

What is compost, how is it formed, and how is it useful and why worms?

PROJECT PUMPKIN (gr 3-5)

Soil Conservation: Composting and Worms **(ILS 6D, 10A, 10 B, 11A, 12A, 12B)**

Overview

This curriculum explores the relationship between people and the food they eat. By growing pumpkins in a garden plot, the curriculum takes teachers and students through six features of sustainable agriculture that separate it from conventional farming. If the entire curriculum is completed, students will gain an understanding of sustainability and people's place in the food chain.

Sustainable Agriculture, for the purpose of this curriculum, shall be defined as "a system of food production, supported by consumers, where farming operations, practices and technologies work in harmony with the natural systems that sustain life on earth."

Suggested Grade Level

This curriculum is designed for 3rd through 5th grade levels. The topics covered can be built upon in complexity throughout that age range.

Approximate Time

Session 1 takes 45 minutes, session 2 requires 40 minutes, and session 3 takes 30 minutes, with weekly time to monitor the compost bin.

Objectives

1. The students will observe the relationship between resources and output in an ecosystem by learning the role of worms in converting raw materials into a usable output.
2. The students will increase their understandings of decomposition and life cycles.
3. The students will learn about the process of composting, what can and cannot be composted by worms, and by making a worm bin composter in the class.
4. The students will use the products of their compost bins to enrich their plants' soil.

Activity Abstract

In this activity, students will observe decaying organic materials in nature. They will play a game to introduce the concept of the various materials that produce compost successfully. They will receive instruction about making a classroom worm bin. Students will provide materials that worms will turn into a rich compost product that can be used to enrich classroom plants.

Background Information

Basics of composting. Composting is a natural process that can be containerized outdoors or inside. It is the biochemical process that occurs when organic matter is

broken down by decomposer organisms into a nutrient rich soil conditioner called humus. Mold and bacteria and higher level organisms like beetles, centipedes and earthworms are all busy recyclers. Organic matter contains carbon, which is a source of energy for microorganisms in the soil. By breaking down organic matter left over from dead plants and animals they create valuable nutrients necessary for rich and fertile soil for new seedlings to grow. This creates the cycle all over again.

Understanding Worms. There are 2,700 different kinds of earthworms in the world. Earthworms are slimy, covered with mucous that keeps them moist so they can breathe through their skin. In one acre of soil there can be a million or more, eating 10 tons of leaves, stems, and dead roots in one year and turning over 40 tons of soil. Depending on amount of soil moisture, worms are able to advance from a central point at a rate of 5 to 10 yards per year. They live near the top of the soil, digging horizontal tunnels. They are valuable to farmers because they aerate the soil as they tunnel through it eating the organic materials they encounter. Their castings (poop), containing the recycled nutrients from the various debris they eat, add fertilizer to the soil.

Native earthworms were seriously affected during the glacial period 10,000 and more years ago. The native worms were unable to overcome the effects of the long term changes in their environment and, as a result, the earthworms we know of today are of European origin. Most of the dominant species that we see in gardens and yards were brought over by settlers over the last 400 years.

The three major worms in North America – night crawlers, the standard sized earthworm, and even the smaller red worms – are not native. Red worms called red wigglers will work best for the worm bin project. They are easy to obtain and eat a great deal. Red wiggler worms can be bought at a bait shop or through one of the sources listed in the reference section.

In a compost pile or worm bin, worms really like old vegetables, fruits and peels and any other organic (naturally made) foods. They don't like anything toxic like the chemicals in junk foods, cakes and candy. What's more, they're vegetarians and won't eat meat or bones. There is concern in some circles that citrus peelings are too acidic for the worm bin situation. Worms have been known to crawl out of the bedding and onto the sides and lid if conditions are wrong for them. If the moisture level seems all right, the bedding may be too acidic. This can happen if you add a lot of citrus peels and other acidic foods. Adjust by adding a little garden lime or crushed eggshells and cutting down on acidic wastes.

If you have the correct ratio of surface area to worms to food scraps, there is little to do, other than adding food and turning the bedding, until about two and a half months have passed. By then, there should be little or no original bedding visible in the bin, and the contents will be brown and earthy looking worm castings. The contents will have substantially decreased in bulk too.

It is important to separate the worms from the finished compost, otherwise the worms will begin to die. There are several ways to do this. Quickest is to simply move the finished compost over to one side of the bin, place new bedding in the space created, and put food waste in the new bedding. The worms will gradually move over and the finished compost can be skimmed off as needed. Worms will reproduce in the worm bin. Evidence of this is the presence of cocoons, small lemon-shaped worm egg cases (about the size of a matchhead) that can carry from 2 to 20 worms.

If you have the time or want to use all the compost, you can dump the entire contents of the bin onto a large plastic sheet and separate the worms manually. Most children love to help with this process, and they will certainly learn more about worms. By separating the worms from the compost, you save more worms for your next bin. Mix a little of the finished compost in with the new bedding of the next bin, and store the rest in plastic bags for use as required.

An extra fun tip! By listening carefully, one can actually hear the worms working away on their “feast.”

Materials

- Hand lenses for each student or pair of students
- Book: “Willie Ate a Worm” by Jack Prelutsky
- 1 game board per 2-3 students. (See separate document, Journey to Compostia, for game board.)
- 1 game token per student (colored paper chip, coin, etc.)
- 1 spinner divided into four equal parts for each set of players. (See appendix B for copy of the spinner.)
- paper clip or bobby pin to be spun around a pencil point for each team
- clean plastic storage bin with lid (do not use clear plastic; worms like dark) with approximately the following dimensions: 2-3 feet long, 1 1/2-2 feet wide and 8-12 inches deep.
- plastic tray, such as cat litter pan, boot tray, or large plastic tray for drainage
- plastic screening or mesh used for crafts
- duct tape or hot glue gun
- shredded paper for bedding
- drill
- red wiggler worms (available from bait shops or through catalogs--see references)
- soil thermometer
- spray bottle
- large spoon to stir worms

Set-up

Find a place outside that has a rotting log or some type of decomposition occurring. Gather materials to play Compostia Game (game boards, tokens spinners, paperclips). Gather all remaining materials for making the worm compost bins.

Procedure (Session 1)

1. Tell the class that today you are taking them to see one of your favorite natural areas. Act really excited about all the crazy creatures and wonderful things that live there.
2. Pass out hand lenses to each student.
3. Explain that the things you’re going to see wonderful, but often small, so they need to be sure to look closely.
4. **Hands-on experience.** Head outside towards the decomposing area you picked out. As you arrive,

Guidelines for decomposing area:

1. Go on your hands and knees so they don’t miss seeing the small stuff.
2. Anything they move, they have to put back, including the rotting logs themselves.
3. No killing anything, even if they think it’s gross.

- review some of the rules for visiting your special area (see →).
5. Turn the log and search for evidence of all the decomposing critters that live there. You might find worms, millipedes, centipedes, spiders, rolie-polies, mushrooms and other fungi, etc.
 6. **Introduce scientific principle.** Gather the class to talk about what you've seen. What is happening to the log? How did it start? (As a tree). How did it die? What are all the critters and fungi doing on the log? (Breaking it down, or decomposing it, so it will turn back into soil.)
 7. Have the students see if they can find any place where the rotting log feels or smells like soil – earthy and crumbly. How did it get that way?
 8. Have the students see if they can find a place where a new plant is growing from the rotting log. Why is this a great place to grow? (Lots of nutrients from the decomposing log).
 9. Find a rock or a stone. Ask the students if the rock is also decomposing. (No; it is wearing away, turning back into soil, but not through the same process involving critters and fungi. Those can only work on organic, or living, material.)
 10. Explain to students that the decomposers they see are only part of the process. Pick up a handful of decomposing stuff. Explain that in your hand, there are also millions of critters, like bacteria, that are so small that we can't even see them. They do a lot of decomposing as well.
 11. Ask the students, how long do they think it will take for the whole log to turn into soil? (Many, many years)
 12. **Conclusion/wrap-up.** Explain that people try to speed up this process that takes so long in nature by making containerized compost bins. That's what the class will be doing to create a material that can help their plants grow better.
 13. Return to classroom.

Procedure (Session 2)

14. Read aloud "Willie Ate a Worm" by Jack Prelutsky.
15. **Tap prior knowledge.** Based on the story, discuss what worms might eat. What happens to what they eat? What do students know about compost? How might it be useful?
16. Split the class into groups of 2-3 students.
17. **Hands-on experience.** Explain that students will play a game called "Journey to Compostia". The object of the game is to stay out of the garbage can while progressing to the center of the game board where there is a large outdoor-style compost pile. Use the spinner to determine who plays first, then spin to find out the number of spaces to move. Follow the directions in the spaces. The first one in the compost pile gets to "be the worm." Encourage other players to continue to move toward the compost pile. *Maybe a game piece called "the worm" can be used to designate the first to arrive in the center.*
18. **Introduce scientific principle.** Discuss the game. Ask the students if there is any relationship between what they learned from the game and what they saw earlier under the rotting log. Ask if any students have a compost pile or have seen one. What did they learn from the game that are good materials to place in a compost pile? Which of these might be found in a student's lunch leftovers that

could be added to a classroom pile? Which items are not good for a healthy compost pile? (Perhaps create lists on the board.) What else does a compost pile need to continue the breaking down of the materials? What “critters” might be seen in a compost pile? What unseen organisms might be in one? Ask if students have ever found an object that had been buried in the ground and if they could recognize what it was. What made it change faster than objects not buried in soil? Did the game board contain any words they didn’t know (humus)? Can you figure out what they mean?

Procedure (Session 3)

1. **Tap prior knowledge.** Review what the class has learned about compost bins and worms. Explain that today we will make a worm compost bin for the class to use. The class will make one bin, so we’ll have to take turns doing the jobs so everyone gets a chance.
2. **Hands-on experience.** Drill several small holes in the bottom of the storage bin. These will be for drainage. You want to keep your worms moist, but not too wet. Worms will die if they dry up or get submersed in water!
3. Place the screen/mesh over the bottom of the bin to prevent stuff from clogging the holes.
4. Put bin on tray.
5. Drill small vent holes on either side near the top of the bin to help provide air circulation.
6. Cover the vent area with screening or mesh to keep worms in and insects out. Secure the screening with a hot glue gun or duct tape (may eventually have to be replaced due to the humid conditions.)
7. Place the lid on the bin to keep the bin dark. Worms need darkness. The lid will also help slow down moisture loss from the bedding and keep unwanted insects out.
8. Fill the bin to the top on one side with the bedding.
9. Use spray bottle to moisten, but do not wet.
10. Worms are expected to eat a pound of food per week for every square foot of surface space in their bin. The real test of the correct amount of food is attention to what remains at the end of the week. When adding food waste do not always put it in the same place. Follow a rotating sequence to keep food from piling up.
11. Cover the food with bedding.
12. Over the next few months, have students add appropriate food scraps to the bin. Have students gently stir worm compost weekly (to add oxygen to the compost) and take the temperature of the compost to make sure it’s in the right range (40 to 90 degrees F is the optimal temperature range). These tasks could become a rotating classroom job; it could also be the basis of a graphing project!

Keeping them alive!

Worms need:

1. Temperature 40°-90°F
2. Moisture
3. Air
4. Food, such as plant material other things the students learned in game
5. Bedding. Shredded office-type paper is best; shredded cardboard (produces dust which may be harmful to breathe); shredded newsprint (may require prep time to shred by hand, may mat down when wet. No colored in or slick colored inserts).

13. As decomposition becomes evident in the worm bins, assign student to keep a log noting when particular items were added, the type of items added, and when evidence of decay started. If there are problems with the bin such as a bad smell or flies developing, they can possibly refer to their notes to determine the source. **Appendix A tells about possible problems with your bin!** After the worm bins have been in action for a while, students may start to notice that the buried material starts to resemble a usable compost. Engage them in a discussion after having the diarists report their results. Discussion should include student comments about the best materials for composting, length of time it takes to develop a useful product, when the worm eggs began to appear.
14. If you have the correct ratio of surface area to worms to food scraps (1 sq. ft/pound food), there is little to do, other than adding food, until about two and a half months have passed. By then, there should be little or no original bedding visible in the bin, and the contents will be brown and earthy looking worm castings. The contents will have substantially decreased in bulk, too.
15. Add the humus to your plants or garden and watch them grow!

Extensions

1. A creative writing assignment could be writing about living in a compost pile from the worm's point of view and include student reflections on their observations and learning.
2. For an alternative experiment using various food types in different compost bins, see <http://commtechlab.msu.edu/sites/letsnet/noframes/Subjects/science/B2U1.html>
3. For an alternative experiment testing various types of worm castings for content and use in growing seeds, see <http://commtechlab.msu.edu/sites/letsnet/noframes/Subjects/science/b2u113.htm>

References

“Bring in the Cleanup Crew,” Jaffe, R. and Appel, G. 1990 The Growing Classroom: Garden Based Science. Addison-Wesley Publishing Company, Menlo Park, CA

“Making a Worm Bin,” “Composting with Worms,” Sharon A. Yiesla, Unit Educator, University of Illinois Extension, Lake Unit, 100 S. Highway 45, Grayslake, IL 60030

<http://www.urbanext.uiuc.edu/worms/index.html>

<http://yucky.kids.discovery.com/noflash/worm/index.html> (**diagram of earthworm body parts/works**)

<http://yucky.kids.discovery.com/noflash/worm/pg000102.html> (inside an earthworm diagram)

<http://www.yucky.com/worm> Travel through Wendell the Worm's World. Learn about worms as recycling, worm body parts, worm fun, and view the worm art gallery.

<http://yucky.kids.discovery.com/noflash/worm/multi/wormbirth.mov> (**video showing birth of a worm**)

<http://yucky.kids.discovery.com/noflash/worm/multi/heart.mov> (**video showing 5 hearts of a worm**)

<http://yucky.kids.discovery.com/noflash/worm/multi/womaninbin.mov> (**video** of woman inside a worm bin author of Worms Eat My Garbage)

<http://www.extension.umn.edu/extensionnews/2002/EarthwormsDamageTheSoils.html>

<http://www.oznet.ksu.edu/geary/AV2002/av042302.htm>

<http://www.wormwoman.com> Meet the worm woman who started it all!

<http://yucky.kids.discovery.com/noflash/worm/pg000224.html> (**Plans** for worm bin composting)

<http://www.ccc.govt.nz/waste/Guides/WormComposting/index.asp>

(Tips for **making and using a worm bin.**)

Worm Bin Project

<http://commtechlab.msu.edu/sites/letsnet/noframes/Subjects/science/B2U1.html>

Students will learn about decomposition and the worm's life cycle in a unit of study.

<http://www.sci.mus.mn.us/sln/tf/w/worms/worms/compost.html> create your own compost school project

<http://www.sci.mus.mn.us/sln/tf/w/worms/worms/worms.html>

See first graders at the Museum Magnet School exploring the world of worms Science Museum of Minnesota Online Worm Project

<http://www.cityfarmer.org/wormgloss82.html>

(Worm Words Glossary for Teachers: Learn the words that pertain to worms & worm composting.)

<http://www.urbanext.uiuc.edu/worms/wormlinks/index.html> links for worms

<http://www.sci.mus.mn.us/sln/tf/w/worms/worms/song.html>

<http://commtechlab.msu.edu/sites/letsnet/noframes/Subjects/science/B2U1.html> (worm bin **unit project**)

<http://letsgetgrowing.com/> build a worm bin

<http://commtechlab.msu.edu/sites/letsnet/noframes/Subjects/science/b2u113.html>

<http://www.cityfarmer.org/wormcomp61.html#wormcompost>

<http://www.urbanext.uiuc.edu/worms/wormdeli/index.html> online test to see what goes into compost

<http://www.urbanext.uiuc.edu/bugreview/index.html> **garden pests**

<http://www.urbanext.uiuc.edu/> **good general site with many links**

CATALOGS



<http://letsgetgrowing.com/>

An online **catalog** with hundreds of environmental science and nature education products including worm bins for K-12 classrooms.

<http://www.cityfarmer.org/wormsupl79.html>

List of worm sellers in the United States and Canada

The author would like to give special recognition to Sharon Yiesley, XXXXXXXX, from the Lake County Agricultural Extension Service for information on building worm bins.

Appendix A: Troubleshooting.

Avoiding Possible Problems

The most common problem is unpleasant, strong odors caused by lack of oxygen in the compost due to overloading with food waste. Food sits around too long, and the bin contents become too wet. The solution is to stop adding food waste until the worms and micro-organisms have broken down what food is in there, and to gently stir up the entire contents to allow more air in. Check the drainage holes to make sure they are not blocked. Drill more holes if necessary. Worms will drown if their surroundings become too wet.

Worms have been known to crawl out of the bedding and onto the sides and lid if conditions are wrong for them. If the moisture level seems all right, the bedding may be too acidic. This can happen if you add a lot of citrus peels and other acidic foods. Adjust by adding more crushed eggshells and cutting down on acidic wastes.

Fruit flies can be an occasional nuisance. Discourage them by always burying the food waste and not overloading. Keep a piece of old burlap sacking on the surface of the compost in the bin. If flies are still persistent, move the bin to a location where flies will not be bothersome.

To avoid fly and smell problems, always bury the food waste by pulling aside some of the bedding, dumping the waste, and then cover it up with the bedding again. Bury successive loads in different locations in the bin.