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Introduction to Composting General Composting for High School Agricultural Classes

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INTRODUCTION TO COMPOSTING
GENERAL COMPOSTING FOR HIGH SCHOOL AGRICULTURAL CLASSES

by

Brett K Wilson

B.S., Southern Illinois University, 2014

A Research Paper
Submitted in Partial Fulfillment of the Requirements for the
Master of Science

Department of Plant Soil and Agricultural Systems
in the Graduate School
Southern Illinois University Carbondale
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RESEARCH PAPER APPROVAL

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in the field of Plant, Soil, and Agricultural Systems

Approved by:
Dr. Karen Jones, Chair

Graduate School
Southern Illinois University Carbondale
August 12, 2021

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Introduction to Composting - General Composting for High School Agricultural Classes

Unit: Composting

Problem Area: What is composting and the different types

Lesson: Composting

Student Learning Objective - Students should achieve the following objectives from this lesson:

1. Define “composting” and other necessary terms
2. Understand the history and modern use of compost
3. Understand the different styles of composting
4. Examine the waste classifications of compost
5. Develop a compost recipe

Resources -

1. “Types of Composting and Understanding the Process.” *EPA*, Environmental Protection Agency, 29 Aug. 2016, www.epa.gov/sustainable-management-food/types-composting-and-understanding-process.
2. Rostek, Andrew. "Composting| KC." (2016).

Equipment, Tools, Supplies, and Facilities -

- Media Projector (Power Point, Google Slides, Smart Board, TV, Projector)
- Visual aides
- Copies of sample test, lab sheets, and/or other items designed for duplication
- Materials listed on duplicated items
- Computers with printers and Internet access
- Classroom resource and reference materials

Key Terms -

Composting	**Onsite Composting**
Vermicomposting	**Castings**
Worm Tea	**Aerated Windrow Composting**
Leachate	**Aerated Static Pile Composting**
In-Vessel Composting	**Anaerobic**
Aerobic	

Interest Approach -

- The students already know about how wasteful human life can be. Through this lesson students will explore the ability to create a useful material out of a waste product.
- Students would have already completed the horticulture unit, and now will have the understanding of what to do with plant material that is considered waste material.

OBJECTIVE 1: Define "composting" and other necessary terms

1. Anticipated Problem: What is composting, and how can it play a vital and important role in a greenhouse and garden setting.
    a. Define composting, give some source material
        i. Composting - decomposition of organic materials in a controlled manner.
        ii. Anaerobic - digestion of compostable materials that decomposes organic matter in the absence of oxygen.
            1. Release large amounts of biogas that can be burned to create energy for onsite activities
            2. Produces noxious odors
            3. Compost could contain organic acids that may kill plant roots.
        iii. Aerobic - or pile composting, is the most common form of decomposition.
            1. Natural processes are accelerated as mechanical and biological decomposition of the compostable material is accelerated through turning and microbial activity.
            2. Labor intensive due to the air flow needed from aeration or turning
            3. Can be odor free with the right management style.
            4. Can take longer to process due to microbial activity and improper management.
        iv. Source Materials -
            1. Green Organic Material - grass clippings, food scraps, and manure - all contain large amounts of Nitrogen
            2. Brown Organic Material - dry leaves, wood chips, and branches, - all contain large amounts of carbon but little to no nitrogen.
            3. Creating the right compost mix takes patience and experimentation making it a fun science project.
        v. Basics
            1. Aside from source material, a few other areas need to be followed to create a good compost substance.
                a. Particle Size - Small particles increase surface area allowing microorganisms to readily feed. The smaller particles will provide insulation for the compost pile keeping it at the optimum temperature. However, particles that are too small

can cause poor circulation of air which is needed for the breakdown process.

b. Moisture - Microorganisms living in and breaking down the compostable material are like all other living organisms and need water to survive. Water or moisture may be contained in the organic material being broken down, but can also be added through rain fall and waterings.
c. Oxygen - Air flow is needed to help speed up the process of decomposition. This can be achieved by turning the pile, placing the pile on a series of pipes, or including different bulking agents like wood chips or newspaper to allow for aeration of the compost pile. Too much air flow can slow down the decomposition rate by drying out the pile.
d. Temperature - The core temperature of the pile should be at least 140°F. Certain temperatures promote rapid composting and destroy pathogens and weed seeds. Too low of conditions can cause rotting of the pile.

OBJECTIVE 2: Understand the history and modern use of compost

1. Anticipated Problem: What is the history of urban agriculture and its use of compost?
    a. Urban agriculture is a long standing practice
    b. Urban gardens first appeared in 16th century Europe. Allotments, or community gardens in Europe, helped to provide adequate food for poor villagers in the early days of the industrial revolution.
    c. Ebenezer Howard first integrated these gardening practices in the early 20th century.
    d. Throughout the middle 20th century, Americans were encouraged to start urban gardens to help with the war effort. This trend extended post war as a form of “Victory Garden,” and helped to become many families' primary source of food.
    e. Garden waste was used as a natural soil amendment to help keep the garden healthy. This amendment was an early form of composting.
2. Anticipated Problem: What is the modern use of urban agriculture and its use of compost?
    a. Urban agriculture has increased in popularity with the perception of locally grown healthy foods.
    b. Urban gardens have started appearing in more and more cities, ranging from community style gardens in parks to rooftop gardens and greenhouses on city buildings.
    c. The material that is considered waste is now being used in a much larger way where it is directly incorporated back into the soil or it is hauled off and added into a large-scale city wide composting center.

OBJECTIVE 3: Understanding the different styles of composting

1. Anticipated Problem: What are the different styles of composting?
    a. Onsite Composting - Small decomposing piles that can be started in a garden using food and yard waste.

b. Vermicomposting - Uses red worms in bins that feed on food scraps, yard waste, and other organic material to create a compost material (casting) and a liquid fertilizer (worm tea).
c. Aerated Windrow Composting - Also known as turned windrow composting is for large volumes of organic waste material that utilizes a machine to turn from time to time.
d. Aerated Static Pile Composting - Produces compost relatively quickly (3-6mo) in a pile that forces air throughout the pile.
e. In-Vessel Composting - Can process large amounts of waste without taking up much space, and it can accommodate virtually any type of organic waste (meat, animal manure, biosolids, food scraps).

2. Anticipated Problem: How do the different styles differ? How are the different styles alike?
    a. Onsite Composting
        i. Meant for small amounts of food waste and yard trimmings. Large amounts of food waste and animal products are not appropriate for this style of composting.
        ii. Changes in weather will not have a large effect on this style.
        iii. Proper burial of food scraps needs to be practiced to keep out unwanted pests.
        iv. This style takes very little equipment to start and maintain.
        v. Creating compost can take up to two years, this process can be sped up with manual turnings.
        vi. This compost should not be used as the potting soil for houseplants due to the chance of different seeds that may not break down during the composting process.
        vii. Grass clippings can be left on your lawn for natural breakdown known as grass-cycling.
        viii. Leaves can be set aside to be used as a natural mulch and moisture bearer later on.
    b. Vermicomposting
        i. Uses red worms in bins that feed on food scraps, yard waste, and other organic items to create a compost material called castings.
        ii. One pound of worms can eat up to a half a pound of organic material a day.
        iii. Typically takes 3-4months to produce usable castings.
        iv. Castings can be used as potting soil.
        v. Worm tea is another byproduct of vermicomposting. It is used as a high quality liquid fertilizer for houseplants or gardens.
        vi. Vermiculture compostable materials
            1. Food scraps
            2. Paper
            3. Yard trimmings (grass and plants)
        vii. Works well for apartments and small offices.
        viii. Easily used in education to teach about conservation and recycling.

ix. Worms need to be fed the proper diet and kept in the right conditions. The worms do not do well with direct sunlight or extreme temperature. Shade or having the vermicomposting bins inside is the best option.

c. Aerated Windrow Composting
   i. Suited for large volumes of material
      1. Usually collected from communities or food processing entities
   ii. Yields significant amounts of compost that can be marketed to raise money for the community.
   iii. Forms the organic waste into long rows, "windrows," and aerating them from time to time either manually or by a machine.
   iv. Piles range from 4-8' high and 14-16' wide, this still maintains an even core temperature and oxygen flow to the piles core.
   v. Large columns of washes can be used.
      1. Yard trimmings, grease, liquids, animal byproducts
   vi. Utilizes large amounts of land, equipment, and labor to maintain the facility and the compost.
   vii. Water evaporation is an issue in some areas, resulting in the piles being covered.
   viii. Windrows can be shaped to allow water to run off the sides and not absorbed into the pile.
   ix. In cold climates the composting still works due to the core of the pile reaching 140°F.
   x. Leachate is a microbial water that is released during the compost breakdown that can contaminate the groundwater. It should be collected and reused to help maintain a healthy compost, or treated to be released safely into the environment.
   xi. Windrow composting is a large-scale operation and might be subject to regulations at the local, state, or federal level. Tests will need to be done on the produced material for safety of use. These agencies also enforce the odors that may be produced by a facility.

d. Aerated Static Pile Composting
   i. Works well for large quantities of yard trimmings and compostable municipal solids from local governments, landscapers, or farms.
   ii. Animal byproducts and grease can slow the compost rate down.
   iii. Piles can be made inside bunkers with pipes laid underneath the pile for air flow up. Wood chips and paper scraps are layered throughout the pile to help allow for air flow.
   iv. Like with windrows, water evaporation is an issue in some areas and should be covered.
   v. The cold does not usually affect the static pile as the core temperature is high, but placing the piles inside can help keep the process from being interrupted in severe cold times.

vi. With no physical turning of the pile being down, a careful eye needs to be on the outer edges of the pile to make sure that they are heating as well as the inner core.
vii. Applying a layer of wood chips or finished compost at the top of the pile will help alleviate any odors or pests from digging into the pile.
viii. This system is expensive due to the monetary investment needed to create a facility, install air systems, maintain equipment, and labor.
ix. Having a controlled supply or air allows construction of large piles which require less land than the windrow method.

e. In-Vessel Composting
   i. Involves feeding organic material into a drum, silo, or concrete bunker. This allows for control over the environmental conditions surrounding the compostable material.
   ii. The material is mechanically turned or mixed to allow for proper aeration.
   iii. Scalable - Small enough to fit in a school or a kitchen or can be large enough to accommodate a food processing plant.
   iv. Electronic control of the climate allows year-round use.
   v. Little odor or leachate produced.
   vi. Expensive and can use a lot of technical education.
   vii. Uses less land and labor then other methods.

OBJECTIVE 4: Examine the waste classifications of compost

1. Anticipated Problem: What are the different ingredients that can be added into a compost recipe?
   a. Green Waste - High in Nitrogen. All will have high moisture content, but will lead to odor if composted alone
      i. Vegetable scraps
      ii. Coffee Grounds
      iii. Grass Clippings
   b. Brown Waste - High in Carbon. Slow decaying dry material that can tie up to much nitrogen if composted alone
      i. Leaves
      ii. Straw
      iii. Saw Dust
      iv. Animal Bedding
2. Anticipated Problem: What happens in the case of improper compost ingredients
   a. Improper ingredients can lead to unusable compost. This could range from a variety of different reasons:
      i. Too Basic
      ii. Too Acidic
      iii. Improper mixtures can cause harm to your gardens leading to dead plants, excess weeds, or even dead zones.

OBJECTIVE 5: Developing a compost recipe

1. Anticipated Problem: What do we have in the greenhouse, garden, kitchens, or classrooms that can be used for a compost recipe?

Greenhouse	**Garden**	**Kitchens**	**Classrooms**
Plant Cuttings	Plant Waste	Food Scraps	Pencil Shavings
Leaves	Leaves		Coffee Grounds
Waste Soil	Waste Vegetables		Animal Bedding

Developing an In-Vessel Compost Recipe - Lab

Purpose

1. The purpose of this activity is to test your knowledge using the different items that were found in objective 4 of the lesson to develop an In-Vessel Compost Recipe.

Objective

1. Use the items found in Objective 4 to develop a recipe for composting that can be used to create a compost mixture in an In-Vessel Composter

Materials

1. Green and Brown Waste
2. 3 five gallon buckets
3. Drill and 3/16" drill bit
4. Garden trowel
5. Gloves
6. Safety glasses
7. Scale
8. Infrared Thermometer

Procedure

1. Using the chart from Objective 4, collect 1 gallon of each of your items that you listed.
2. What do you have that is "Green Waste" VS "Brown Waste"?

Green Waste	Brown Waste

3. With your drill and bit, make a few holes in the bottom of one of your buckets. This will allow any water or liquids to drain from your bucket and into your second or third bucket.

4. Weigh your materials that you have collected for your Green and Brown Waste, and put their weights in the chart below.

Green Waste Weight	Brown Waste Weight

5. Next mix your waste products together in your bucket with the holes in it. This bucket should be sitting in one of your whole buckets.
6. Once mixed carefully add a quart of water, and mix it in.
7. Make sure to keep track of the amount of water you continue to add.
8. Check the temperature of your compost mixture daily, keeping track of your temperatures.
9. Each day check your bottom bucket by switching it out with the additional bucket. Weigh the liquid contents of the bottom bucket, and keep that listed. Add the liquid back into the compost mixture, making sure to stir it in.
10. If your bottom bucket has no liquid in it, add a quart of water back into your mixture.
11. After a few weeks your compost mixture should be broken down and ready to use as a soil amenity for a potted plant.
12. If your compost is not ready after a few weeks, don't worry. Some compostable materials take longer than others. Repeat the above steps until it is ready.
13. If your compost is ready, it should have a rich black look to it, be slightly warm, and smell earthy.
14. Answer the following questions about the lab you just completed.
    1. What kind of reaction was this?
        a. Anaerobic
        b. Aerobic
    2. What system did this lab mimic?
    3. How would you change this lab? What would you add and subtract?
    4. How can this lab be implemented on a larger scale at your house? At the School? At a restaurant? In our community?
    5. If your compost project never finished, what would you do to change your end result? This is not changing the lab, but changing what you personally did with your lab.

Introduction to Composting Test

(CLASS)

(YEAR)

Matching

Match the term with correct definition

A. Composting	**B. Onsite Composting**
C. Vermicomposting	**D. Castings**
E. Worm Tea	**F. Aerated Windrow Composting**
G. Leachate	**H. Aerated Static Pile Composting**
I. In-Vessel Composting	**J. Anaerobic**
K. Aerobic	

1. _____ Decomposition of organic materials in a controlled manner
2. _____ Digestion of compostable materials that decomposes organic matter in the absence of oxygen
3. _____ Digestion of compostable materials that decomposes organic matter with oxygen
4. _____ Small decomposing piles that can be stated in a garden using food and yard waste
5. _____ Uses red worms in bins
6. _____ Also known as turned composting
7. _____ Uses forced air through the pile
8. _____ Processes large amounts of waste without taking up much space
9. _____ Worm made compost material
10. _____ Liquid fertilizer from Vermicomposting
11. _____ Microbial water used to maintain healthy compost

Multiple Choice

Pick the letter of the correct answer

1. Contains large amounts of Nitrogen
    a. Brown Material
    b. Black Material
    c. Leachate
    d. Green Material

2. Contains large amounts of Carbon
    a. Brown Material
    b. Black Material
    c. Leachate
    d. Green Material
3. This is important for the insulation of the compost pile and for ease of microbial breakdown.
    a. Particle Size
    b. Moisture
    c. Oxygen
    d. Temperature
4. The core temperature of a compost pile should be at least?
    a. 190°F
    b. 95°F
    c. 140°F
    d. 25°F
5. Who first integrated urban gardening practices in the early 20th century?
    a. Ebenezer Howard
    b. Mr. Wilson
    c. John Deere
    d. Cyrus McCormick
6. What were gardens called post WWII?
    a. Green Roofs
    b. Greenhouses
    c. Victory Gardens
    d. War Gardens
7. This composting technique is meant for small amounts of food waste and yard trimmings, and cannot handle large amounts of either.
    a. Onsite Composting
    b. Vermicomposting
    c. Aerated Windrow Composting
    d. Aerated Static Pile Composting
    e. In-Vessel Composting
8. Creates a tea and casting as a finished product
    a. Onsite Composting
    b. Vermicomposting
    c. Aerated Windrow Composting
    d. Aerated Static Pile Composting
    e. In-Vessel Composting

9. Large scale composting operation that takes a lot of room and most ingredients are collected from a large scale collection.
    a. Onsite Composting
    b. Vermicomposting
    c. Aerated Windrow Composting
    d. Aerated Static Pile Composting
    e. In-Vessel Composting
10. Piles can be made inside bunkers with pipes underneath the bin for air flow.
    a. Onsite Composting
    b. Vermicomposting
    c. Aerated Windrow Composting
    d. Aerated Static Pile Composting
    e. In-Vessel Composting
11. Small enough that it can work well for a school project, kitchen, or home.
    a. Onsite Composting
    b. Vermicomposting
    c. Aerated Windrow Composting
    d. Aerated Static Pile Composting
    e. In-Vessel Composting

Short Answer

Answer the following questions with either a list or a paragraph

1. List the five types of composting talked about in this lesson. Describe the difference and similarities of each composting style.

2. List out five Green Waste compost items and five Brown Waste compost items.

3. From the discussion in class, how could you fix an improper compost pile?

Introduction to Composting Test Key

MATCHING

1. **A**
2. **J**
3. **K**
4. **B**
5. **C**
6. **F**
7. **H**
8. **I**
9. **D**
10. **E**
11. **G**

Multiple Choice

1. **D**
2. **A**
3. **A**
4. **C**
5. **A**
6. **C**
7. **A**
8. **B**
9. **C**
10. **D**
11. **E**

Short Answer

1. **List the five types of composting talked about in this lesson. Describe the difference and similarities of each composting style.**
    a. **Onsite Composting**
    b. **Vermicomposting**
    c. **Aerated Windrow Composting**
    d. **Aerated Static Pile Composting**
    e. **In-Vessel Composting**

    Similarities and differences will vary, please refer to objective 3.2 for a full listing

2. **List out five Green Waste compost items and five Brown Waste compost items**
    a. **Green Waste - Answers may vary**
    b. **Brown Waste - Answers may vary**
3. **From the discussion in class how could you fix an improper compost pile?**
    a. **Answers may vary, but should contain the following discussion points.**
        i. **Correct the pile by adding more items that are a base/acid in nature to correct the current issue.**
        ii. **Start over with fresh materials, and slowly add your old pile into it**
        iii. **Keep playing with your current pile, remembering to stir frequently and add more materials in.**

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