over a 5 to 10 day period. Soil without mulch should dry out the fastest. Sandy soil should lose water faster than both clay and organically rich soil. Students should be evaluated on the completeness of data gathering and accuracy of the graph for water-loss percentage.

Cool Soil – Using a heat lamp, students will test different mulches for heat loss and gain. Soil with mulches should heat up more slowly and lose heat more slowly than non-mulched soil. The surface temperature of the soil will change more quickly than the temperature of deeper areas. The gravel mulch will heat up the quickest and hold the heat the longest.

Material Breakdown: The Source of Life – Students will investigate the decomposition rates of various mulches. This activity takes one class period to set up; observations will then occur over a 10-week period. Students will observe that:

- shredded bark breaks down more quickly than large bark;
- a thin, unprotected sheet of clear plastic will quickly break down in sunlight;
- black plastic breaks down more slowly than clear plastic; and
- shredded styrofoam is not biodegradable, nor is gravel (at least not within the time frame of this experiment).

From this experiment, students should see that organic mulches break down to improve the texture of the soil. Although plastics and gravel hold in moisture, they do not improve soil texture.

Complementary Activities

The following activities complement the **Problem to Solve** for this chapter:

- ✓ **3-4: Design a Drip**
- ✓ **6-4: Dripping Blooms**
- ✓ **6-7: A Desert Blooms in My Garden**

Background Information: Much Ado About Mulch

In New Mexico's semi-arid environment, mulch helps conserve water, moderate temperature changes, and slowly enrich the nutrient-poor soils (depending upon what type of mulch is chosen). Mulches provide quantifiable changes in soil temperature and water retention rates. Plus, mulches are also widely used for their aesthetic value.

There are two types of mulch, organic and inorganic. There are pros and cons to both types.

Organic:
Organic mulches consist of bark, wood chips, pecan shells, pine needles, leaves, and other materials that were once living. All organic mulches decompose and will therefore need to be occasionally replaced. (In the arid Southwest, the decomposition process is very slow, especially for larger materials.) Decomposing organic mulches will add nutrients to the soil, increase the humus layer, and improve the soil's water-holding capacity. However, the chemical process of decomposition uses nitrogen from the soil. Because nitrogen is an important plant nutrient, a slow-release fertilizer should be added to the soil to compensate for the loss of nitrogen. A slow-release formula is recommended because adding too much nitrogen too quickly can "burn" plant roots.

Inorganic:
Inorganic mulches consist of different types of rocks, plastic film, and landscape fabric. By definition, inorganic mulches do not decompose into soil-building nutrients, and they will need to be replaced only if they are damaged or blown/washed away.

- **Rock mulches** come in a variety of sizes and colors. A layer of rock mulch will last indefinitely in the landscape. Rock mulches can also increase air temperature in the landscape due to reflectivity[1] and heat retention, creating a heat sink[2]. Plants that are native to hot, rocky environments will do well with rock mulches. However, plants not native to a hot environment can be damaged by the increase in temperature and the reflection of sunlight to their undersides caused by rock mulches. During the colder months, rock mulch can provide a source of heat to protect cold-sensitive plants.

- **Plastic film and sheeting** are good at preventing unwanted weed seeds from sprouting and for holding water in the soil. However, they are less effective at stopping the growth of weeds that distribute their seeds through the air. That's because air-distributed weeds can grow on top of the plastic, particularly if a layer of decorative rock is placed on top of the plastic.

Background Information: Much Ado About Mulch (continued)

Other problems with plastic films include inhibiting the propagation[3] of desired landscape plants, blocking the movement of water and oxygen into the soil, and increasing water runoff.

- **Landscape fabric** (also commonly called "weed barrier") is a flexible open-weave textile, usually made of high-strength polypropylene mesh. Landscape fabric can protect the soil surface from water and wind erosion, and, when used under a layer of mulch, it will prevent weeds from coming up underneath it. Unlike plastic coverings, landscape fabric allows rainwater to drain through it into the soil. When weed seeds do sprout on top of landscape fabric, however, their roots can sometimes become entwined into the fabric. This can make it difficult to remove the weeds without damaging the fabric. For most uses, landscape fabric is now preferred over plastic films.

Benefits of Mulching

1. **Mulch reduces reflectivity** (except for rock mulches). Native sand and clay soils reflect the heat and light up onto the undersides of plant leaves. Organic mulches have a darker, more multi-faceted surface that reflects less light. As a result, organic mulches cool the area around plants and reduce the rate of evaporation. Inorganic rocks increase reflectivity, which is fine for some native plants but can scorch or burn more sensitive plants.
2. **Mulch stabilizes soil temperatures.** Mulch moderates the temperature fluctuations around the root zones of plants. As a result, the surface of the soil is cooler in the summer (which slows down the rate of evaporation) and warmer in the winter (which prevents soil heaving[4] in freeze/thaw cycles).
3. **Mulch keeps water in the root zone.** Because mulch slows the rate of evaporation, more water is held in the soil. Thus, plant roots have more time to access the water.
4. **Mulch builds soil.** Organic mulches eventually break down and add nutrients to the surface of the soil, increasing the humus layer and improving water-holding capacity.
5. **Mulch prevents weeds.** Mulch prevents sunlight from reaching the top layers of the soil, thereby slowing down weed seed germination. Landscape fabrics and plastic films also form a protective layer through which weeds have trouble pushing.
6. **Mulch controls erosion.** Mulch softens the impact of rain and slows down the movement of water. The slower water movement prevents runoff and allows the soil to absorb the water. The additional moisture encourages root growth, which in turn serves to further stabilize the soil. Mulch also keeps soil from blowing away in the wind.
7. **Mulch reduces maintenance.** The mulched area between plants requires less weeding.
8. **Mulch reduces water use.** Mulch keeps moisture at plant root zones and reduces the rate of evaporation. As a result, mulched areas need less water. Plus, mulched areas that do not include landscape plants do not require any water at all.

Background Information: Much Ado About Mulch (continued)

Mulch Calculations

The thicker the layer of mulch, the more that mulch will block weeds and moderate soil temperature fluctuations. However, a thicker mulch layer means that rainwater will have further to go before it reaches plant roots.

Mulch is usually sold in cubic yards. One cubic yard is 27 cubic feet of material. (To get an idea of what that would look like, visualize a large pickup truck with the truck bed full of mulch.) One cubic yard of material will cover 324 square feet at the depth of one inch. So to calculate the amount of mulch needed for a given area:

1. Figure out the square footage of the area to be landscaped.
2. Multiply the square footage by the depth desired (in inches), and
3. Divide by 324 square feet.

The equation would look like this:

Area to be Landscaped x Desired Depth of Mulch = Cubic Yards of Mulch Needed
324 Square Feet

See the following chart for calculating the area covered by one cubic yard of mulch.

Calculations for Depth and Amount of Mulch Materials		
One cubic yard of mulch covers approximately:	80 square feet	When 4 inches deep
	100 square feet	When 3 inches deep
	160 square feet	When 2 inches deep
	324 square feet	When 1 inch deep

To change the calculations to metric, see Appendix N.

FINAL THOUGHT

Mulches are a cost-effective way to reduce water evaporation and soil temperature fluctuations. Virtually any type of material can be used as mulch. Have your students suggest some nontraditional mulch materials, then discuss the pros and cons of using these new materials.

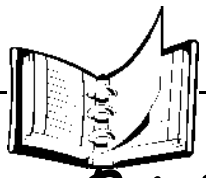
FOOTNOTES (PAGES 132-133)

[1] Reflectivity – the amount of light and heat that bounces off the surface of the soil, rocks, or off buildings onto plants

[2] Heat Sink – retention of heat in an area due to material absorbing heat from the sun and releasing it slowly

[3] Propagate – to reproduce, in the case of plants through seeds or roots

[4] Soil heaving – the expansion and contraction of the soil due to changes in temperature



Problem to Solve: Pete Tucker's Mulch

Hidalgo County Extension Agent
300 Shakespeare
Lordsburg, New Mexico 88045

Dear County Extension Agent:

Help! My elderly mother's garden is drying up and growing only tumbleweeds. The heat and high winds are killing her plants. The landscape has two main components: native flowering shrubs and more sensitive annual flowers. Many of her annuals have already died. She just can't seem to get enough water on the plants to keep them growing this year.

During most years her garden does fine. The soil is pretty good for this area and we include soil amendments when necessary. The landscape is about 20 feet by 40 feet and is in full sun. We irrigate by hand watering whenever necessary.

What can we do to help save her plants?

Sincerely,

Pete Tucker

Pete Tucker's Mulch: Project Cover Sheet

Mr. Tucker needs some advice on what to do in his mother's garden. Use the information you have learned from the activities and handouts in Chapter Four: Mulching to come up with a potential solution to Mr. Tucker's problem.

You can also include anything that you have learned from previous chapters.

If you are recommending mulch, be sure to include the type of mulch, how thick it should be applied and the potential cost. Always include an explanation of your recommendations.

Be prepared to present your information to Mr. Tucker.

Your completed project will include:

_____ Heat Beneath My Feet Student Worksheet or journal pages

_____ Solar Still Student Worksheet

_____ A World of Mulches Poster

_____ Keeping the Water Student Worksheet or journal pages

_____ Cool Soil Student Worksheet or journal pages

_____ Material Breakdown journal pages

_____ Information for Mr. Tucker with cost calculations for his solution

Pete Tucker's Mulch: Tips For Getting Started

If you are having trouble getting started, answer the following questions and then use your answers to formulate a solution for Mr. Tucker.

1. What did you learn about soil temperatures and evaporation rates when the soil is exposed to full sun?

2. What have you learned about mulches that might help Mr. Tucker? Start a list.

3. Are there any mulches that work well for native plants?

4. What mulch would work best for heat-sensitive plants?

5. Can you use anything from the previous chapters on soil and irrigation to help Mr. Tucker?

Mulching Guidelines

Mulching is our way of imitating a process that occurs in nature. On a forest floor, the soil is littered with layers of leaves, pine needles, and sticks. These layers keep moisture from evaporating, protect the soil from erosion, and break down (decompose) to enrich the soil.

When we mulch, we use a variety of materials to copy this natural process in our gardens. In New Mexico's semi-arid environments, mulch helps conserve water, prevent erosion, moderate temperature changes in the soil, and (sometimes) slowly enrich the nutrient-poor soils in which we garden. Mulch is also widely used for its beauty.

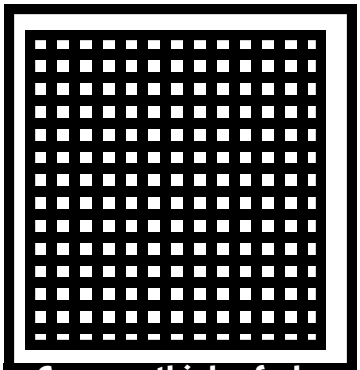
There are two types of mulch, organic and inorganic. To decide which mulch will be the best for your garden, research your soil type, the types of plants in the landscape, and the local environmental conditions. Then compare these to the pros and cons of each type of mulch.

Organic: Organic mulches are materials that were once living. They include: bark, wood chips, pecan shells, pine needles, leaves, and much more. All of the organic mulches decompose and will need to be occasionally replaced. However, in the arid Southwest, the decomposition process is very slow due to lack of water. The size of the organic materials also influences the rate at which they decompose. The larger the materials, the longer the decomposition will take. Your main replacement concern will be that the lighter materials will blow away in the high winds.

What makes something organic?

When the organic materials decompose, they add nutrients to the soil, increase the humus layer, and increase the water-holding capacity of the soil—all of which help plants grow. However, the process of decomposition uses nitrogen, which most plants require as a nutrient. Therefore, a slow-release fertilizer should be added as a soil amendment to compensate for the loss of nitrogen. Whenever you add a fertilizer, remember to always follow directions on the label and be cautious. Adding too much nitrogen too quickly can burn the roots of plants.

Inorganic: Inorganic mulches are materials that have never been alive. They consist of different types of rock, plastic film, and landscape fabric. Inorganic mulches do not decompose and will last a long time. They only need to be replaced if they are damaged.



Can you think of why plastic film might be considered an organic material?

- **Rock mulches** come in a wide variety of sizes and colors. Rock mulches are often used as a primary groundcover, creating beauty and color without introducing plants. Rock mulches can increase air temperature in the landscape due to reflectivity[1] and heat retention, which creates an effect called a heat sink[2]. Plants that are native to hot, rocky environments thrive when surrounded by rock mulches. The plants not native or adapted to this environment can be damaged by the increase in temperatures and the reflection of sunlight to their undersides caused by rock mulches. During the colder winter months, rock mulch can provide a source of heat to protect cold-sensitive plants.

[1] Reflectivity – the amount of light and heat that bounces off the surface of the soil, rocks, or off buildings onto plants
[2] Heat Sink – retention of heat in an area due to material absorbing heat from the sun and releasing it slowly

Mulching Guidelines (continued)

- **Plastic films and sheeting** are good for preventing unwanted weed seeds from sprouting in the soil. However, they are less effective at stopping the growth of weed seeds that are blown on top of the plastic. Air-distributed weeds can still sprout if a layer of decorative rock is placed on top of the plastic. Other problems with plastic sheeting include inhibiting the propagation[3] of desired landscape plants, blocking the movement of water and oxygen into the soil, and increasing water runoff.
- **Landscape fabric** (also commonly called "weed barrier") is a flexible open-weave textile, usually made of high-strength mesh. Landscape fabric can protect the soil surface from water and wind erosion. Like plastic films, landscape fabrics are often used with a layer of rock or organic mulch on top for aesthetic reasons. Unlike plastic coverings, landscape fabric allows rainwater to drain through it into the soil. When weed seeds do sprout on top of landscape fabric, however, their roots can sometimes become entwined in the fabric. This makes it difficult to remove the weeds without also damaging the fabric. For most uses, landscape fabric is now preferred over plastic films.

Benefits of Mulching

1. Mulch reduces reflectivity (except for rock mulches). Native sand and clay soils reflect heat and light up onto the undersides of plant leaves. Organic mulches that have a darker, more multi-faceted surface will tend to reflect less light. As a result, organic mulches cool the area around plants and reduce the rate of evaporation. Inorganic rock mulches are the only ones that will increase the reflectivity. This can scorch or burn more sensitive plants.
2. Mulch stabilizes soil temperatures. Mulch reduces temperature changes around the root zones of plants. This can prevent the soil from getting too hot in the summer or freezing in the winter. The cooler surface in the summer will also slow down the rate of evaporation, and the warmer surface in the winter will prevent soil heaving[4] in freeze/thaw cycles.
3. Mulch keeps water in the root zone. Because mulch slows the rate of evaporation and slows the movement of water, more water is held in the soil. That means plant roots have more time to access the water.
4. Mulch builds soil. Organic mulches eventually break down and add nutrients to the surface of the soil, increasing the humus layer and improving water-holding capacity.
5. Mulch prevents weeds. Mulch prevents sunlight from reaching the top layers of the soil, which slows down the germination of weed seeds. Landscape fabrics and plastic films also form a protective layer through which weeds will have a difficult time pushing. The thicker the layer of mulch, the less sunlight will get through and the harder it is for the weeds to grow.
6. Mulch controls erosion. Mulch keeps the soil from blowing away in the wind and softens the impact of rain. Mulches also prevent water and soil runoff by slowing the movement of the water, which allows the soil to absorb it. This additional moisture encourages root growth, which in turn serves to stabilize the soil, a win-win situation.
7. Mulch reduces maintenance. Mulching the area between plants will prevent weed growth. That means less weeding.
8. Mulch reduces water use. Mulched areas keep moisture in plant root zones and reduce the rate of evaporation. As a result, mulched areas need less water. Plus, mulched areas that do not include landscape plants will not require any water at all.

[3] Propagate – to reproduce, in the case of plants through seeds or roots
[4] Soil heaving – the expansion and contraction of the soil due to changes in temperature

Mulching Guidelines (continued)

Mulch Calculations

The thicker the layer of mulch, the more that mulch will block weeds and reduce soil temperature fluctuations. However, a thicker mulch layer means that rainwater will have further to go before it reaches plant roots. It will be up to you to decide which thickness is most appropriate for your landscape.

Mulch is usually sold in cubic yards. One cubic yard is 27 cubic feet of material. (That's about how much the bed of a large pickup truck holds.) One cubic yard of material will cover 324 square feet at the depth of one inch. So to calculate the amount of mulch needed for a given area:

1. Figure out the square footage of the area to be landscaped.

2. Multiply the square footage by the depth desired (in inches), and

3. Divide by 324 square feet.

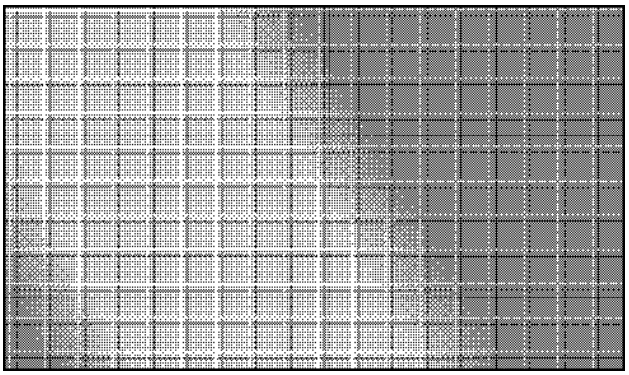
The equation looks like this:

$$\frac{\text{Area to be Landscaped} \times \text{Desired Depth of Mulch}}{\text{324 Square Feet}} = \text{Cubic Yards of Mulch Needed}$$

The following chart shows approximately how much area can be covered by one cubic yard of mulch.

Calculations for Depth and Amount of Mulch Materials		
One cubic yard of mulch covers approximately:	80 square feet	When 4 inches deep
	100 square feet	When 3 inches deep
	160 square feet	When 2 inches deep
	324 square feet	When 1 inch deep

To change the calculations to metric, see Appendix N.



Final Thought

Mulches are a cost-effective way to reduce water evaporation and soil temperature fluctuations. That's why mulches are such a good idea for New Mexico's landscapes. Virtually any type of material can be used as mulch. How many kinds of mulches can you list?

Charts & Graphs

A VARIETY OF MULCHES			
Organic Mulch Materials			
Mulch Material	**Suggested Depth**	**Advantage**	**Disadvantage**
Shredded Bark	3"-4"	Binds soil; lets water in; not prone to wash away; slow to break down	Expensive; must be applied thickly; ineffective if too thin
Wood Chips	3"-4"	Lets water in; cools soil; keeps weeds down; improves water-holding capacity of soil	Can include resident insects; takes nitrogen from soil as it decays
Chunk Bark	4"-6"	Course texture; lets water in; superior weed control	May blow in wind, wash away on slopes; expensive; breaks down slowly so does not add to soil
Chipper Debris	3"-4"	Available from tree crews; sometimes free; adds humus as it breaks down	Uneven appearance; coarser pieces may not decay fast enough; may hide delicate plants
Sawdust and Fine Wood Shavings	1"-3"	Available in some areas; decomposes and adds to soil; seed-free; holds water; easy to apply	May injure plants with wet weight; depletes nitrogen; catches fire easily; may compact and form a barrier over soil
Pine Needles	2"-3"	Easily applied; good-looking; cheap; increases water-holding capacity of soil; decomposes; adds humus; lets water in	Long-lasting in arid environment; not always available; settles; lets water transpire out

To change the calculations to metric, see Appendix N.

Charts & Graphs

A VARIETY OF MULCHES			
Organic Mulch Materials			
Mulch Material	**Suggested Depth**	**Advantage**	**Disadvantage**
Evergreen Boughs	2"-4"	Easy to handle; quick to apply and easy to remove; available in many areas	Fire hazard when dry; attractive to mice and other rodents
Lawn Clippings	1" at a time	Readily available; lets water in; inhibits transpiration	May have chemicals on it; if applied thickly when green it can get slimy and smelly and heat up
Wheat, Oats, Barley, or Rye Straw	4"-6"	Available in some areas; inexpensive; breaks down slowly and adds to soil; lets in water; cools soil	Can be unsightly; blows around; may mat down; can harbor insects, diseases, weeds and rodents
Leaves And Leaf Mold	2"-4"	Lets water in and retains it; readily available; improves water-holding capacity of soil; one of the best mulches for trees, perennials and wildflowers; when it starts to look old it can be tilled in for use as a soil amendment	Can pack down too much; can hold weed seeds, insects, rodents, and diseases; likely to blow away
Partially Decomposed Compost	2"-4"	Can be made on site; no cost; excellent way to improve soil and its water holding capacity; average at letting water in	Needs to be stored & aged on site; is bulky and unsightly during storage; takes time to collect & compost

Charts & Graphs

A VARIETY OF MULCHES			
Organic Mulch Materials			
Mulch Material	**Suggested Depth**	**Advantage**	**Disadvantage**
Strawy Manure	2"-4"	Low-level fertilizer; good soil builder; adds humus and becomes plant food	Limited source of supply; may burn plants due to high ammonia content; may have insects, disease and weed seeds
Cottonseed Hulls, Pecan Shells, Peanut Hulls, Buckwheat Hulls	2"-3"	Easy to handle; lets water in the soil; decomposes slowly and increases water-holding capacity of soil	May change soil chemistry; may need nitrogen supplementation
Newspaper	1" or less	Available and cheap; easy to apply; keeps water in; controls erosion	Decomposes rapidly; lets little water in; may blow away
Inorganic Mulch Materials			
Plastic Film	3-10 mm (Plastic film and landscape fabric are sold in a variety of thicknesses measured in mm.)	Holds water effectively; controls weeds; light and easy to transport	Must be covered with other materials; can injure plant roots because of heat buildup; can lead to lack of air and oxygen exchange in soil; doesn't hold on slopes; labor intensive; encourages "zeroscape" solutions

Charts & Graphs

A VARIETY OF MULCHES			
Inorganic Mulch Materials			
Mulch Material	**Suggested Depth**	**Advantage**	**Disadvantage**
Woven Landscape Fabric	3-10 mm	Great weed control; combines with organic mulches to give a natural appearance; lets water through	Expensive; labor intensive; the roots of weeds that germinate above the fabric entangle in the fabric making the weed hard to remove without disturbing the fabric
Gravel, River Rock	1"-3"	Lets water in; lasts a long time; doesn't break down; variety of appearances; good for arid plants such as natives to hot, dry, rocky areas	Expensive; is mined from another area; hard to keep clean; reflects heat and light; creates a "heat sink"
Crushed Stone	1"-3"	Lets moisture in soil; keeps moisture in root zone; many colors; good for arid plants such as natives to hot, dry, rocky areas	Expensive; can be too reflective; will not prevent growth of weeds; hard to clean; creates a "heat sink"
Pumice	2"-3"	Holds some water but lets most water into soil; lightweight; wide color variation; good for arid plants such as natives to hot, dry, rocky areas	Breaks down in a few years but doesn't integrate into soil; will not prevent growth of weedy grasses

Charts & Graphs

Cost Estimates for Mulch[1]		
ORGANIC MATERIALS	**Size of Unit**	**Cost of Unit**
Deco Shred Bark (4"-8")	Cubic Yard	$20.50
Wood Chips (Appx. 1")	Cubic Yard	$20.50
Nugget Bark (uniform in size and shape)	Cubic Yard	$31.50
Chipper Debris		Free, if gathered from neighbors or utilities as they trim branches and eliminate debris with chippers
Pine Needles		Free, if gathered from mountain neighborhoods. Before gathering, make sure not to eliminate natural mulch from the forest, only take the excess. Do not gather on public land!
Lawn Clippings		Free, from lawn
Straw (Barley)	Bale	$3.50
Leaves		Free, but only available seasonally
Compost	Cubic Yard	$22.50 or Free, if homemade
Manure		Usually free from horse farms
Pecan Shells	Cubic Yard	$20.50
Newspaper	6-8 sheets thick	Free, from gathered recycling
INORGANIC MATERIALS		
Plastic Film	10'x 100'x 6 ml	$27.00
Woven Landscape Fabric	3' x 100'	$34.50
River Rock (2"-4")	Cubic Yard	$32.00
Crushed Stone[2] 1/2"	Cubic Yard	$25.50
Crushed Stone 3/4""	Cubic Yard	$22.00
Crushed Stone 1 1/2"	Cubic Yard	$22.00
To change the calculations to metric, see Appendix N.		

[1] Costs vary depending upon location and availability. Check the local supplier for updates on pricing.
[2] Crushed stone can come from a variety of sources and varies greatly in price.

Heat Beneath My Feet

Main Question:
Do soil temperatures vary? Why?

Objectives:
- To test the soil temperatures around the school
- To test the effect of soil depth on temperature fluctuations

Subjects: science, math

Time: 1 hour (can vary)

Vocabulary:
north exposure, south exposure

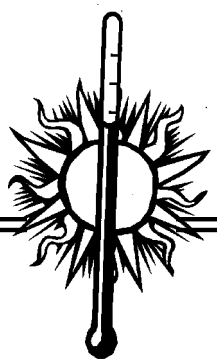
Advance Preparation:
- Be sure to get a cooking thermometer that includes lower temperatures. A range between 50°-100° F should be appropriate for summer-like days.
- Choose areas around the school that vary in vegetation, exposure, and soil types. Students should include this information on their Student Worksheets.

Setting the Stage:
- Ask students if they have ever dug down into the ground and noticed changes in temperature.
- Have they ever hiked underground, such as in Carlsbad Caverns or the Ice Caves near Grants? What is the temperature like there?

TEACHER TIP:
If classes are scheduled throughout the day, have each class record time and temperature at the same locations. Compile the data. On the second day, have students graph the data from all of the classes to see how the temperatures have changed throughout the day.

Materials:
- 4 soil/cooking thermometers
- 4 school site plan (optional)
- 4 rulers
- 4 mulch materials (optional)

Heat Beneath My Feet



Taking Temperatures

1. Select a site around the school that is in full sun for most of the day.

2. Read and record the air temperature.

3. Read and record the soil temperature at the surface and at depths of 5 cm, 10 cm, 15 cm, and 20 cm.

4. Repeat this procedure at several locations around the school. Look for sunny versus shady areas, north exposure versus south exposure, or wet versus dry areas.

5. Graph the results.

6. Generate hypotheses on how the soil temperature could be modified.

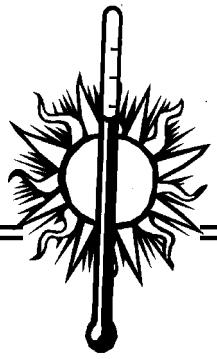
Extension:

- Test the hypotheses that were generated on how to modify the soil temperature.
- Repeat this experiment at different times of the year.

NAME

Student Worksheet

Heat Beneath My Feet



Normal Soil Temperatures

1. Describe your location:_____
_____

Time:_____ Air Temperature: _____

Soil temperature at 5 cm: _____ 10 cm: _____ 15 cm: _____ 20 cm: _____

2. Describe your location:_____
_____

Time:_____ Air Temperature: _____

Soil temperature at 5 cm: _____ 10 cm: _____ 15 cm: _____ 20 cm: _____

3. Describe your location:_____
_____

Time:_____ Air Temperature: _____

Soil temperature at 5 cm: _____ 10 cm: _____ 15 cm: _____ 20 cm: _____

4. Describe your location:_____
_____

Time:_____ Air Temperature: _____

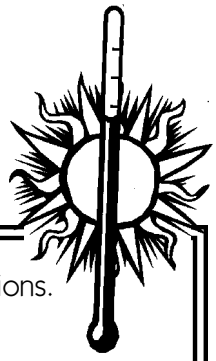
Soil temperature at 5 cm: _____ 10 cm: _____ 15 cm: _____ 20 cm: _____

If you have more then 4 locations, continue data on back.

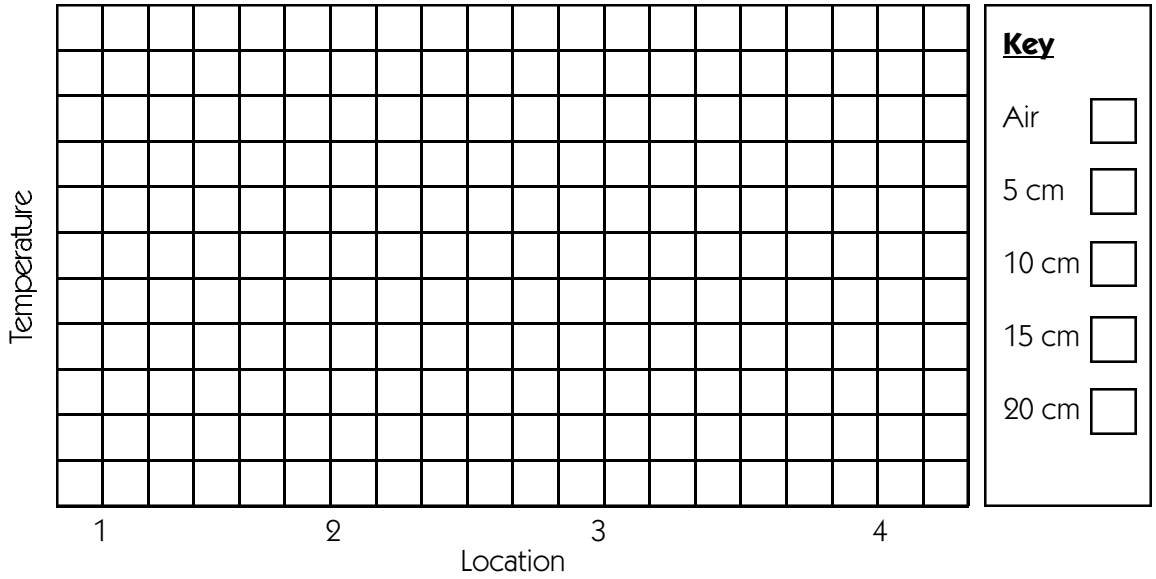
(continued on next page)

Student Worksheet

Heat Beneath My Feet



Develop a key and a temperature scale, then graph the data for each of your locations.



1. Why did different locations have different temperatures? If you did not get different temperatures, explain why.

2. Did certain locations have a more consistent temperature, even at different depths? Why?

3. What do you think the temperatures would be at 50 cm?

4. How could we stabilize the soil temperatures (keep the temperatures closer together at all depths)?

A Solar Still

(A Solar Still has been adapted from the Harvesting Water activity in the *Conserve Water* children's booklet. It is used with permission from Project WET/The Watercourse at Montana State University.)

Main Question:

How much water is in soil?

Objectives:

- To determine what soils hold water
- To compare soil exposure to water-holding capacity
- To determine how much water is present in soils around the school

Subjects: science, math

Time: 1 hour for setup; 10 minutes per day per solar still for data gathering

Vocabulary: solar still

Advance Preparation:

- Locate several places around the school where the stills can be set up, will not be disturbed, and will not receive irrigated water. Choose sites in sun and shade and in different kinds of soil.
- Check with groundskeeper about digging small holes.

Setting the Stage:

- Have students guess how much water is in different types of soil.
- Discuss how elements (sun, wind, location) might affect how much water is in the soil.

Materials:

- 4 trowel
- 4 clear plastic wrap (colored plastic will not work)
- 4 10-ml graduated cylinder per still
- 4 1 small jar per still
- 4 large rocks for holding still
- 4 1 small pebble per still

A Solar Still

How to Make a Solar Still

1. Mark a circle 24 centimenters (cm) wide on the ground. Using a trowel, dig a hole 16 cm deep, with a flat bottom.

2. In the center of the hole, dig a smaller hole wide enough and deep enough to hold the small jar so that the lip of the jar is just below the bottom of the first hole (about 10 cm).

3. Cover the large hole with a square of clear plastic wrap that is about 20 cm longer than will be needed to secure the ends.

4. Put stones at the corners to hold the plastic in place, leaving the extra 20 cm slack in the middle of the plastic.

5. Put a stone in the center of the plastic to form a cone pointing down, with its tip centered over the small jar. The plastic can be hanging in or over the jar but do not let the plastic touch the jar.

6. At the end of each day, go to each still, collect the water in the small jar and measure it in a 10-ml graduated cylinder.

7. Record the data.

8. Put the still back together for measurement the next day.

Extension:

- Sprinkle the same amount of water into the large hole of each still and measure how much water evaporates versus how much water is pulled down by gravity, infiltrating the soil.

- Repeat the solar still experiment after a rain or next to an irrigation system.

Activity Tip

The plastic material will heat the soil underneath it, evaporating any water that is close to the surface. The water will collect on the underside of the plastic and drain down into the smaller jar. If you are not getting any results, try adjusting the plastic cone so that it centers better over the small jar. (NOTE: Sometimes a smaller stone or a wider jar will help.)

NAME

Student Worksheet

A Solar Still

Data

In the table below, record the amount of water collected from each solar still.

Still Number	Soil Type	Location	Day 1	Day 2	Day 3

1. What type of soil held the most water (the largest amount of water collected in the graduated cylinder)?

2. How did the location of the still affect the amount of water collected?

A World of Mulches

Main Question:
What is a mulch?

Objectives:

- To describe materials that have been used for mulch
- To research best uses for different mulches
- To determine costs of mulching

Subjects:

science, art, language arts, math

Time: 1 hour for research; 1 hour for making poster; 10 minutes per group for presentations

Vocabulary: compost, organic, inorganic

Advance Preparation:

- Arrange library time or computer lab time for research, or provide adequate books in the classroom.
- This project can be done by individual students, in pairs, or in groups.

Setting the Stage:

- Ask students why mulching is useful.
- What common materials are used as mulches? What are other materials that could be used?
- Encourage students to be creative and come up with unusual materials. A good option is to see if the waste products from a local industry can be used as mulch.

TEACHER TIP:

This activity can be completed in one period if the teacher brings in samples of mulches and the class develops a "pros and cons" list for each of the mulches.

Materials:

- 4 gardening references
- 4 poster board or butcher paper
- 4 glue (optional)
- 4 Internet
- 4 markers or crayons
- 4 samples of mulches from garden center

A World of Mulches

A. Presentation

1. Using poster board and markers, prepare a poster about mulches. Include pictures or examples, cost per square-foot, availability, pros and cons, and where in the landscape each type would be used.

2. Present the research to the class.

B. Background Research

1. Using available materials (books, videos, Internet, etc.), research why mulches are used and what materials have traditionally been used as mulches.

2. Call local home improvement centers or landscapers to determine costs for mulches (don't forget to include delivery charges).

Extension:

- Compare chart generated in class to **A Variety of Mulches** chart.
- Simulate mulches using materials found in the kitchen. Dried peas can serve as gravel; rice can serve as bark; plastic wrap can serve as weed barrier cloth; powdered cereal can serve as compost; etc. Students can paint the materials the appropriate colors and use them in their poster presentations, or design landscapes using the simulated mulch materials.
- Test out ideas for alternative mulch materials on plants in the classroom or around the school.
- Contact local industries to obtain by-products that could be used as mulch: shredded tires, recycled plastics, corn husks, etc.

Activity Tip
If the class has access to a computer and would like to integrate technology, students could make a Microsoft PowerPoint® presentation.

Keeping the Water

Main Question:
How much water will mulch save?

Objectives:
- To test rate of water loss for different types of soil
- To evaluate the effect of mulches on decreasing water loss

Subjects: science, language arts, math

Time:
Activity 1: 1 hour to set up; $^1/_2$ hour per day to weigh

Activity 2: 1 hour to set up; $^1/_4$ hour per every other day to collect samples

Vocabulary: porous, organic, permeable

Advance Preparation:

- Highly organic soils include micro and macro invertebrates. A good place to find highly organic soil is the forest floor, a high decomposition area, or the compost bin.

Setting the Stage:

- Ask students where the water in the soil goes. Is there a way to keep water in the soil?
- Do all soils lose water at the same rate? How would this affect the plants placed in each soil type?

Materials:

- 4 scales
- 4 sandy soil
- 4 clay soil
- 4 highly organic soil
- 4 gravel
- 4 shredded bark
- 4 9 wide-mouth cans of the same size, either plastic or metal (vegetable cans or sturdy plastic cups work well); do not use paper that will allow water to seep through over time
- 4 graduated cylinder or measuring cup

TEACHER TIP:
To speed up this activity, set cans under a heat lamp.

Keeping the Water

Laboratory Testing

1. Label the cans "1" through "9."
2. See Table 1 below for the specific contents of each can.
3. Fill all the cans with the same amount of soil (to about 5 cm from the top of the can). Cans 1, 2, and 3 are sandy soil; cans 4, 5, and 6 are clay soil; and cans 7, 8, and 9 are the highly organic soil
4. Add 5 cm of gravel mulch to cans 2, 5, and 8.
5. Add 5 cm of bark mulch to cans 3, 6, and 9.
6. Do not add anything to the control cans 1, 4, and 7.
7. Weigh all of the cans.
8. Add 100 ml of water to each can. If the cans are very small or very large, adjust the water amount (as long as it is the same amount for each can).
9. Re-weigh all of the cans.
10. Record both the pre-water and the post-water weights on the chart on the student worksheet.
11. Set all the cans together in a warm place.
12. Weigh the cans every 1 to 2 days until they return to their original weights.
13. Record weight on chart on student worksheet.

Contents for Each Can			
Soil	**No mulch (control)**	**Gravel**	**Bark**
Sandy soil	Can 1	Can 2	Can 3
Clay soil	Can 4	Can 5	Can 6
Compost soil	Can 7	Can 8	Can 9

Extension:

- Test the rate of water loss for different types of soils and mulches.
- Put plants in the soil and compare the rate of water loss.

NAME

Keeping the Water

Student Worksheet

Weight of Cans

Calculate the total percentage of water lost from the original weight of soil and water.

Can #	Initial Weight	Weight with water added	Weight on Day #_____	Weight on Day #_____	Weight on Day #_____	Weight on Day #_____	Percent Water Loss
1							
2							
3							
4							
5							
6							
7							
8							
9							

Calculate the percentage (%) of water loss for each can using the following equation:

$$\% \text{ Water Loss} = \frac{\text{Initial weight of Soil - Current weight of Soil x 100}}{\text{Initial weight of Soil}}$$

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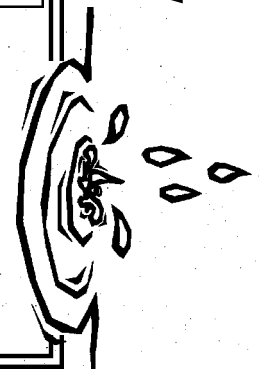


Student Worksheet

NAME

Keeping the Water

1. Which can had the most water loss?

   What was its soil type?

   What was its mulch?

2. Which can had the least water loss?

   What was its soil type?

   What was its mulch?

3. Which mulch worked best for sandy soil?

4. Which mulch worked best for clay soil?

5. Which mulch worked best for the highly organic soil?

6. Why do you think the mulch worked or did not work?

Cool Soil

Main Question:
Does mulch control temperatures?

Objectives:

- To test the ability of different mulches to moderate soil temperatures

Subjects: science, language arts, math

Time: 1 to 1 1/2 hours

Vocabulary: heat sink

Advance Preparation:

- Obtain a heat lamp or a lamp with a high-wattage incandescent light bulb that can be focused on a small area. Be careful not to leave the lamp on too long or leave flammable objects near the lamp.
- Students will be asked to record the temperature every five minutes for 30-60 minutes. A Journaling Activity — such as recording observations, describing mulches, or even story writing — is recommended to help fill the time.

Setting the Stage:

- Ask students if they have ever used mulch for plants. What are the benefits of using mulch?
- How could it be advantageous to plants to have stable soil temperatures and even moisture retention?
- Hypothesize on why an organic mulch, such as bark, might be better at stabilizing temperatures than gravel or plastic.

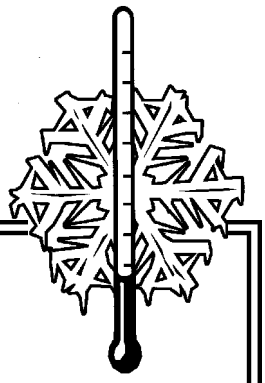
Materials:

- 4 4 tin* cans or heavy plastic cups of same size
- 4 gravel
- 4 bark
- 4 watch
- 4 shredded newspaper
- 4 8 thermometers
- 4 lamp
- 4 soil (any type will work)

* If using tin or metal cans, use pot holders when handling.

TEACHER TIP:
This activity works best under the controlled environment of the heat lamp where the temperatures will change more quickly.

Cool Soil



Setting Up the Experiment

1. Fill the four cans with soil to within 5 cm of the top of the can.
2. Moisten the soil so that it is crumbly.
3. Cover the top 5 cm of each can with different mulches: gravel, bark, shredded newspaper. Leave one without mulch for the control.
4. Use a thermometer to take the temperature at the surface of each mulch.
5. Record the temperature.
6. Insert a thermometer into each can so that the bottom of the bulb is 8 cm deep (past the 5 cm of mulch and 3 cm into the soil).
7. Record the temperature.
8. Set the four cans so that they are all an equal distance from the lamps, or put all four cans outside in full sun.
9. Record the temperature every five minutes for the next 30-60 minutes.
10. Turn off the light, or move the cans to the shade. Continue to record the temperature in each can every five minutes for the next 30-60 minutes.

Extension:

- Test other mulches, or try different types of soils.
- Put thermometers at various levels in the can to see how far heat can penetrate.
- Test dry vs. wet soil.

NAME

Student Worksheet

Cool Soil

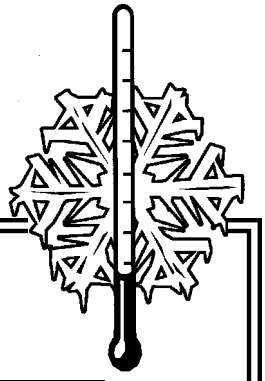


Table 1: Control. Record temperatures.
Try to take a measurement every five minutes.
Be sure to record your actual minutes at the top of the table.

	Time in minutes	0	5										
Heating	Surface												
Heating	At 8 cm												
Cooling	Surface												
Cooling	At 8 cm												

Table 2: Gravel Mulch. Record temperatures.

	Time in minutes	0	5										
Heating	Surface												
Heating	At 8 cm												
Cooling	Surface												
Cooling	At 8 cm												

Table 3: Bark Mulch. Record temperatures.

	Time in minutes	0	5										
Heating	Surface												
Heating	At 8 cm												
Cooling	Surface												
Cooling	At 8 cm												

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NAME

Student Worksheet

Cool Soil

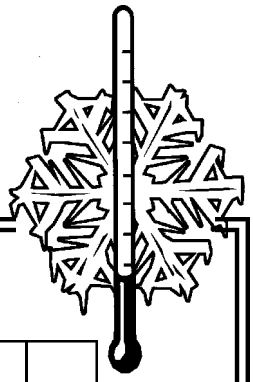


Table 4: Newspaper Mulch. Record temperatures.

	Time in minutes	0	5										
Heating	Surface												
Heating	At 8 cm												
Cooling	Surface												
Cooling	At 8 cm												

1. Compare the change in temperature among the four cans. Did they all gain heat at the same rate? Explain.

2. List the mulches from the slowest to the fastest gain in heat.

3. Did they all lose heat at the same rate? Explain.

4. Was the order of heat gain the same as the order of heat loss? If not, list the slowest to the fastest.

5. Why do you think it is important to moderate soil temperatures?

Material Breakdown: The Source of Life

Main Question:
Which mulches decompose?

Objectives:
- To determine what kinds of mulches can be decomposed and which are resistant to decomposition
- To test the effect of sunlight on the breakdown of materials
- To investigate the effect of particle size on rate of decomposition

Subjects: science, language arts, math, art

Time: 1 hour to setup; 10 minutes per week to check for 4 to 8 weeks

Vocabulary: decomposition, fertilizer, amendment, mulch

Materials:

- 4 soil rich in organic material
- 4 whole leaves (deciduous leaves work best; do not use green leaves)
- 4 large bark
- 4 4 ml black plastic – 1 square foot or less
- 4 4 ml clear plastic – 1 square foot or less
- 4 shredded bark
- 4 shredded newspaper
- 4 gravel
- 4 Styrofoam cup pieces
- 4 landscape fabric
- 4 20 plastic cups, minimum 5 cm diameter
- 4 nitrogen source (urea, fertilizer, etc.)
- 4 10 petri dishes large enough to cover the plastic cups
- 4 2 large trays to hold cups

Advance Preparation:

- Gather materials. If all mulch types listed above are not available, others can be substituted or some can be deleted.
- Fertilizers will increase the rate of decomposition. Read directions carefully and do not over-fertilize.
- Plastic food wrap held with rubber bands can be substituted for the petri dishes.
- This experiment is designed as a demonstration project for the whole class.

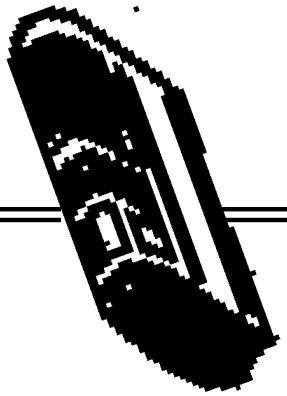
Setting the Stage:

- Ask students what happens to leaves that fall on the ground in the autumn. Do leaves look the same after sitting out all winter?
- What would happen if no decomposition occurred?

TEACHER TIP:
Clear and black plastic can be purchased from the landscape or painting sections in home improvement centers. Using different thicknesses than those recommended may cause varied results.

Activity Procedure

Material Breakdown: The Source of Life



Setting up the Cups

1. Mix the nitrogen source with the soil until it is evenly dispersed. This amended soil will aid in the decomposition.
2. Label one set of cups with the type of mulch to be used or 1 through 20.
3. Punch a couple of small nail-size holes in the bottom of each plastic cup for drainage.
4. Fill all of the cups with the amended soil to within 3 cm of the top.
5. Add 2 cm of mulch to the top of the soil in the cups. Each of the sample mulches will have two experiment cups.
6. Cover each cup with an upside-down petri dish. This will keep the water in the soil and help foster the decomposition.
7. Place cups 1 to 10 in one large tray and cups 11 to 20 in a second large tray.
8. Add water to the trays to a depth of at least 3 cm. Maintain this depth throughout the observation period.
9. Place cups 1 to 10 in a darkened area at room temperature.
10. Place cups 11 to 20 in an area of the classroom where they will receive direct sunlight.
11. Observe the cups once a week and note any changes. Be sure to test the strength of the mulch materials from time to time.

Cup Number	Mulch
1 & 11	none (control)
2 & 12	shredded newspaper
3 & 13	whole leaves
4 & 14	large bark
5 & 15	shredded bark
6 & 16	gravel
7 & 17	black plastic
8 & 18	clear plastic
9 & 19	weed barrier cloth
10 & 20	shredded Styrofoam

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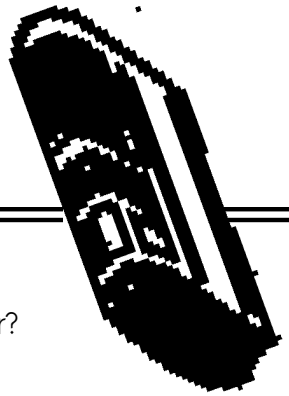
Activity Procedure

Material Breakdown: The Source of Life



Discussion:

- What was the first sign of decomposition? On which sample(s) did it occur?
- Which mulch decomposed the quickest? The slowest? Did any of them not decompose at all?
- Did the results of the cups receiving sunlight differ from those in the dark?
- What are the benefits of mulches that decompose? What are the disadvantages?

Extension:

- Test the ability of different types of soils to decompose materials.
- Experiment with commercial decomposition additives, such as different nutrients — phosphate, kelp, bone meal, etc.
- Compare the effect of decomposition with no water and with various amounts of water.
- Add earthworms, isopods, mites, nematodes, etc. to the pots to observe the role of macroinvertebrates.

RESOURCES:

The Mulch Book: A Complete Guide for Gardeners, written by Stu Campbell and published by Storey Books, is a wonderful guide to everything imaginable about mulch. It includes benefits, drawbacks, tips for vegetables and fruits, and an astounding list of the different types of mulches. It is available from a variety of sources, ISBN0-88266-659-2.

http://srd.yahoo.com/goo/mulch/6/*http://forums.gardenweb.com/forums/soil/ – forum for questions

http://srd.yahoo.com/goo/mulch/10/*http://landscaping.about.com/cs/mulchmaterials/ – links to mulch, stone, and landscape fabric pages

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