What is composting?

Using the natural process of decay to change organic wastes into a valuable humus-like material called compost

Benefits of compost

Promotes soil health

- Supplies organic matter to soil
- Attracts earthworms
- Stimulates beneficial soil microorganisms
- Increases soil water holding capacity
- Increases soil nutrient retention

Benefits of compost

Promotes soil health

- Improves soil tilth and friability
- Improves soil drainage
- Loosens heavy clay soils
- Suppresses soil-borne plant pathogens (diseases)

Benefits of compost

Plant nutrients

Compost is not a fertilizer, but does contain plant nutrients
- Nitrogen and phosphorus are mostly in organic forms
  - Released slowly to plants
  - Not readily leached from the topsoil
- Compost contains many trace nutrients that are essential for plant growth

Composting - Speeding up the natural decay process

A compost pile or bin allows you to control
- Air (oxygen)
- Water
- Food, and
- Temperature

By managing these factors you can speed up the otherwise slow natural decay process
What do you need to make compost?

• Decomposers – Your composting work crew. These are the microbes (mainly bacteria and fungi) that do all the work for you.
• Food for the decomposers
  The organic materials to be composted
  • The right amount of air, water, and warmth to keep the work crew happy

Where do the decomposers come from?

If you build it, they will come...

• Soil
• Leaves
• Food scraps
• Manure, and
• Finished compost
  Each of these will add microorganisms to the compost pile

One teaspoon of good garden soil to which compost has been added contains

• 100 million bacteria
• 800 feet of fungal threads

Numerous additives and starters are available but are not needed for good or rapid composting

What is the best food for your decomposers?

All organic materials will compost, but not all should be added to a backyard compost pile

Organic wastes that should be composted include:

• Garden trimmings
• Grass clippings
• Leaves
• Kitchen scraps

Also
• Used potting soil
• Manure
• Sawdust
• Hair

Materials to avoid...

Avoid organic materials that could cause problems during or after composting

• Oil, fat, grease, meat, fish or dairy products, unwashed egg shells (tend to attract pests, vermin)
• Hard to kill weeds (bindweed, bermudagrass, nutsedge) and weeds that have gone to seed (could infest garden area when compost is used).
### Materials to avoid…

- **Cat or dog waste** (attracts pests, could spread disease)
- **Diseased or insect ridden plants** (could infect or attack garden plants when compost is used)

### Materials to avoid…

- **Lime** (increases compost pH and promotes ammonia odor problems)
- **Wood ash**, add sparingly to the pile (will add some potash to compost but will increase pH and ammonia odor problems)

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### Is shredding necessary?

**Smaller particles decompose faster**

- Have greater surface area per unit volume
- Allows microbes to get at more of the food
- Chipping or shredding coarse materials (twigs, stems) will speed up the rate at which they decompose

**Smaller particles will also decrease airflow into the pile**

- May lead to anaerobic conditions
- Pile may need to be turned more often

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### More about food for your decomposers

Your compost workers will thrive if you give them a balanced diet.

- Composting will be most rapid if the decomposers are fed a mix of carbon-rich and nitrogen-rich materials.
- Carbon-rich organic wastes are known as “browns”
- Nitrogen-rich organic wastes are known as “greens”

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### Browns

High carbon materials such as

- Leaves (30-80:1)
- Straw (40-100:1)
- Paper (150-200:1)
- Sawdust (100-500:1)
- Animal bedding mixed with manure (30-80:1)
### Greens

**High nitrogen materials such as**

- Vegetable scraps (12-20:1)
- Coffee grounds (20:1)
- Grass clippings (12-25:1)
- Manure
  - Cow (20:1)
  - Horse (25:1)
  - Poultry (10:1), with litter (13-18:1)
  - Hog (5-7:1)

### Browns

- Decay very slowly
- Coarse browns can keep pile aerated
- Tend to accumulate in the fall
- Tie up nitrogen in soil if not fully composted
- May need to stockpile until can mix with greens

### Greens

- Decay rapidly
- Poor aeration – may have foul odors if composted alone
- Tend to accumulate in spring and summer
- Supply nitrogen for composting
- Best composting if mixed with browns

### Greens

- High nitrogen materials such as
  - Decaying materials that need oxygen
  - The fastest way to make high-quality compost
  - Produces no foul odors
  - Aerobic decomposers produce heat

### Aerobic composting

- Composting with decomposers that need air (oxygen)
- The fastest way to make high-quality compost
- Produces no foul odors
- Aerobic decomposers produce heat

### Aerobic composting and temperature

- Active composting occurs in the temperature range of 55°F to 155°F
- Pile temperature may increase above 140°F, but this is too hot for most bacteria and decomposition will slow until temperature decreases again.
- A thermometer is a nice tool but is not essential for good composting

### Does my compost pile have to get hot?

- Good compost can be made in a pile that never gets hot, but...
  - Decay will be slower and it will take longer to make compost
  - Not enough air, too little or too much water, or too many browns in the mix could all keep a pile from heating.
- High pile temperature provides the benefits of
  - The most rapid composting
  - Killing pathogenic (disease-causing) organisms
  - Killing weed seeds

### Compost Temperature

- Need 130°F temp for 3 days to kill most plant & animal pathogens & weed seeds
- Eventually some resource will become limiting: simple foods, oxygen, or nitrogen will be used up and microbial activity (and temperature) will drop off.

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**Master Gardener Meeting -- Marshfield, MO 3/15/2018**
Getting air to your decomposers

Warm air rising through the pile draws fresh air in from bottom and sides
Wind can stimulate aeration

Pile aeration
Depends upon adequate porosity

• Porosity is the air-filled space between particles
• “Browns” help to maintain good porosity in the pile
• A compacted pile has lost porosity; can be increased by turning

• Aeration can be increased by inserting sticks, cornstalks, or perforated pipes into or under the pile

Pile aeration
Getting air to your work force

• Turning the pile mixes fresh air into the pile
• Turning tools can make the job easier

Water

• Rapid decomposition requires optimum water content
  • If too dry, bacterial activity will slow or cease
  • If too wet, loss of air in the pile will lead to anaerobic conditions

• Pile water content should be at 40-60%
  • As wet as a wrung-out sponge
  • If too dry, add water as you turn the pile
  • If too wet, add browns and/or turn the pile

Taking care of your compost pile

• The most rapid composting is achieved by
  – Adding mixed browns + greens
  – Regularly turning (mixing) the compost pile
  – Controlling water content
• When pile no longer heats after mixing, allow it to cure (stand without mixing) for at least 4 weeks before using the compost
Making compost the fast way
(Instructions for active composters)

• Turn the pile every 5 to 7 days,
  – move outer material to the pile center
  – add water if needed
• During the first few weeks, temp should reach 140°F
• After about 4 weeks, less heat will be produced and compost will maintain lower temp (100°F)

When is compost finished?

Compost is mature when
• The color is dark brown
• It is crumbly, loose, and humus-like
• It has an earthy smell
• It contains no readily recognizable feedstock
• The pile has shrunk to about 1/3 of its original volume

Simple tests for finished compost

Bag test: sealing compost in a plastic bag for several days should produce no foul odor

Germination test: will seeds germinate in the compost? (good test to use if compost will be part of a potting mix)

Where should I put my compost pile?

• Shaded area will help prevent drying out in summer
• Avoid areas that will interfere with lawn and garden activities
• Adequate work area around the pile
• Area for storage
• Water available
Considerations for locating the compost pile

- Good drainage
- Away from any wells
- Near where finished compost will be used
- Be a good neighbor
  - Make your composting area attractive, or
  - Keep it out of your neighbors’ view

Composting options

- Pile
- One-bin
- Multi-bin
- Wire collector
- Tumbler
- Trench

Pile composting

- Passive
  - Most inexpensive
  - Minimal management
  - Inconsistent results

Pile composting

- Aerated
  - Scaleable
  - Turned every 1-14 days
  - Can be expensive

Bin construction

- Ideal size is approximately a 3-foot cube
  - Promotes good air movement
  - Retains sufficient heat to maintain warm temps
  - Piles larger than 5 x 5 x 5 feet are difficult to turn and tend to become anaerobic in the center

One-bin composter

- Most popular
- Inexpensive
- Easily movable
- Has a lid
- Some have bottoms
- Is scavenger-resistant
- Holds heat well
- Easy to access finished product
- Often made of recycled plastic
The Earth Machine Bin

Multi-bin composter
- For households with significant waste
- Move materials between bins as batches finish
- For the “serious” composter

Wire collector composter
- Quick to build
- Inexpensive
- Little heating takes place
- Susceptible to scavengers
- Can be covered with lid
- Easy to access – remove the wire!

Tumbler composter
- Small
- Can be expensive
- Very fast – 3 weeks!
- Many choices

Homemade tumbler composter
Source: dixiegrilling.com/tumbler.htm
**Trench composting**

- Dig trench or hole ~ 1 ft deep
- Add wastes + garden soil
- Cover with soil
- Easy
- Protects from pests
- Improves garden soil

**Compost troubleshooting**

**Odors**

Odors are one of the most frequent but easily avoidable composting problems.

- **Rotten odor**
  - Putrid smell or rotten egg smell
  - Usually results from anaerobic conditions
  - Excess moisture, compaction
  - Turn pile, add dry porous material (browns), cover kitchen scraps

- **Ammonia odor**
  - Too much nitrogen (greens)
  - Add high carbon material (browns), turn pile

**Temperature**

- **Low pile temperature**
  - Pile too small, cold weather, too dry, poor aeration, or lacks nitrogen
  - Make pile bigger or insulate sides, add water, turn the pile, add greens or manure

- **High pile temperature**
  - Pile too large, insufficient ventilation
  - Reduce pile size, turn

**Pests: raccoons, rats, insects**

- Presence of meat scraps or fatty food waste, rotten odors
- Remove meats and fatty foods, cover with sawdust or leaves, turn the pile
- Compost in an animal-proof bin
  - Covered bin, trash can bin, cone bin, or barrel bin
  - Wire mesh sides and floor (1/4 – 1/2 in openings)
- Use worm composting (vermicomposting) for food scraps

**Using finished compost**

- **Soil amendment**
  - Be sure that compost is mature, has an earthy smell (no ammonia or rotten smell), looks dark and crumbly with no recognizable feedstock
  - Compost improves soil health when mixed in the top 4 to 6 inches (work in no more than a 2” layer of compost)
  - Will improve water and nutrient retention of sandy soils
  - Will loosen compacted clay soils and make them more friable

- **Lawn topdressing**
  - Be sure compost is very mature to avoid harming the lawn
  - Use fine (screened) compost, 1/4” depth raked over lawn
  - Best if lawn is cored before applying compost
  - Retains moisture, supplies slow release nutrients, prevents soil compaction

- **Potting mix**
  - Compost must be very mature to avoid injury to plants
  - Use fine-textured compost
  - Mix no more than 1/3 compost by volume
Mulching benefits

- Prevents mower blight
- Suppresses weeds
- Reduces turf competition
- Improves moisture retention
- Moderates soil temperature
- Reduces soil erosion
- Adds organic matter
- Can provide nutrients
- Easier to maintain beds
- Pleasing to the eye

How mulch works

- Mulch keeps sunlight from reaching the soil, minimizing evaporation.
- Moisture is lost to evaporation.
- Plant roots use moisture from the soil.
- Heat builds up. Weed seeds germinate when exposed to light, but stay dormant under mulch.
- Rain and sprinklers splatter and erode unmulched soil.
- As organic mulch breaks down it releases nutrients that plants use.

Too much mulch can starve plants for water
Cooling effects of mulches

• Compared:
  – Bare ground
  – Rubber mulch
  – Mini-bark
  – Pallet mulch
  – Cedar mulch

• Results:
  – Ambient air temp 98.2°F
  – Soil temps at 1¼ inches
    • Bare soil – 101.6°F
    • Under mulches – 83-89°F

Source: Dr. Curtis Swift, Colorado State University Extension, 8-13-2003

Inorganic mulches

• Rock, gravel, rubber, plastic, weed barrier fabric
  – Do not provide the soil benefits of organic mulch
  – Rock can increase soil temperature as it absorbs heat
  – Light-colored rock may reflect heat onto plants

Source: Dr. Linda Chalker-Scott, Ph.D, Extension Horticulturist, Washington State University

Rubber mulches

• Weed control – not as effective as organic mulches
• Flammable – highly & difficult to extinguish
• Permanent? – like organic mulches, it decomposes
• Non-toxic? – Leachates can be toxic to aquatics and plant roots

Source: Dr. Linda Chalker-Scott, Ph.D, Extension Horticulturist, Washington State University

Organic mulches

• Leaves/leaf mold
• Grass clippings
• Wheat straw
• Pine straw
• Shredded bark or wood waste

Source: https://extension2.missouri.edu/g6960

Inorganic mulches

<table>
<thead>
<tr>
<th>Material</th>
<th>Resistance to Incorporation</th>
<th>Microclimate</th>
<th>Resistance to Wind Blowing</th>
<th>Availability</th>
<th>Source of Leachates and Runoff</th>
<th>Fire Hazard</th>
<th>Comments</th>
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<tr>
<td>Black supported</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Excellent</td>
<td>No</td>
<td>Not情</td>
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<td>Crushed rock</td>
<td>Excellent</td>
<td>Good</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Excellent</td>
<td>No</td>
<td>Many color</td>
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<td>Composted woodchips</td>
<td>Excellent</td>
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<td>Excellent</td>
<td>Excellent</td>
<td>Excellent</td>
<td>No</td>
<td>multiphase</td>
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<tr>
<td>Gravel</td>
<td>Excellent</td>
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<td>Excellent</td>
<td>Excellent</td>
<td>Excellent</td>
<td>No</td>
<td>Use caution</td>
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<tr>
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<td>Excellent</td>
<td>Excellent</td>
<td>Excellent</td>
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<td>Not情</td>
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<tr>
<td>Vermiculite</td>
<td>Poor</td>
<td>Poor</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Excellent</td>
<td>No</td>
<td>physical</td>
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<tr>
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<td>Good</td>
<td>Excellent</td>
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<tr>
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<td>Excellent</td>
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<tr>
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<td>Good</td>
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<td>Use caution</td>
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<tr>
<td>Peroxy</td>
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<td>Excellent</td>
<td>Excellent</td>
<td>Excellent</td>
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<td>Not情</td>
</tr>
<tr>
<td>Vermiculite</td>
<td>Poor</td>
<td>Poor</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Excellent</td>
<td>No</td>
<td>physical</td>
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</tbody>
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Single-season mulches

• Grass clippings
• Leaves
• Compost
• Shredded paper
• Peat moss
• Straw
• Corn stalks
• Ornamental grasses (chopped)
### Organic Mulches (that break down in one season)

<table>
<thead>
<tr>
<th>Material</th>
<th>Resistance to compaction</th>
<th>Attractiveness</th>
<th>Resistance to wind blowing</th>
<th>Availability</th>
<th>Source of weeds &amp; disease</th>
<th>Fire hazard</th>
<th>Comments</th>
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</thead>
<tbody>
<tr>
<td>Compost</td>
<td>Good</td>
<td>Good</td>
<td>Excellent</td>
<td>Poor</td>
<td>Fair</td>
<td>No</td>
<td>Value varies with ingredients</td>
</tr>
<tr>
<td>Hay</td>
<td>Good</td>
<td>Fair</td>
<td>Good</td>
<td>Poor</td>
<td>Fair</td>
<td>Yes</td>
<td>Good when available</td>
</tr>
<tr>
<td>Lawn clippings</td>
<td>Poor</td>
<td>Poor</td>
<td>Good</td>
<td>Excellent</td>
<td>Fair</td>
<td>No</td>
<td>Compacts first</td>
</tr>
<tr>
<td>Leaf mold</td>
<td>Good</td>
<td>Good</td>
<td>Excellent</td>
<td>Fair</td>
<td>No</td>
<td>No</td>
<td>Value varies with ingredients</td>
</tr>
<tr>
<td>Leaves</td>
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<td>Unsatisfactory</td>
<td>Poor</td>
<td>Poor</td>
<td>Good</td>
<td>No</td>
<td>Compacts first</td>
</tr>
<tr>
<td>Pine straw</td>
<td>Unsatisfactory</td>
<td>Unsatisfactory</td>
<td>Excellent</td>
<td>Good</td>
<td>Poor</td>
<td>No</td>
<td>Compacts first</td>
</tr>
<tr>
<td>Straw</td>
<td>Unsatisfactory</td>
<td>Poor</td>
<td>Poor</td>
<td>Good</td>
<td>Excellent</td>
<td>No</td>
<td>Must be shredded, unsightly</td>
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<tr>
<td>Waste paper</td>
<td>Poor</td>
<td>Unsatisfactory</td>
<td>Poor</td>
<td>Good</td>
<td>Excellent</td>
<td>No</td>
<td>Good when available</td>
</tr>
</tbody>
</table>

Resource: [https://extension2.missouri.edu/g6960](https://extension2.missouri.edu/g6960)

### Persistent mulches

- Bark chips
- Wood chips
- Sawdust
- Pine straw
- Cottonseed hulls
- Pecan hulls

### Organic Mulches (that persist more than a year)

<table>
<thead>
<tr>
<th>Material</th>
<th>Resistance to compaction</th>
<th>Attractiveness</th>
<th>Resistance to wind blowing</th>
<th>Availability</th>
<th>Source of weeds &amp; disease</th>
<th>Fire hazard</th>
<th>Comments</th>
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<tbody>
<tr>
<td>Bark chunks</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Excellent</td>
<td>No</td>
<td>No</td>
<td>Generally available, expensive</td>
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<tr>
<td>Cottonseed hulls</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Excellent</td>
<td>No</td>
<td>No</td>
<td>Hard to keep in place</td>
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<tr>
<td>Pine needles</td>
<td>Excellent</td>
<td>Good</td>
<td>Good</td>
<td>Fair</td>
<td>Good</td>
<td>No</td>
<td>Especially good on acid-loving plants</td>
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<tr>
<td>Sawdust (coarse)</td>
<td>Fair</td>
<td>Fair</td>
<td>Good</td>
<td>Good</td>
<td>Excellent</td>
<td>No</td>
<td>Add nitrogen, can be heavy</td>
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<tr>
<td>Sawdust (fine)</td>
<td>Fair</td>
<td>Fair</td>
<td>Poor</td>
<td>Poor</td>
<td>Good</td>
<td>No</td>
<td>Compacts too easily, requires changes</td>
</tr>
<tr>
<td>Shredded bark</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Excellent</td>
<td>No</td>
<td>Good when available</td>
</tr>
<tr>
<td>Wood chips</td>
<td>Good</td>
<td>Good</td>
<td>Excellent</td>
<td>Good</td>
<td>Excellent</td>
<td>No</td>
<td>Requires changes</td>
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<td>Wood shavings</td>
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<td>Good</td>
<td>Good</td>
<td>Fair</td>
<td>Excellent</td>
<td>No</td>
<td>Requires changes when spaded under</td>
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Resource: [https://extension2.missouri.edu/g6960](https://extension2.missouri.edu/g6960)

### Problems with Organic Mulches

- Toxic metabolites
  - Sour mulch syndrome
- Exotic fungal wildlife
  - Artillery fungus
  - Bird’s nest fungus
  - Stinkhorn fungus

### Sour Mulch Syndrome

- Soggy Mulch Pile
- Volatile Organic Acids
- Leaf Burn

Effect of volatile acetic acid from sour mulch

### Artillery (Shotgun) Fungus

- Woody mulch
  - Sphaerobolus stellatus

Black spots on cars and house siding
Exotic Fungal Wildlife

- **Stinkhorn fungus** *(Mutinus elegans)*
- **Bird’s nest fungus** *(Cyathus striatus)*


### Proper mulching techniques

- **2”-3” thick layer:** refresh yearly or as needed
- **Start 3”-4” from tree trunk**
- **Extend out to dripline**
- **Think “bagel”, not “volcano”, around trees**

### How much mulch to order?

- **Example #1:**
  - For a bed that is 30 feet long and 6 feet wide, how much mulch is needed to apply a 3-inch layer?
  - First, convert the thickness of the layer in inches into feet (3” = 0.25 ft.). Multiply the thickness in feet by the square footage of the bed. 
  - \((30 \times 6) \times 0.25 = 45 \text{ cu.ft.}\)
  - **Answer:** 45 cu.ft. ÷ 27 = **1.7 cu.yds.**

- **Example #2:**
  - How much mulch is needed to apply a 3-inch layer to 10 trees with a crown spread of 6 feet diameter?
  - First, convert the thickness of the layer in inches into feet (3” = 0.25 ft.). Then multiply diameter x diameter x 0.8 to get square footage area per tree. Then multiply area x thickness x number of trees.
  - \((6 \times 6 \times 0.8) \times 0.25 \times 10 \text{ trees} = 72 \text{ cu.ft.}\)
  - **Answer:** 72 cu.ft. ÷ 27 = **2.7 cu.yds.**

### Composting / mulching resources

- G6956 Making and Using Compost
- G6957 How to Build a Compost Bin
- G6960 Mulches
- G6958 Grass Clippings, Compost and Mulch: FAQs
- Compost Analysis (MU Extension)
- Worm Composting (MO Dept. of Natural Resources)
- MP906 Community Gardening Toolkit (MU Extension)
- Webster County Extension Center
For More Information

Robert A. (Bob) Schultheis
Natural Resource Engineering Specialist
Webster County Extension Center
800 S. Marshall St.
Marshfield, MO 65706
Voice: 417-859-2044
E-mail: schultheisr@missouri.edu
Web: extension.missouri.edu/webster

Program Complaint Information
To file a program complaint you may contact any of the following:
University of Missouri
• MU Extension AA/EEO Office
  109 F. Whitten Hall, Columbia, MO 65211
• MU Human Resources Office
  130 Neonel Bldg, Columbia, MO 65211
USDA
• Office of Civil Rights, Director
  Room 326-W, Whitten Building
  14th and Independence Ave., SW
  Washington, DC 20250-4410

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