

Backyard Composting

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Gardeners have long made and used compost because of the way it improves garden soil. Today, home composting is a cornerstone of sustainable living. We transform yard debris and food scraps into a valuable soil amendment and close the recycling loop in our own backyards.

The Science of Composting

The cycle of growth and decay. Composting carries out part of the earth's biological cycle of growth and decay. Plants grow by capturing the sun's energy along with carbon dioxide from the air and nutrients and water from the soil. When plants (and the animals that eat them) die, they become raw materials for the composting or decay process. Microorganisms, fungi, insects, worms, mites, and other creatures convert the carbon from dead plants into energy for their own growth, releasing carbon dioxide into the air. Similarly, they recycle the nutrients from the decaying plants into their own bodies and eventually back into the soil. Other plants and microorganisms use the carbon and nutrients released by the composting process, and the cycle begins again.

The material that remains from the decay process is similar to soil organic matter. It holds water and nutrients in the soil, and makes the soil more porous and easier to dig.

Fast or hot composting. We can manipulate the decay process to make it proceed quickly. We do this by balancing food, water, and air in the compost pile to favor the growth of thermophilic (high-temperature) microorganisms. One byproduct of microbial activity is heat. When conditions are favorable for high-temperature microorganisms, compost piles heat rapidly to 120°F–150°F. This temperature range kills most weed seeds and pathogens (disease organisms), but does not kill

mycorrhizae (beneficial fungi that help plant roots absorb nutrients). Once the hot phase is complete, lower-temperature microorganisms, fungi, worms, insects, and other invertebrates complete the decay process.

Slow composting. If we do not maintain ideal conditions for hot composting, microorganisms will still break down the wastes. Decay will be slower, cooler, and less effective at killing weed seeds and pathogens.

Managing the Decay Process

You can affect the speed of the composting process and the quality of the compost product by managing the factors described below.

Food (raw materials). For fast composting, the initial mix must have the proper moisture and air content, and organic materials that provide a rich food (energy) source for bacteria. A list follows of some materials commonly used in making compost. They are separated into "energy" materials, "bulking agents," and "balanced" materials.

Energy materials provide the nitrogen and high-energy carbon compounds needed for fast microbial growth. If piled without bulking agents, these materials usually are too wet and dense to allow much air into the compost pile. When you open the pile, it will have a foul, "rotten egg" smell.

Bulking agents are dry, porous materials that help aerate the compost pile. They are too low in moisture and nutrients to decay quickly on their own.

Balanced raw materials. Some raw materials contain a balance of energy and bulking agent properties. These materials will compost readily without being blended with other ingredients.

Compost Raw Materials Table

<p>Bulking Agents (Low moisture, high porosity, low nitrogen)</p> <ul style="list-style-type: none">• wood chips• sawdust• wheat straw• corn stalks
<p>Energy (Green) Materials (High moisture, low porosity, high nitrogen)</p> <ul style="list-style-type: none">• grass clippings• fresh dairy, chicken, or rabbit manure• fruit and vegetable waste• garden trimmings
<p>Balanced Raw Materials (Low to medium moisture, medium porosity, medium nitrogen)</p> <ul style="list-style-type: none">• ground tree and shrub trimmings• horse manure and bedding• deciduous leaves• spoiled hay

Examples include horse manure mixed with bedding, spoiled alfalfa hay, and deciduous leaves. These materials are handy for ensuring the success of hot compost piles.

Mixing bulking agents with energy sources provides the right balance of moisture, air and nutrients for rapid composting. A **mixture of one part energy source with two parts bulking agent (by volume) usually gives a reasonable mix for rapid composting.**

Particle size. Grinding, cutting, smashing, or chopping raw materials reduces particle size. Small particles have more surface area for microbial activity and are easier to mix. Hot composting requires a relatively uniform particle size of 1/8–1 inch in diameter. Woody branches that have not been ground often make it difficult to turn a pile. They also decompose very slowly. We suggest grinding or chipping woody branches, or piling them separately.

Mixing. Contrary to advice in many publications, layering is not the best way to build a pile. If all the materials are on hand,

mix them thoroughly throughout the pile. If materials accumulate over time, add new materials to the center of the pile. This practice will help aerate the center of the pile, where anaerobic conditions are likely to occur.

Pile size. The pile must be big enough to hold heat. A hot pile decays much faster than a cold pile. Small piles are usually colder, because they have small cores that hold less heat. Small piles also dry out faster. A pile of about one cubic yard is big enough for year-round composting, even in cold-winter areas.

Moisture. All materials in the pile must be moist, but not soaking wet. The mixed material should feel moist, but you should not be able to squeeze water out of it with your hands. At dry times of the year, you may need to add water. In rainy winter locations, a pile may not heat up unless you cover it to keep out rainwater. Check moisture when you turn the pile.

Aeration. The microorganisms responsible for fast decomposition need oxygen. In the pile, oxygen is consumed by microbes. The pile

needs to be porous to pull outside air into it. Use enough bulking agents to create a porous pile. As the pile decomposes, it settles, reducing aeration. Turning the pile or adding bulking agents improves aeration.

Microorganisms. Raw materials used to form a compost pile usually contain all the microorganisms needed to make compost. You do not need to add soil or compost starters with “special” microorganisms. The best source of microorganisms (if needed) is finished compost.

Nutrients. Just like people, microorganisms need nutrients (such as nitrogen, phosphorus, sulfur) to grow and reproduce. These nutrients occur in the raw materials used in the compost mix. Additional fertilizer from any source (organic or inorganic) usually is not needed. Nitrogen fertilizer may be beneficial for mixes consisting mainly of bulking agents. The best way to add fertilizer is to dissolve it in water and wet the pile with a dilute fertilizer solution. Compost additives such as blood meal and bone meal are simply organic fertilizers; they do not contribute anything magic to the compost pile.

How to Make Compost

Slow Composting

Employing slow composting is an easy and convenient way to turn yard wastes into a useful soil amendment. It is often the best method for people who do not have the time to tend a hot compost pile. Simply mix nonwoody yard wastes into a pile and let them sit for a year or so. Microorganisms, insects, earthworms, and other decomposers will slowly break down the wastes. A mixture of energy materials and bulking agents provide the best food source and environment for decomposition (see table).

Add fresh wastes to the pile by opening the pile, placing fresh wastes in the center, and covering them. This helps aerate the pile and also buries the fresh wastes so they do not attract pests.

Fruit and vegetable wastes are particularly appealing to pests, such as flies, rats and raccoons. To avoid pests, bury these wastes within the pile. If you bury the vegetable wastes

in the pile and pests are still a problem, you may need to use a pest-resistant bin or keep vegetable wastes out of the pile.

You also can bury vegetable wastes directly in your garden. Dig a hole or a trench about a foot deep, add a few inches of vegetable wastes, mix them with the soil, and refill the trench with soil. Another way to avoid pests is to compost vegetable wastes in a worm bin.

Slow composting does not produce the heat needed to kill many weed seeds. It is best to pull and compost weeds before they go to seed. If you put seeds in the compost pile, be prepared for more weeding.

Fast Composting

If you create and maintain a balance of air, moisture, and energy for the compost microorganisms, they will produce a hot compost that will break down quickly and kill off many weed seeds and disease organisms. Making hot compost takes extra effort, but it produces a high quality product quickly. One method for making hot compost is described below:

Building the Pile

- Step 1. Collect enough material to make a pile at least 1 cubic yard in volume (an open pile 5 feet wide at the base by 3 feet high holds about a cubic yard). You need roughly two parts bulking agent to one part energy material (see table). Chop, shred, mow, or smash coarse materials so they will break down faster.
- Step 2. Start the pile by adding energy material and bulking agent, and mixing with a pitchfork.
- Step 3. Squeeze a handful of the mixed material to check its moisture level. If you can barely squeeze out a drop of water, the moisture level is ideal. If the pile is too dry, add water, and check the moisture again. If it is too wet, mix in some drier material.

Piles vs. Bins

You do not need a bin or other container to make compost. Piles work well. Some people prefer containers because they look neater, or because it is easier to shield them from pests. Containers can be simple or fancy. Make them from materials such as old pallets, lumber, mesh fencing, or cinder blocks. You can also purchase pre-made bins. For hot compost, each bin should be about 3 feet by 3 feet by 3 feet in size. Avid composters often have three bins: two for turning, and one for curing compost.



Compost ready for curing.

Step 4. Continue adding energy material and bulking agent, mixing, and checking moisture until the pile is built.

Turning the Pile

Use a pitchfork to turn the pile weekly, and add water when needed. Turning improves the porosity of the pile and speeds the biological decay. Turning also mixes material from the outside of the pile into the hot center. Cover the pile during rainy periods so it will not get too wet.

Curing Phase

After initial mixing, a carefully tended pile usually stays hot (120°F–150°F) for several weeks. The pile will shrink to about half its original volume during the hot phase. The pile then needs to sit another for 4–8 weeks to cure. Temperatures during curing are 80°F–110°F. The compost is ready to use when at least 8 weeks have passed since initial mixing, the pile no longer heats when turned, and the material looks dark and crumbly.

Curing affects the availability of nitrogen and the microbial activity of the compost. Uncured compost may harm some plants. This is most likely when compost is used in potting soil or

to start seeds. Curing is less critical when small amounts of compost are worked into soil.

Compost Use, Health and Safety Questions

Are there any plant materials to keep out of a compost pile? If you are composting by the slow method, keep diseased plants, seed heads, and rhizomes (runners) of weeds out of your compost pile.

Some plants contain compounds that slow microbial decay. Western red cedar, often used for fence posts because of its resistance to decay, can break down slowly in compost piles.

Can a compost pile catch on fire? A compost pile will only ignite if it has a very hot zone next to a dry zone. Fires will not start in moist piles or in small, backyard piles.

Can I use manure in my compost? Fresh animal manures sometimes contain human pathogens such as *Salmonella* sp. or *E. coli* O157:H7, or parasites, such as *Cryptosporidium parvum*. These pathogens are not taken up into plants, but they can be present in soil that adheres to the surfaces of roots or low-growing leaves and fruits. Careful washing with detergent or peeling will remove most of the pathogens responsible for disease, but some risk remains. Alternatively, thorough cooking will effectively kill pathogens carried on garden crops. If no

What if my hot compost isn't hot?

- If the pile is dry ...
- If the pile is mostly bulking agent ...
- If the pile is too wet ...
- If the pile has a foul smell ...
- If the pile is too small ...
- If it is cold outside ...

Check the pile

- it needs more moisture.
- it needs more nitrogen. Add energy materials or nitrogen fertilizer.
- add more bulking agent. Cover the pile or build a larger pile during the rainy season.
- it needs more air and less water. Try turning the pile more often or adding more bulking agent
- it will not hold the heat.
- try building a larger pile to hold the heat.

Sometimes you may have several problems to overcome. If you cannot get the pile to heat, all is not lost, because the pile will still break down by the slow method.

fresh manure is used in the garden, the risk is minimized.

The greatest risk from manure-borne pathogens is for root crops such as carrots, leaf crops such as lettuce, and fruit crops such as strawberries. The edible part of these crops may become contaminated with soil, the crops are difficult to wash, and they are often eaten raw.

Pathogens in fresh manure typically die off in the environment over time, especially when the manure dries or is exposed to freezing and thawing. The rate of pathogen die-off depends on the type of pathogen and manure, and on environmental conditions such as temperature, moisture, and sunlight. Thorough, high temperature composting kills pathogens, but it is difficult to maintain these conditions in a backyard compost pile. You can limit exposure to pathogens by excluding fresh manure from backyard compost that will be used on fresh garden crops.

Do not use dog or cat manure in your compost pile or garden. Some of the parasites found in these manures may survive for long periods in compost or in the soil and remain infectious to people.

For more information on animal manure and

food safety, refer to *Food Safety Begins on the Farm*, produced by the Cornell University Good Agricultural Practices Program.*

Are herbicides a problem in compost? Although it is a rare occurrence, herbicides from compost have harmed plants grown in soils amended with the compost. Herbicides break down in the environment over time, with the rate of breakdown depending on the type of herbicide and environmental conditions. The higher temperatures and biological activity in a compost pile accelerate the breakdown of most herbicides. Binding with organic matter in the compost also inactivates herbicides. Breakdown and binding reduce the risk of herbicide damage.

Lawn clippings may be a source of herbicides in some home compost piles. The best way to eliminate this source of herbicides is to leave treated grass clippings on the lawn, rather than compost them. Leaving clippings also benefits the lawn. If you suspect herbicides in your compost pile, let the pile sit for a year or more, allowing more time for breakdown and binding. Other options are to avoid herbicide use in areas where you compost the residues, or choose herbicides that break down quickly in the environment.

*Reference: Rangarajan, A., E.A. Bihn, R.B. Gravani, D.L. Scott, and M.P. Pitts. 2000. *Food safety begins on the farm: A grower's guide*. Cornell Good Agricultural Practices Program. Cornell University College of Agriculture and Life Sciences.

Using Compost in Your Yard

The best part about compost is the benefit it provides for your garden. Mix compost with the soil to add organic matter, or use it as a mulch.

Amending soil. Well-decomposed, earthy composts are good soil amendments. They make the soil easier to work and create a better medium for plant growth. You can mix 1 to 3 inches of compost into your soil before you plant a garden, lawn, perennial bed, or cover crop.

Mulches. Composts applied to the soil surface help control weeds, conserve water, and protect the soil from erosion. The best time to apply compost mulches is in early summer, after plants are established and the soil has warmed.

Later, mulches can be dug or tilled into the soil. When mulching perennial plantings, choose compost made from woody bulking agents, because it decomposes slowly, resists compaction, and slows weed establishment.

Composting and the Environment

Backyard composting reduces the flow of wastes to landfills or burn piles and produces valuable organic matter for the soil at the same time. Composting does all this using a process fueled by the solar energy captured in plant tissue. These benefits are the same whether we compost in carefully tended hot piles, or in neglected slow piles. Backyard composting is a simple, yet important way to improve our communities and the environment.



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