An ILSR Composting Learning Activity

Building Piles and Measuring Bulk Density

2 hrs

Compost process

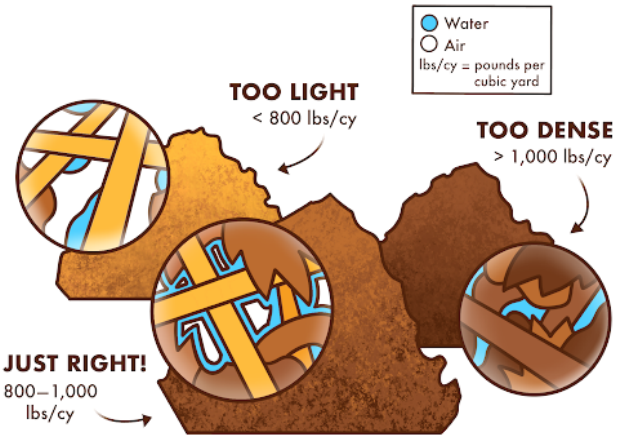
High school age and older

Materials

- A surface or container for mixing materials (such as a concrete pad or 3 metal mixing tubs)
- Compost recipe sample materials:
  - Straw (1 bale)
  - Fruit and vegetable scraps (fresh!) (~7 cubic feet or 50 gallons)
  - Woodchips (~5 cubic feet)
  - Fall leaves (~16 cubic feet or just over 0.5 cubic yards)
  - Note: The above amounts are suggested.
- Six 5-gallon buckets (straight sides)
- Three wheelbarrows (optional)
- Gloves for participants
- 3 shovels (ideally flat if using a concrete or asphalt surface)
- 3 to 6 pitchforks
- 3 sidewalk ice scrapers (optional, for chopping big pieces of food scraps)
- 1-gallon container
- Permanent pen markers (3)
- Measuring tape (1 to 3)
- Scale (pounds)
- Water
- Calculator (phone apps acceptable)

Background

The density of a compost pile is important to maintaining adequate free air space and airflow through the pile. If the pile is too compacted, anaerobic conditions may result, which in turn can lead to odor issues. If the pile is too porous, decomposition will slow. Measure bulk density when you're first building your pile, new to composting, or when you're troubleshooting.



This bulk density measuring activity is adapted from Washington State University's Procedure for Calculating Compost Bulk Density as well as from the NYC Compost Project Master Composter Course Manual's Bulk Density & Free Air Space Test.

Objectives

1. To understand how different compost pile recipes impact bulk density
2. To demonstrate the importance of pile bulk density in composting
3. To measure bulk density in a compost pile mix
4. To understand what the ideal bulk density is

Instructions for Groups

1. Have the compostable materials separated and ready for participants to access
2. Divide participants into 3 groups
3. Give each group a separate recipe:
   - Group A: 3 parts by volume straw to 1 part by volume food scraps
   - Group B: 2 parts by volume leaves, 0.5 part by volume straw, 0.5 parts by volume woodchips, to 1 part by volume food scraps
   - Group C: 1 part by volume leaves to 3 parts by volume food scraps
4. Give each group the worksheet on the following page
5. Give each group two 5-gallon buckets, gloves, two pitchforks, a shovel, and the metal mixing tub, if needed. Assign them an area to create their recipe.
6. Instruct each group to make their recipe using one of the 5-gallon buckets for estimating the volume of each material part. Alternatively, each group could have a wheelbarrow and use the wheelbarrow for this. Ask each group to mix their materials together using their pitchforks. Have them chop any large pieces of food scraps such as pineapple tops, broccoli stems, and corn cobs with the sidewalk scrapers.
7. Have each group measure the bulk density of their recipe/pile.
8. Have each group compare their bulk density measurements and share their observations.

Instructions for Measuring Bulk Density

1. With a 1-gallon measuring container, fill a 5-gallon bucket with 5 gallons of water, as the top brim of a "5 gallon bucket" is often more than 5 gallons. Mark this line on at least three places on the inside of the bucket with a permanent pen. (Empty the bucket.)

2. Measure height from bottom of inside of bucket to the 5-gallon line, divide this number by 3, and mark the inside of the bucket as above at 1× and 2× this number. For example, if the 5-gallon mark is 12 inches, dividing by 3 will get 4 inches; mark that bucket at 4 inches and at 8 inches.[1]

3. Weigh the empty bucket and record weight.

4. Fill the bucket to the ⅓ line with the compost pile mix.[2] Drop the bucket squarely from approximately 1-foot high to the ground (hard surface) 10 times. Use gravity to drop the bucket, not force.

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6. Fill the bucket to the ⅔ line with the compost pile mix. Drop the bucket squarely from approximately 1 foot high to the ground 10 times.

7. Fill the bucket to the 5-gallon line with the compost pile mix. Drop the bucket squarely from approximately 1 foot high to the ground 10 times.

8. Fill the bucket again to the 5-gallon line (do NOT drop bucket!) and weigh in pounds.

9. Record weight and complete calculations below to determine the bulk density.

[1] Use buckets with straight sides; that is, the diameter at the top of the bucket is the same as the diameter at the bottom.

[2] To use this bulk density measurement test when building a composting pile or for troubleshooting, use material representative of the pile. Take samples from several locations in the pile. Dig into the pile a couple of feet, do not take from the dried-out outer layer of the pile unless the pile was just turned.

Bulk Density Test Worksheet

A. Weight of bucket with material (lbs)	
B. Weight of empty bucket (lbs)	
C. Weight of material [line A minus line B]	
D. Convert to pounds per cubic yard. Multiply weight of material by 40 [line C times 40] This is your recipe's bulk density.	

Ideal bulk density = 800 to 1,000 pounds per cubic yard (lb/cy)

If the bulk density is <800 lb/cy, the recipe likely is too light or porous and decomposition will be slow.

If your bulk density is >1,000 lb/cy, the recipe is likely too dense and compact and may lead to anaerobic conditions. Add bulking agents such as wood chips to increase pore space.

Alternative Option: Measuring Free Air Space

You can use the result of the bulk density test to calculate the amount of free space (FAS) in your recipe or compost pile.

Instructions

1. Place the bucket full of material on level ground.
2. Fill the bucket with water completely, but without overflowing.
3. Weigh the filled bucket. Be careful! Bucket will be very heavy.
4. Record weight and complete calculations in the worksheet below.

Free Air Space Test Worksheet

E. Weight of bucket with material and water	
F. Weight of bucket with material only [result of bulk density test, line D]	
G. Weight of water [line E minus line F]	
H. Calculate percentage of free air space by multiplying weight of water by 2.4 [line G times 2.4]	

Ideal free air space = 55 to 65%

<40% indicates compaction and/or anaerobic conditions

Sources

- https://puyallup.wsu.edu/soils/bulkdensity/
- https://www1.nyc.gov/assets/dsny/docs/about_nyc-master-composter-manual-mcm_0815.pdf

Provide each group with a unique recipe.

Group A RECIPE

3 parts by volume straw
1 part by volume food scraps

Group B RECIPE

2 parts by volume leaves
0.5 part by volume straw
0.5 parts by volume woodchips
1 part by volume food scraps

Group C RECIPE

1 part by volume leaves
3 parts by volume food scraps