Home Composting Guide

By Ann Lindsey

When gardeners asked for more information on composting, we asked composting expert Ann Lindsey to write this guide. For many years, Ann was the Public Education Coordinator at the UC Santa Cruz Farm and Garden Project, a large organic market garden that educates apprentices and the public in biointensive growing practices. Ann has led numerous composting workshops in many different locations and has also written extensively for the Life Lab Gardening Science Program that introduces gardening as part of school curricula nationwide.

INTRODUCTION

If you can only do one thing to improve your garden this year, build a compost pile. No matter your soil type, your climatic zone, or your choice of crops, composting will enhance your garden soil, resulting in stronger plants and healthier produce. Organic gardeners have long regarded compost as the cornerstone of garden soil fertility. Compost builds healthy soil, producing healthy, strong plants that are more resistant to pests and disease.

Making your own compost completes a natural cycle in your garden. From the garden come nutrient-rich weeds, fallen leaves, clippings, and crop residues. Heaped into a pile they decompose into compost that can be dug into the soil, returning nutrients and organic matter to the garden. Composting is really quite simple, inexpensive, ecologically sound, and utterly foolproof—no matter what you do, your pile will eventually rot into soil-enriching compost!

A few myths about compost should be debunked. Composting is not difficult; it can be done without odor, flies and other pests; and it can be made without a complicated composting apparatus. The only way to start composing is to build a heap. Perhaps you've tried it—but still your compost pile remains a rather mysterious entity that sometimes "works" and sometimes doesn't. For all gardeners I have this advice: get to know your compost pile. With a basic understanding of the composting process, even novices can make a pile that produces wheelbarrows full of rich, soil-building compost.

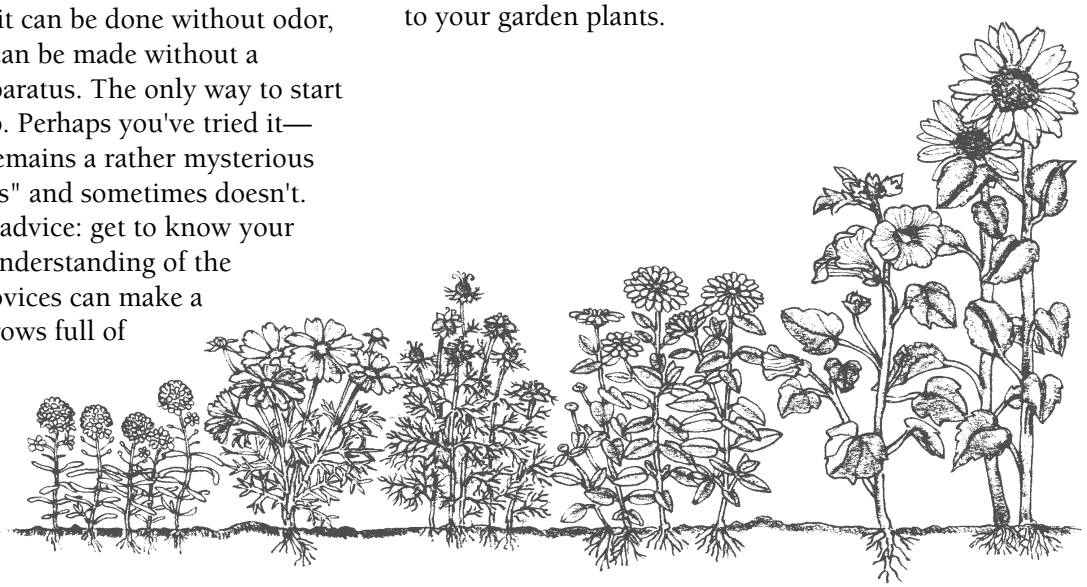
For Beginning and Experienced Composters, this Guide Contains the Following Information

1. Why compost and what is compost.
2. What materials to compost and how to judge them.
3. How to make and maintain a compost pile.
4. How to use finished compost.
5. How to troubleshoot your present and future piles.
6. Special tips for special situations.

Why Compost? Feeding the Soil to Feed the Plant

While compost is a panacea for all garden soils, poor soils will especially benefit from consistent applications. For example, Renee's Garden Seeds trial garden in Felton, CA, has very sandy soil that originally leached water and nutrients like a sieve. Years of adding compost to this sandy soil has vastly improved its ability to hold both water and nutrients. Whether your soil is mostly sand, mostly clay, or somewhere in between, composting will help build workable, healthy, garden soil.

Building soil is an essential concept for good organic gardening, best summed up by the adage: "feed the soil to feed the plant." In adding compost to the soil, you are replenishing the reserve of organic matter and nutrients that are taken out with the garden crops. Essential to all soil ecosystems, organic matter is the food for soil organisms. By composting, you are feeding the soil creatures, from the tiniest bacteria to the longest worm, who in turn make nutrients available to your garden plants.



The Benefits of Compost in the Soil

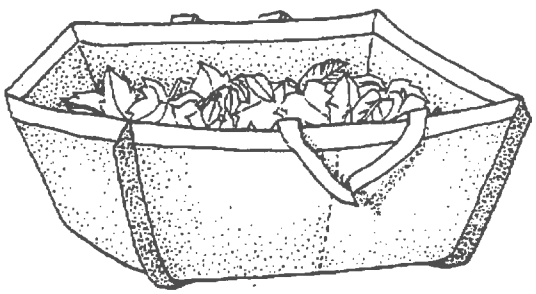
1. Improves soil structure.
2. Aids in water retention (important in sandy soils).
3. Improves aeration and drainage (important in clay soils).
4. Aids in nutrient retention.
5. Contains a low level of nutrients slowly released to plants.
6. Increases the number of microorganisms in the soil.
7. Increases heat absorption of soil.
8. Helps neutralize soil pH, acting as a pH "buffer."

What is Compost?

All organic materials—whether leaves, bones, coffee grounds, or heaps of dead weeds—will eventually rot. However, a random stacking of organic materials won't necessarily result in great compost. Therefore, compost is perhaps best defined as a pile of organic materials deliberately assembled for fast decomposition. As you make a pile, think of yourself as catering to the creatures of decomposition—countless bacteria, fungi, and later, the worms, sowbugs, and other creatures. By deliberately mixing organic materials with an eye to moisture and aeration, you can create the conditions that decomposer creatures love, so they will rapidly render your pile of debris into rich, brown, soil-building compost.

Making Compost is Simple: Greens + Browns + Moisture + Air

For efficient decomposition, a compost pile needs a good balance of the Basic Four: Greens + Browns + Moisture + Air. "Greens + Browns" is a simplified reference to balancing the nitrogen materials (grass clippings, vegetable trimmings, green weeds) with the carbon materials (such as fallen leaves, straw, sawdust). "Moisture + Air" reminds us that fast decomposition requires both a good moisture content and ample oxygen for decomposer organisms in the pile. Other variables that affect the composting process include the size of the compost materials, the volume of the pile, the number of times a pile is turned, and the amount of soil added to the pile. These considerations will be discussed in greater detail on the following pages.



Materials for Composting

If you have a garden, a yard, and a kitchen, you undoubtedly are generating great materials for your compost pile. Use materials that are readily available; special ingredients, such as manure, are not necessary to make good compost. The leaves you rake from under your trees, the grass clippings from your lawn, the weeds from your garden, yesterday's oatmeal, and even yesterday's newspaper can all be composted easily. The list of organic materials that make good compost materials is much longer than the list of things not to compost (see the list on page 3, "What NOT to Compost and Why").

Evaluating Compost Materials; What is Brown? What is Green?

Every piece of organic material contains carbon and nitrogen in differing ratios. Some materials are very high in carbon, such as sawdust and straw. Others contain a relatively generous amount of nitrogen compared to carbon, such as grass clippings, garden weeds, and chicken manure. Understanding which materials are high in carbon, and which are high in nitrogen, will help you build a pile with a good balance of ingredients for decomposition. The chart on page 3 will give you an idea of the carbon-to-nitrogen ratio of some common compostable materials.

COMMON COMPOST MATERIALS; Average Carbon-to-Nitrogen Ratios

BROWN MATERIALS	Sawdust	500:1
	Chipped woody brush	300:1
	Newspaper	200:1
	Straw	60:1
	Dry leaves	60:1
	Dry hay or weeds	40:1
GREENISH-BROWNISH MATERIALS	Mixed green/brown plant materials	30:1*
	Horse manure w/straw bedding	25:1
GREEN MATERIALS	Green weeds	20:1
	Finished crop plants and leafy plantings	20:1
	Kitchen scraps	20:1
	Grass clippings	15:1
	Chicken manure	10:1

* The ideal carbon-to-nitrogen ratio for composting is around 30:1. This merely means that most decomposer creatures prefer a diet that has 30 times as much carbon as it has nitrogen. These creatures use carbon for energy (much as we use carbohydrates) and use nitrogen to build their bodies (much as we use protein). Some compost materials, such as mixed weeds or horse manure in straw, may have a carbon-to-nitrogen ratio close to 30:1. These "greenish-brownish" materials can be composted successfully without adding any other materials. However, most compost materials are best balanced by other materials.

WHAT NOT TO COMPOST AND WHY

1. Meat and bones, dairy products and greasy foods are likely to attract pests.
2. Cat, dog, and human feces can contain harmful pathogens.
3. Pernicious weeds, especially those with rhizomonous root systems, may not be killed in the composting process.
4. Diseased plants and bug-infested plants should be kept out of slow, cool piles and should be added with discretion to the center of hot piles (when it doubt, keep it out).
5. Weeds with mature seed heads should be kept out of slow, cool piles to avoid spreading.
6. Needles from conifers are very slow to break down and can often be quite acidic.
7. The leaves from eucalyptus, walnut and laurel trees contain tannins. (A few are okay.)

Greens = Nitrogen Materials

For gardeners, green weeds, green crop residues, and vegetable trimmings are readily available sources of nitrogen materials. Young, green plants are very high in nitrogen. To capture the most nitrogen for your compost pile, pull out finished crop plants and weeds while they are still green. Cover green materials with a tarp to retain their moisture and nitrogen until you are ready to build a pile.

Browns = Carbon Materials

Brown materials, those with high carbon to nitrogen ratios, are carbon sources for the compost pile. Straw, leaves, dry grass are typical examples of brown materials. In the chart above, note that some materials are more "brown" (carbonaceous) than others. Dry, brown materials usually need moistening before use. Straw and sawdust can be soaked in a wheelbarrow and then drained for best results. Brown materials can be stored easily in a bin for later use. (For example, fallen dead leaves or dry weeds, stockpiled in autumn, can be used for layering with fresh green materials the following spring.)

Making a Compost Pile

Layering Green and Brown

Beginners can use this rule of thumb: layer 50% green to 50% brown by volume. Layers can be 2 to 8 inches thick depending on the particle size and moisture of the materials. (An exception is grass clippings, whose high moisture content and small particle size makes them mat and compact; use no more than a 2-inch layer at a time.) For example, layer 4 inches of brown leaves on top of 4 inches of green weeds (sprinkle generously with water and a little soil), and repeat. Layering is a good way of estimating equal proportions. Please don't waste time trying to mathematically calculate the elusive 30:1 carbon to nitrogen ideal. Experiment with different combinations of materials and then note what happens.

A large pile with a good balance of brown and green materials should decompose quickly, generate heat, and can give off a very slight smell of ammonia (one form of nitrogen gas). If a pile doesn't have enough nitrogen, it won't get very hot and won't decompose quickly. To speed it up, turn the pile and layer in high nitrogen materials. A pile with too much nitrogen will get very hot and will have a strong smell of ammonia. A pile with excess nitrogen can sometimes become anaerobic, generating a "rotten eggs" smell, especially if the materials are very wet. To remedy this problem, turn the pile to aerate it, and layer in some carbon materials as the pile is rebuilt.

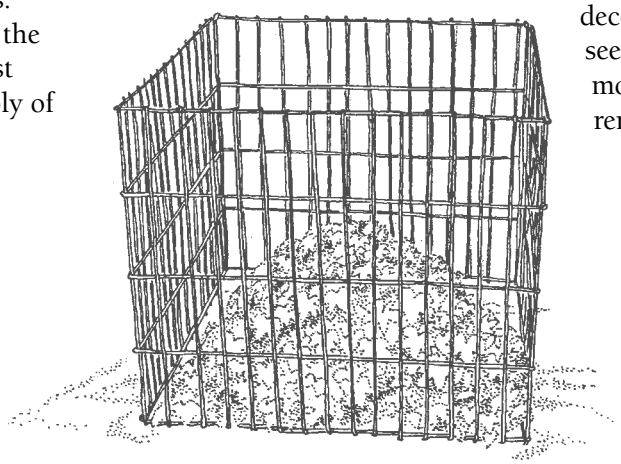
Moisture: The Wrung-Out Sponge Test

A compost pile should ideally be 40 to 60% moisture or as "moist as a wrung-out sponge." For best results, water should be layered in as needed with other ingredients as the pile is built. In warm, dry climates, water is most often the missing ingredient in unsuccessful piles. Meanwhile, in cold, wet climates, excess moisture can lead to soggy, compacted piles. Decomposer organisms, from the smallest bacteria to the longest worm, need a consistent supply of moisture for peak efficiency.

Before beginning a pile, consider the moisture level of the different compost materials, as well as your climate and the time of year. Fresh, young weeds from your irrigated garden can contain 60-70% moisture-no need to add water to them. Meanwhile, straw, sawdust, and dry leaves can all be dry enough to merit a good soaking. Climatic considerations—rainfall, humidity, heat—should also be factored into the watering plan. In the Pacific Northwest and on the East Coast, rainfall may provide adequate moisture to a pile built slowly over time. A pile built in the summertime will need more water than a pile built in the fall that will sit over the winter for many cold, damp months.

Generally, the easiest way to ensure consistent moisture throughout the pile is to water each brown layer as you go. Use a hose sprayer or mister for good coverage, taking special care to wet the corners and the edges of the pile. The hardest way to water a pile is to wait until the pile is finished, and then try to soak it from the top, hoping water will trickle down. This does not work very well. Build the water in with the other layers. If you are slowly building a pile over time, remember that much of the moisture can evaporate from the top foot of the pile, so rewet the top of the pile as you build it.

Too much moisture can result in compaction and a loss of oxygen in the pile. When oxygen is squished out, anaerobic bacteria come into the scene, generating an unsavory "rotten eggs" smell. Very moist materials, such as kitchen scraps, can cause pockets of compaction and anaerobic decomposition if they are layered too thickly. If a pile seems too wet, turn it to aerate it and add some bulky dry materials. In rainy climates, cover piles with tarps to guard against water-logging piles and leaching their reserve of nutrients. Too little moisture can result in piles that will not heat up and will decompose slowly. Sometimes a pile will have dry pockets where a layer was not watered enough. Always expect that the outside 12 inches of material will be dry and less decomposed than the inside. If a pile seems dry, turn it, examining it for moisture, and add water as needed to render it as moist as a wrung-out sponge.



AIR: Building It Into a Pile

The best decomposers for composting are aerobic (oxygen-requiring) bacteria. If a pile lacks adequate oxygen—either because it is too wet, too dense, or too big—anaerobic bacteria will take over, producing their characteristic "rotten eggs" smell. Air can be "built into" a large pile in the following combination of ways:
1. Be sure to first loosen the soil that will lie under the pile; 2. Add bulky materials to the bottom of the pile; 3. If using layers of wet, finely-textured materials such as grass clippings, layer them with bulky materials to avoid compaction; 4. Turn the pile at least once.

Oxygen is often the limiting factor in later stages of decomposition. Watch how much a large pile condenses in the first few weeks. Much of the oxygen in the pile can get used up or compressed out in this initial stage. As oxygen becomes less available, the microbial activity slows down. Turning the pile will reintroduce oxygen which can help the pile heat up again. If a pile becomes compacted due to excess moisture, aerate it by turning it and adding some bulky materials.

Build a Compost Layer Cake

1. Loosen soil under area where pile will be built.
2. Layer brown materials (2 to 8 inches thick) covering at least a 3 x 3 foot area.
3. Water as needed to make material "moist as a wrung-out sponge."
4. Layer green materials (2 to 8 inches thick) pulling material out to corners and edges.
5. Add a sprinkling of soil or finished compost.
6. Repeat layers, watering brown layers as needed, and keeping shape cubical until pile is 3 to 4 feet tall.
7. Finish pile with a brown layer and cap it with a 2 inch layer of soil.

Particle Size of Materials

The size of organic materials affects how fast they compost. Materials with smaller particle sizes have more overall surface area exposed for bacteria and other decomposers to munch on. For this reason, chopping large rough materials (especially wood stalks) will speed the composting process. A sharp spade can be used to coarsely chop garden weeds and crop residues; a shredder can be used for woody prunings that are thicker than a pencil; and a lawn mower can be used for leaves. Warning: If the particle size of all the materials is very small, the layers can compact and become matted.

Size of the Compost Pile

When the conditions are right in a compost pile, it becomes a small ecosystem teeming with decomposer organisms of different sizes and shapes. To achieve the benefits of hot composting, a pile must have a volume of three feet cubed or greater. Some sources say that piles should be closer to four feet cubed, but not much larger than five feet tall and five feed wide (and any length). A large, properly built pile is self-insulating and can reach temperatures from 140 to 160° sustained for ten days to two weeks. These high temperatures will kill most weed seeds and plant pathogens. Hot composting also yields a high-quality end-product by rapidly reducing organic matter while conserving nutrients in a stable form. A smaller pile may also heat up, but it won't sustain high temperatures long enough to kill a significant number of weed seeds and pathogens.

Turning and Maintenance

Turning a compost pile speeds the composting process and produces a better end-product for several reasons:
1. Oxygen is reintroduced to the pile; 2. The brown and green materials are re-mixed; 3. Outside materials are put in the middle of the reconstructed pile, resulting in more thorough decomposition; 4. As you turn, you can troubleshoot any problems and remedy them in the rebuilding process. With hot composting, it's best to turn the pile about 3 weeks to one month after initial construction. At this point, oxygen becomes the limiting factor and the pile cools down. When turned, the pile can reheat with a new surge of microbial activity. Be sure to try and turn the pile at least once, if not more often.

Strategically locating your compost pile will facilitate its construction and maintenance. Piles should be close to the garden, within reach of a garden hose, and preferably on level ground with space for stockpiling ingredients. Locating piles under deciduous trees will serve to shade them in the summer when the foliage is thick, and will expose them to the warming sun when the tree is bare in the winter. In warm, dry climates maintenance should include sprinkling the outside of piles that sit out in the sun. General maintenance for piles includes covering them with sheet plastic or a tarp to retain moisture in the summer and to avoid leaching in the winter.

Cold Winter Composting

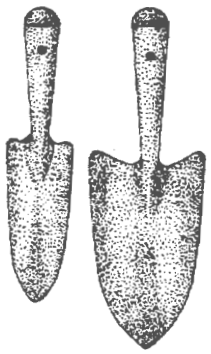
The heat generated by a compost pile is an internal process. Even in cold winters, the hot composting process can continue at very low levels if a pile is large enough to be self-insulating. While bins, tarps, and layers of extra straw can help insulate a pile, the composting process will slow down in cold winter weather. The process does not stop completely, however. Cold-tolerant bacteria and fungi continue to work away inside the pile, slowly but surely. For best results, build a large (four-foot-cubed) pile in the fall, heap on extra straw or leaves, tarp it and, come spring weather, turn it to aerate and reactivate it.

Bins and Systems

There are as many composting styles and systems as there are composters. In creating a system that works for you, consider what quantity and type of materials you have, how fast they accumulate, how much effort you want to put into composting, and what kind of end-product you want. Don't worry if you haven't got enough materials to build a large hot composting pile. Slowly-built piles that don't heat significantly will still create usable compost, just take longer to break down.

Bins offer several advantages for either fast or slow composting systems. Primarily, they are great for corralling the organic materials into a neat heap that approximate a cube (rather than a free-standing pyramid). Some bins have a front gate that can be easily opened while building or turning a pile. When a pile is ready to be turned or used, the whole bin can be removed from around the pile for easier access, and a new or reconstructed pile can be made in the bin.

Some people prefer to have two or three bins to accommodate different stages of their composting process. With a two-bin system, one pile can be made and allowed to mature while another pile is slowly heaped up in the other bin. Another method, called rapid composting, involves makes a hot composting pile and turning it frequently between the two bins. (If turned daily, a hot compost pile can produce finished compost in under three weeks!)



Useful Compost Making Tools

- Pitchfork for building and turning piles.
- Sharp spade for chopping materials.
- Hose with an on-off sprayer.
- Bins for the pile or stockpiling materials.
- Large tarp.
- Compost thermometer (optional).

When Is It Done?

An average compost pile can take three to six months to mature if not turned. However, some piles can be finished in three weeks. Here are the variables that make the difference: 1. The number of times a pile is turned, 2. The particle size of the compost materials, 3. The climate and the season.

If you want finished compost in a hurry, the key is to turn your pile more often. The more times a pile is turned, the faster it will decompose. Turning a pile once or twice can shorten its maturation time to two or three months. Weekly turning can yield finished compost in one to two months; daily turning will finish it in two to three weeks.

Another factor that affects a pile's maturation time is the particle size of the compost materials. To speed up the composting process, chop large stalks with a spade and shred woody trimmings in a chipper.

Climate and season also affect decomposition. Piles made in climates with mild winters can take four to eight months. In very cold climates, winter piles can take even longer than eight months to mature. To assure that composting continues in the pile's center, build a large pile and insulate it with extra leaves, hay, and a tarp.

Signs that your compost pile is ready for use include:

1. The temperature inside the pile has cooled down.
2. Worms, beetles, and sowbugs have moved inside the pile.
3. The pile has an earthy smell and resembles coarse-textured, rich brown soil.

Using Finished Compost

Your finished compost may not look like the finely textured, stick-less stuff available in bags at the garden center. Fear not. Sticks and other materials that haven't thoroughly composted will continue to decompose in the

soil. Most transplants can take a rougher, less-finished compost (for example, tomatoes and brassicas). There is no need to sift compost that is going into a garden bed. For propagation mixes and seed beds, however, always use your most finished, stable compost that has been sifted through a 1/4-inch screen to remove larger particles.

Ways to Use Finished Compost in the Garden

- In newly cultivated or poor soil, turn under a 2-inch layer (or more) of compost into the top foot of the garden bed.
- In established garden beds, turn under a 1/2 to 1-inch layer before each planting.
- Mix in a handful of compost in holes for special annuals; a shovelful for perennials.
- Sift compost as an ingredient for potting soil, or seed sowing mix.
- Use compost as mulch around trees, shrubs, and other established garden planting.
- Make "compost tea fertilizer" by placing compost in a burlap bag and soaking it in a barrel of water. Use the "tea" to irrigate seedlings and the garden. It will not burn plants and provides good complete nutrition.

About Manures

While it's not necessary to use manure to make a "hot" compost pile, manure makes a great compost material—whether layered between plant materials or piled into a heap of its own. Rich in nitrogen and beneficial bacteria, manure also contains a fair amount of phosphorus and some potassium. Well-aged manure can be added directly to garden beds and potting mixes, but fresh manure should always be composted several months before use. All manures are not the same. When considering the use of manure in a compost pile, ask these three questions: 1. What kind of manure is it? 2. How fresh is it? 3. What kind of bedding material, and how much of it, comes along with the manure?

1. What Kind of Manure Is It?

Different animal manures have different carbon to nitrogen ratios and different levels of moisture. Consider the cow. A cow chews its food many times, digesting it through two stomachs, before depositing a very wet cow-pie. The resulting manure contains a lot of well-broken-down organic matter with a low level of nitrogen. Meanwhile, chickens and other poultry will deposit both urine and feces in one solid dropping. For this reason, poultry manures are very high in nitrogen, but should not be considered a good source of organic matter. Adding thin layers of nitrogen-rich chicken manure to a compost pile will help it heat up.

2. How Fresh Is It?

Manure that has been sitting around for months will have a different carbon-to-nitrogen ratio than fresh manure. To conserve the most nitrogen, manure would ideally be collected fresh and put directly into a pile or under a tarp. When manure is left sitting around, much of its nitrogen escapes back into the atmosphere along with a lot of its moisture. Fresh manure will heat a pile; well-aged manure won't bring much heat to a pile, but is a good source of microorganisms and phosphorus. In many areas, horse manure is available for free at local stables. When collecting the manure, here are some guidelines for telling how old it is.

- Fresh manure is moist and smells strongly of ammonia.
- Fresh manure, if piled up, will generate heat.
- Fresh manure is still greenish and is in discernible chunks.
- When it doubt, ask the stable keepers how often they collect manure and how it's stored.

3. What Comes With the Manure?

Sometimes the "manure" collected from stables is largely a pile of dry wood shavings with a few bits of horse manure here and there. A fastidious stable keeper may lay in fresh bedding—wood shavings or straw, for example—in their horses' pens every day. When assessing a manure pile, note how much bedding it contains (and remind yourself that the bedding is a carbon source that will affect the overall carbon to nitrogen ratio of the pile). Also note the moisture level of the bedding materials. Wood shavings do not readily absorb water and will need a generous spraying with each layer. Horse manure in straw bedding makes a wonderful compost material that can be composted in a heap of its own. Straw soaks up urine, thus conserving an additional source of nitrogen.

Another thing that often comes with manure is a supply of weed seeds. Fortunately, composting manure in a hot compost pile should kill most of the seeds.

Troubleshooting for Problem Compost Piles

SYMPTOM	POSSIBLE CAUSE	SOLUTION
1. Pile not heating up	a. lack of nitrogen	a. turn pile, adding nitrogen material like grass clippings (a thin layer) or thicker layers fresh manure, green weeds, etc.
	b. not enough moisture	b. turn pile, look for dry layers, and water as you are rebuilding
	c. pile is too small (in piles under 3 ft. cubed only the center is warm and moist)	c. gather more materials and rebuild a larger pile
2. Pile smells like "rotten eggs"	a. pile too wet, lacks oxygen	a. turn pile to aerate and layer in dry materials
	b. pile is compacted	b. turn pile to aerate
3. Pile smells strongly of ammonia	a. pile has an excess of nitrogen	a. turn pile, adding carbon "brown" material and some soil
4. Pile is attracting pests and flies	a. pile has attractive kitchen scraps near surface of pile	a. keep meat, dairy products, and greasy foods out of pile
		b. bury scraps in center of pile, covering well with soil and brown material

Piling It On: More Resources for The Compost Enthusiast

Let it Rot! The Home Gardener's Guide to Composting, by Stu Campbell, Storey Communications, Inc., Pownall, VT. (Revised Ed., 1998), Paperback , 152 pp.

Campbell's book still tops my list due to its orientation toward gardeners, its entertaining style, its accessibility to novices, and its wealth of information for advanced composters.

Backyard Composting: Your Complete Guide to Recycling Yard Clippings, Harmonious Technologies, Harmonious Press, Ojai, CA, (1997), 96 pp.

Basic information, clearly presented, with an emphasis on recycling organic materials.

Worms Eat My Garbage, by Mary Appelhof, Flower Press, Kalamazoo, MI, (2nd Ed., 2003), 96 pp.

Known as "the bible" among worm composters, Appelhof's book guides readers through the steps of setting up and maintaining a worm composting system.

Rodale Guide to Composting, by Grace Gershuney and Deborah Martin, Rodale Press, Emmaus, PA, (Updated Ed., 1992), 278 pp.

This comprehensive guide has been updated several times over the last two decades.

The Complete Compost Gardening Guide, by Barbara Pleasant and Deborah L. Martin. Storey Books, North Adams, MA, (2008), 320 pp.

A fine new book from two very experienced garden writers on how to compost right in the garden, with or without a bin. Down to earth (!) with excellent photographs and illustrations.

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