Virginia Cooperative Extension

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Backyard Composting

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What Is Composting?

Composting, through manipulation and control, speeds up the natural decomposition of organic matter. It requires optimizing the conditions favorable to the mixed population of microorganisms (mainly bacteria, fungi, and actinomycetes) responsible for the decomposition. These microbes, normally found on the surface of leaves, grass clippings, and other organic materials, thrive in a warm, moist, aerobic (oxygen-rich) environment. Large amounts of organic kitchen, garden, lawn, and landscape refuse can be reduced in a relatively short time to a pile of dark, crumbly, humus-like material that makes an ideal soil amendment.

Benefits of Composting

Regularly adding compost to soil will benefit the soil in a number of ways.

- The soil's structure will improve because compost contains substances that cause aggregation (sticking together) of soil particles.

  - Fine-textured soils (i.e., clay-like) have many tiny pores that hold water tightly and limit air exchange. Such soils hold much water that is unavailable to plants and drain slowly.

  - Coarse-textured soils (i.e., sandy) have fewer, but larger, pores that promote rapid drainage and provide little plant-available, water-holding capacity. Water and accompanying nitrogen fertilizers leach quickly from sandy soil, requiring frequent fertilizer applications.

  - The organic matter in compost can benefit both soil types by increasing pore size and plant-available water in fine-textured soils or by increasing

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water-holding capacity and reducing leaching in coarse-textured soils.

- Because there are many ion exchange sites on compost particles, compost increases nutrient-holding capability (i.e., cation exchange capacity) and the buffering capacity of the soil. This prevents rapid leaching of lime and nutrients and ameliorates the detrimental effects of overliming and overfertilizing.

- Compost and other organic matter turns the soil dark brown or blackish, thus increasing the heat-absorbing capabilities to a small extent.

- Compost reduces soil erosion because it reduces soil surface crusting and promotes water infiltration into soil, rather than running off. It also decreases the bulk density of the soil, making it easier for roots to penetrate the soil and creating a less compact soil.

- Compost provides food for earthworms, soil insects, and microorganisms that contribute to soil quality. Mycorrhizal fungi, which have been proven to benefit plants through their association with plant roots, are also prolific in soil with large amounts of compost. The products from the breakdown of plant and animal refuse contain many fertilizing elements in and of themselves, including trace elements not available from commonly used synthetic fertilizers.

- Compost contains humic and other organic acids whose biostimulant effects have been demonstrated to ameliorate plant drought stress.

- Compost promotes healthy plants that are less susceptible to diseases and insect pests, reducing the need for pesticides.

- Composting helps to recycle plant material and return nutrients to the garden or landscape that might otherwise be sent to landfills at considerable expense both in dollars and in wasted landfill capacity.

Making Compost

What to Compost

A wide variety of organic materials can be successfully composted.

Plant Material

- Grass clippings (if not treated with herbicides or other pesticides; see "Special Concerns," below).

- Leaves.

- Yard trimmings, flowers, and house plants.

- Hay and straw (see "Special Concerns," below).

- Wood chips and sawdust (in small amounts, not treated).

Food Scraps

- Fruit, vegetable scraps, egg shells.

- Coffee grounds and tea bags.

- Food-soiled paper napkins and paper towels.

Miscellaneous Natural Materials

- Animal manure (e.g., chicken, cow, alpaca, horse, etc., if not fed on herbicide-treated pastures or hay; see "Special Concerns," below).

- Small amounts of shredded, uncoated, nonglossy paper or cardboard.

- Fireplace ashes (small amounts).

- Dryer lint (cotton or natural fibers only).

- Cotton and wool rags.

- Hair and fur.

Materials That May Cause Problems

Following are items that may cause problems if they are not composted under optimal conditions (see "Special Concerns," page 3).

Some items attract rodents and other pests and can also cause odors.

- Meat, grease, bones.

- Cheese, sour cream, butter, salad dressing.

- Egg yolks.

- Peanut butter.
- Cat or dog manure.

Others can cause problems in your garden.

- Diseased or insect-ridden plants.
- Grass or plants treated with herbicides or other pesticides.
- Reproductive parts of troublesome weeds or invasive plants, e.g., seed heads, rhizomes, etc.

What to NEVER Compost

- Coal or charcoal ash.
- Black walnut leaves, twigs.
- Pressure or other treated wood, shavings or sawdust.

Special Concerns

Special concerns exist for diseased or insect-ridden plant materials, antibiotics, herbicides, pests, odors, *E. coli*, etc., particularly if they are not composted under optimal conditions.

Proper composting destroys plant disease pathogens, insect eggs, and larvae; degrades antibiotics and most herbicides (except the pyridine carboxilic acids); and destroys *E. coli*. However, because the sides and top of the home compost pile are often cooler than the center of the pile, the entire pile may not have been exposed to a pathogen-killing temperature for a sufficient amount of time (131ºF for three days). Therefore, it is usually best to avoid adding diseased plants (e.g., tomato vines with leaf blight) to your home compost pile. Likewise, it is best to avoid including any lawn clippings or other plant material in the compost pile that has been treated with herbicides.

Some Herbicides May Not Degrade — Even Under Optimal Conditions

Always ask the sources of any manure, hay, or straw that you use in composting (or directly on your landscape or garden) about any herbicides they may have used on their pastures and fields. Your local Virginia Cooperative Extension office can help you determine if grass clippings, manure, or straw is appropriate for use in composting and for landscape and gardening purposes.

Certain herbicides (e.g., aminopyralid, clopyralid, picloram, triclopyr, fluroxypyr) used to kill broadleaf weeds in lawns, pastures, and hay fields may NOT be completely degraded by composting. While these herbicides are not harmful to grasses or animals that eat the grasses, the herbicide can pass through animal digestive systems and into their manure. If the grass, hay, straw, or manure is subsequently included in a compost pile and later spread in a garden or landscape bed, the affected compost could harm or kill many plants, even more than a year later.

Items That May Attract Pests or Cause Odors

Composting under less-than-optimal composting conditions could easily occur when composting at home. As noted previously, maintaining consistently high temperatures throughout the entire pile — especially the sides and top of the pile — may not be possible in small piles.

Likewise, piles built "as you go" by adding material as it becomes available may not always be of an adequate size throughout the composting process to maintain the desired levels of heat. Including meat, grease, bones, cheese, sour cream, butter, salad dressing, egg yolks, peanut butter, and cat or dog manure in smaller piles with lower temperatures could attract vermin, pets, and undesirable insects as well as cause undesirable odors. NEVER include these types of materials if you are cold composting, as described later in this publication.

Reproductive Parts of Weeds or Unwanted Plants

Reproductive parts of weeds and unwanted or diseased plants should be composted in backyard composting systems with caution. The seeds, rhizomes, and stolons of perennial weeds require a composting temperature of 140°F for at least three to five consecutive days to assure destruction of these plant parts.

What to Do With Materials Not Suitable for Your Compost Pile

Put diseased or herbicide-treated plant material, rodent or pest-attracting materials, and undesirable reproductive parts of weeds or other plants in the trash or with

other community yard waste, if permitted. Professional composting operations are able to maintain high temperatures for longer periods of time to help ensure complete destruction of the pathogens and most herbicides.

Caution! When in doubt, keep potentially problem-causing materials out of the home compost pile. While home composting is done with the best of intentions, it is better to err on the side of caution by excluding materials that may cause problems if optimal compost pile size (always 3 feet x 3 feet x 3 feet or larger) and temperatures (above 140°F for three to five days or longer) throughout the entire pile cannot be maintained and guaranteed.

Compost Recipe

The key ingredients and process for successful composting are:

1. A good mix of "brown" dead plant material (carbon) and "green" fresh plant material (nitrogen).

   - Browns (carbon): dry leaves, sticks, untreated wood shavings, paper, hay, straw, other old or dry dead plant material, dryer lint (natural fibers), nonglossy newspapers, including color portions, if vegetable-based (e.g., soy) inks are used.

   - Greens (nitrogen): fresh grass clippings and moisture-containing plant material (recently cut or harvested), coffee grounds, kitchen scraps, manure, hair, fur, cottonseed meal, blood meal.

   - Chop or shred both browns and greens for faster composting (e.g., with a lawn mower, weed trimmer, hatchet, pruning shears, by hand, etc.).

2. Microorganisms are found in sufficient numbers on the brown and green plant material being added to the pile.

3. Add water as you build your pile, if needed. It should be as moist as a wrung-out sponge.

4. Air (oxygen) is added as you build your pile and mix it together.

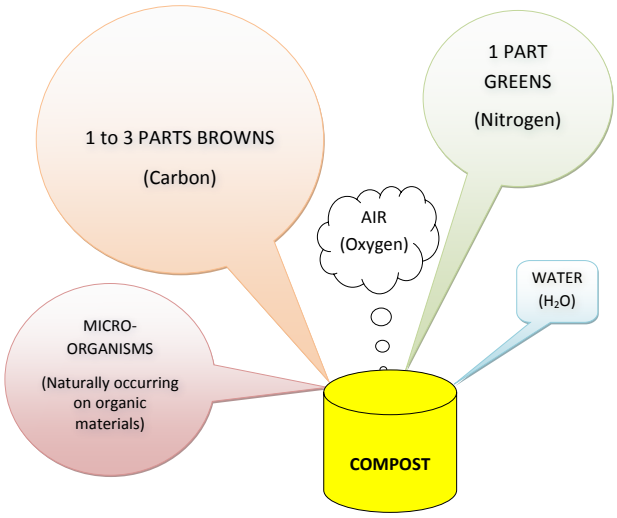


Figure 1. Compost recipe.

What Is a Good Mix of Brown to Green Plant Material?

By volume, the ratio of browns (carbon) to greens (nitrogen) — known as the carbon-to-nitrogen ratio (C:N) — may vary depending on the plant material available. The volume of brown plant material in the pile should equal or be up to three times as much as the green portion of plant material in the pile (C:N ratios of 1:1 to 3:1, by volume). The C:N ratio by volume is impacted by the moisture present in the plant material and how well the plant material has been shredded.

A more accurate measure of the ideal C:N ratio is 30:1 by dry weight, but this is an unrealistic way for homeowners to measure plant material amounts. The reality is that you will probably have a different mix of brown and green plant material available at any one time. The important thing to remember is that there should be more old, dead brown (carbon) plant material than fresh green (nitrogen) material.

If the pile begins to smell bad, you may have too much fresh green material and need to turn the pile and mix in more brown material. A pile that is too tightly packed for air circulation or too wet may also smell and needs to be turned and coarse material added, if necessary. If the pile fails to heat up, you may have too much old, dead brown material and need to turn the pile and mix in more green material. Too much or too little water can also cause a pile to not heat up.

Are Compost Inoculants, Starters, or Activators; Garden Soil; and Other Such Materials Needed?

Research has shown that the naturally occurring microbes found on the surface of plant materials are capable of degrading the plant material without the addition of commercially available inoculants. Inoculants are products that contain bacteria and a medium on which the bacteria can grow. There is no scientific evidence that inoculants increase the efficiency of composting.

Compost starters often contain nitrogen, enzymes, and bacteria. While adding compost starters, garden soil, or finished compost to a pile will add composting bacteria to the pile, they are not necessary.

Many activators contain nitrogen in either organic or synthetic form. If fresh, nitrogen-containing green plant material is in short supply, organic sources such as manure, cottonseed meal, blood meal, or other organic fertilizers are better sources of nitrogen.

Building the Pile

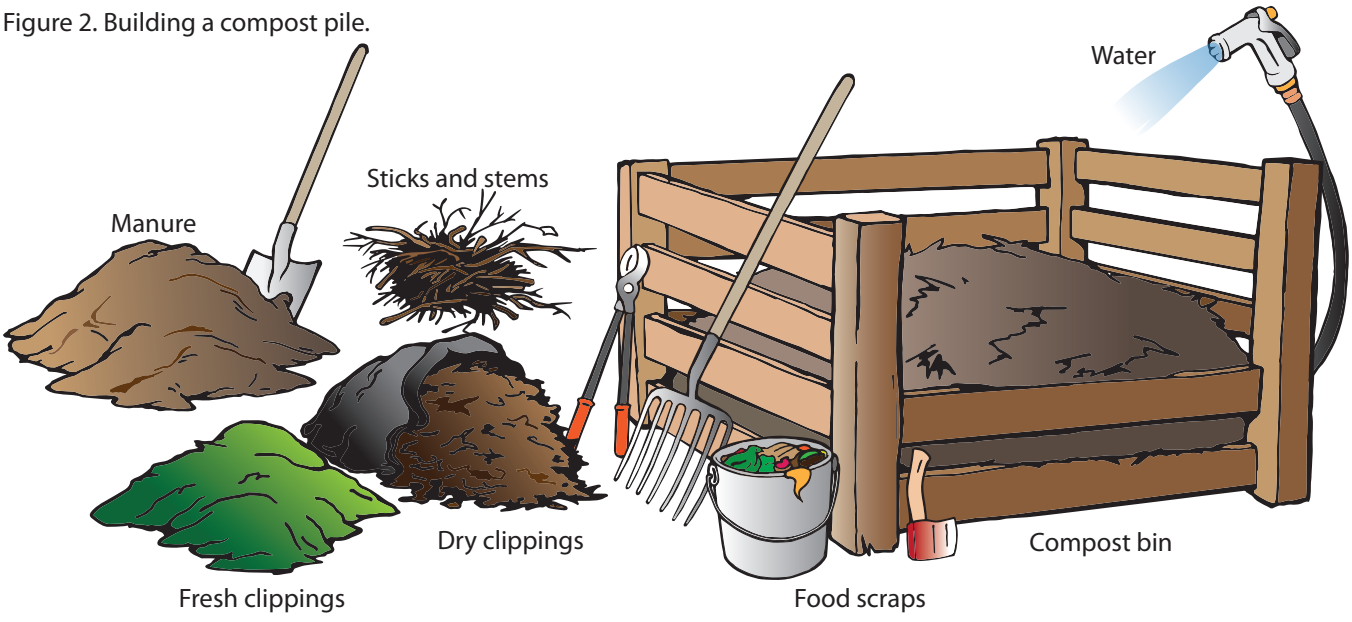
Start your compost pile with about a 3-inch layer of coarse plant material such as small twigs, chopped corn stalks, or an old pallet, if available. This will aid in aeration and drainage. On top of this, begin building your compost pile. Include about one to three times as much old, dead brown material as fresh, moisture-containing green material, by volume. One way to do this is to build the pile in layers with the brown layers being equal to or up to three times as thick as the green layers. After adding a layer of each, mix them together to more evenly distribute the materials within the pile. Add water as you build the pile, if needed, so the pile is about as moist as a wrung-out sponge.

All plant material should be shredded or chopped up as much as possible to provide more plant surfaces for the microorganisms to work on. This will speed up the composting process. In the early spring of the year, it may be difficult to collect sufficient fresh green plant material, while there may be an abundance of old, dead brown plant material. Fresh manure, if available, as well as fresh grass clippings (not too thick a layer because they will mat) may help you supplement the normal, fresh (actively growing) weeds and other fresh green plant material.

Blood meal, cottonseed meal, or organic fertilizers can also be added to a compost pile when green plant material is in short supply. Inorganic nitrogen fertilizer (e.g., urea, etc.) is generally not recommended as an additive for low-nitrogen materials, such as in the composting of leaves alone. While it can initially create an appropriate carbon-to-nitrogen ratio, this readily available nitrogen may quickly transform to ammonia. This gaseous and odorous form of nitrogen is easily lost to the atmosphere, and its loss may result in nitrogen deficiency, limiting the process of decomposition.

Repeat the layers of brown and green plant material as many times as needed to use all the plant refuse available. Building the entire pile as a single batch, to which no additional material is added thereafter, is ideal, if sufficient material is available to do so.

Figure 2. Building a compost pile.



If using a ready-made composter, follow the manufacturer's instructions.

In dry weather, keep the top of the pile lower in the center to cause water to move into the pile rather than to run off. In wet weather, keeping the top of the pile higher in the center helps the water to run off of the pile. Alternatively, a tarp or other cover can be used to minimize the influence of rain on the pile, regardless of the weather. Space under the tarp or other cover must be provided, however, to allow air to circulate in and around the pile. If rain is kept out of the pile, be sure to carefully monitor the moisture of the pile and add water when necessary.

Maintaining the Pile

Water the pile as often as necessary to keep the contents moist, but not soaking wet, paying particular attention to the sides and top of the pile, which tend to dry out fastest. Within a few days, the pile should heat up significantly, often to about 160ºF. This temperature will kill many weed seeds and harmful organisms and is a necessary stage in composting, although temperatures much above 150ºF can kill "good" organisms, too. If the pile fails to heat, it may lack nitrogen or moisture. The pile will also decrease in size after a few weeks if it is composting properly.

If you smell ammonia or other odors, it may mean the materials in the pile are too tightly packed for oxygen circulation, the pile has too much nitrogen-containing material, or the pile is too wet. Turn the pile, adding some coarser material or carbon-containing material as necessary and start again.

The compost pile should be turned (forked over) after the temperature exceeds 140°F for three to five days (usually in the first week after the pile is created). When turning the material, try to move it from the top and outside edges of the pile to the inside portion of the pile and vice versa, to give all the material a turn at the hotter center of the pile. Composting to this temperature is optimum for destroying most pathogens and weed seeds, while allowing for maximum growth and reproduction of fast-composting (thermophilic) bacteria.

A fairly inexpensive, long-stemmed thermometer can be purchased to measure the heat at the center of the pile and determine when to turn the pile to maintain higher temperatures and faster composting. A thermometer is not required to compost successfully, however. The pile can simply be turned after about a month (two weeks if the material is shredded), and again five to six weeks later or more often if time and energy permit.

More frequent turning will help speed the composting process by providing oxygen to the microorganisms working on the compost. Turning the pile will cause the temperatures to rise again, although possibly not as high as the initial 140º+F temperatures that were achieved when the pile was created. As temperatures

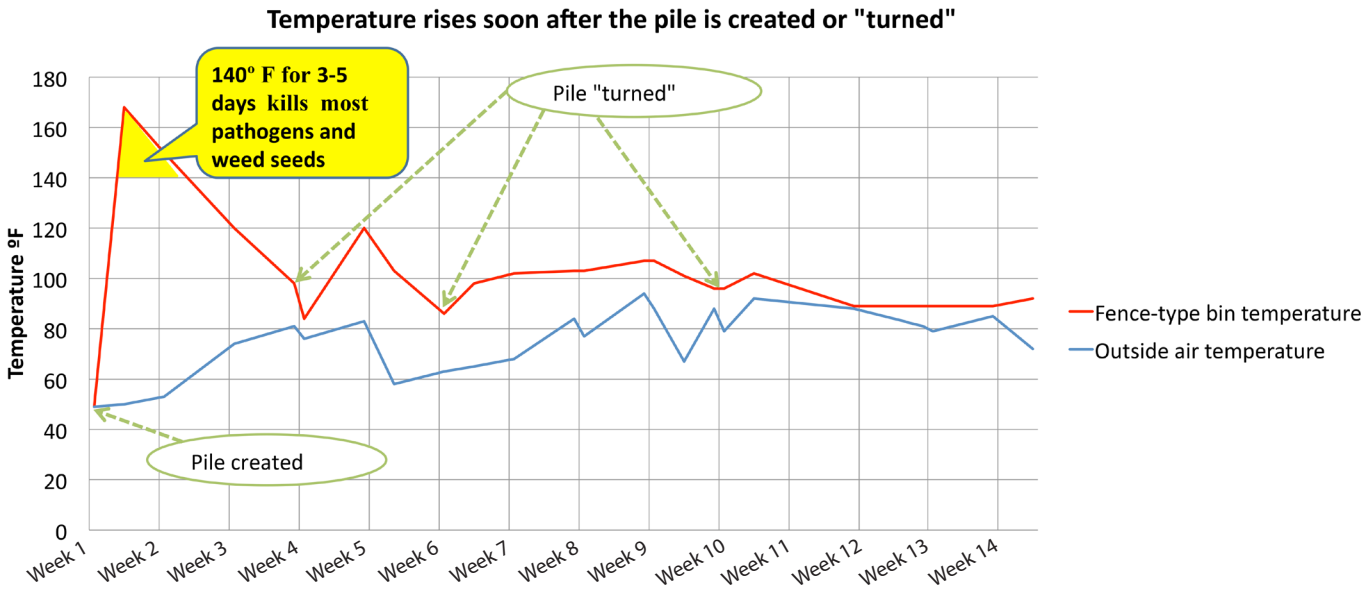


Figure 3. Temperature changes as a compost pile processes plant material. The opportunity to kill most pathogens and weed seeds is soon after the pile is created and temperatures are sufficient (above 140ºF) for three to five days.

lower over time, slower-composting microorganisms (mesophilic bacteria) take over and the composting process will slow down unless the pile is turned. After a few months, even turning will no longer help increase the temperature. This means the composting process is almost complete.

The plant materials should decompose into good compost in about four to five months in warm weather but may take longer under cool or dry conditions. Composting may be completed in one to two months if the materials are shredded, kept moist, and turned several times to provide good aeration.

Stop adding new material to the compost pile as the composting process comes to an end to avoid ending up with a combination of new material mixed in with the composted material. Each time new material is added it causes the composting process to start again. This is why building the pile as a single batch and not adding new material is preferred, if sufficient material is available to do so. If possible, collect new material in a separate location in preparation for building the next compost pile. As you gain experience with your composting process, you will be able to fine tune when to stop adding new material.

Curing

Composts should undergo a maturing or curing period before use to ensure that the most active phase of decomposition is complete. Curing also provides protection against using immature material that could harm crops or plants. The curing stage begins when the temperature levels off and ceases to rise (stabilizes) after pile turning or aeration. Curing is considered complete when internal temperatures decline (under proper moisture and oxygen conditions) to near that of outside air temperatures. It is important to note that compost stability and maturity represent different characteristics of the material. Stable compost does not reheat on turning/aeration when proper conditions are maintained, while mature compost will not impair plant growth.

Curing compost for a period of one to several months before use is best. The compost can be sifted later, if desired. While the compost is curing, cover it with a tarp or other cover to prevent rain from washing away compost nutrients and to minimize weed seeds floating onto the pile.

Finished Compost

When compost is finished, it will be dark and crumbly, like good soil, with a pleasant, earthy smell. Finished compost temperatures will be close to outdoor air temperatures. Only a few leftover corncobs or stalks will remain undecayed. These can be removed and added to the next batch. For use in potting mixtures, a relatively fine sieve (1/4-inch hardware cloth) may be used to sift out the larger chunks. Otherwise, the compost can be spread in the garden as it is and dug or tilled under, ready to offer your soil and plants its many virtues. Again, continue to keep the finished compost covered after the curing process has completed to prevent rain from washing away compost nutrients and to minimize weed seeds floating onto the pile until you are ready to use it in the garden or landscape.

Cold (Slow) Composting

The above description of the composting process is what is commonly called “hot” or “fast” composting. It requires more effort, enough material to build a 1-cubic-yard pile with the proper ratio of carbon (browns) to nitrogen (greens), proper moisture, and turning every few weeks or so to ensure enough oxygen is available. This is necessary for the faster-working (thermophilic) bacteria to do their job at their optimum working temperatures of 122ºF to 140ºF (but not more than 150ºF or they will die).

If you lack the material, time, or desire necessary for hot composting, then “cold composting” is a good alternative for backyard composting. At about 108ºF and lower (to about 77ºF), the slower-working (mesophilic) bacteria thrive, albeit decomposing the plant material at a slower rate. Cold composting allows you to build the pile as material becomes available, even if the ratio of carbon to nitrogen is not quite perfect. The pile does not need to be turned as frequently, if at all, and water can come mostly from rain rather than your garden hose. The composting process will go much slower, of course, and can take as long as two years or more to complete.

Again, stop adding new material to the compost pile a couple months or more before the composting process is complete. If possible, collect new material in a separate location in preparation for building the next compost pile. If you have not been turning the pile, you may be able to simply remove new material from the

top of the pile when you are ready to use the finished compost at the bottom of the pile.

Compost Bins

While compost bins are not required to make good compost, it is helpful to have compost bins in some form to help process plant material into compost.

You can construct two bins out of planks or concrete blocks. Make the bins about 4 feet high, 4 feet wide, and as long as desired; keep one end open for easy access. Leave spaces between blocks or planks for aeration. Accumulate plant refuse in one bin while the composting process takes place in the other. A third bin may be desirable for near-finished or finished compost storage or for periodically turning the compost between the bins as it is being processed.

Another option would be to store green material in one bin and brown material in another prior to mixing them in the remaining bin for creation of the compost pile.

Figure 4. Custom-built wooden compost bins; signs control use if the bins are shared with other users. Note the "Ready to Use" bin on the far right has a cover to help prevent nutrients from washing away due to rain, snow, etc.

A simple, portable compost bin can be made with three or four used freight pallets stood on end in a square or open square and lashed or otherwise held together. This type of bin can be disassembled for easy turning and emptying and then reassembled around the new pile. A circular fence cage supported by three or four wooden stakes will also work.

Figure 5. Double-size bins made from pallets for accommodating larger volumes of material. Compost pile can be "turned" from one side of the bin to the other side or from one bin to the other, as long as a desirable pile size (3 feet x 3 feet x 3 feet minimum) is maintained.

There are also ready-made and kit composters available in a variety of shapes and sizes. Consult your homeowners association regulations and local ordinances before building or purchasing a compost bin to determine if there are limitations on the kind, size, and location of compost bins in your neighborhood.

If a fence-type or lightweight commercial composter bin is used, sometimes the easiest way to turn the pile is to simply lift or remove the lightweight, bottomless bin from the pile and place it in a new location nearby. Then it is easy to turn the material back into the bin.

Ideally, compost bins should be able to hold at least 1 cubic yard (3 feet by 3 feet by 3 feet = 27 cubic feet = 1 cubic yard) of plant material, although two cubic yards (a little less than 4 feet by 4 feet by 4 feet) will be more effective. The larger size allows for the compost to build and maintain heat better even though the pile will reduce in size as the material composts. Piles larger than 5 feet by 5 feet by 5 feet (125 cubic feet or more than 4.5 cubic yards) should usually be avoided for backyard composting because they are difficult for individuals to manage.

Rotating barrels or spheres for turning compost may be difficult to turn/rotate if they are large enough to hold adequate material (a cubic yard or more) needed to generate and hold the heat required to maintain the temperature in the optimal range for an adequate time.

Figures 6 and 7. To "turn" a lightweight compost bin, lift it off the compost pile and place it in a new location.

Whichever type of compost maker or bin you use, it's a good idea to make use of the nutrients that may run off from under the pile. This is easily done by locating the composter in the garden (which also reduces hauling time) or under a large tree. Or, if the compost pile is on a slope, trenching can direct the runoff. The site does not necessarily need to be in the sun because most of the composting heat comes from the action of the microorganisms breaking down the plant material into compost. To reduce drying out by the sun and wind and to limit the impact by heavy rains, you may want to place a tarp or other cover over the compost bin. Provide space under the cover to allow air to circulate. If rain is kept out of the pile, be sure to carefully monitor the moisture of the pile and add water when necessary.

Other Types of Composting

Worm composting (vermicomposting or vermiculture) relies on a special type of earthworm (*Eisenia fetida*) to process kitchen waste into worm castings for use as a composting material. For details on worm composting, see Virginia Cooperative Extension publication 442-005, "Composting Your Organic Kitchen Wastes With Worms" (http://pubs.ext.vt.edu/442/442-005/442-005.html).

Sheet composting is another method of improving soil in a garden, although it is not truly "composting" as discussed above. A layer of organic materials of about 3 to 4 inches is spread over the soil, then covered with a 2-inch layer of soil or tilled under the soil. The organic material is allowed to decay for at least three months prior to cultivating for crops. Sheet composting on an unused portion of your garden in the fall can provide an enriched area for spring planting.

Reviewed by David Close, Virginia Cooperative Extension specialist, horticulture. Photographs and figures by the author.

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