

C O M P O S T I N G

A Guide to Managing Organic Yard Wastes



America's waste disposal sites are filling up. Landfills across the nation are being closed at an alarming rate. Yet the volume of waste our society produces continues to increase.

Twenty percent of the solid waste placed in landfills consists of yard and garden wastes such as leaves and grass clippings. Many states, including North Carolina, are banning these wastes from landfills.

One step we can take toward solving our waste disposal problems is to make use of lawn and garden wastes instead of dumping them.

Through the process of composting, these organic wastes can be recycled to produce a natural material that can be used in gardens, landscapes, and flower beds.

When mixed with soil, compost increases the organic matter content, improves the physical properties of the soil, and supplies essential nutrients, enhancing the soil's ability to support plant growth. Compost can also be applied to the soil surface to conserve moisture, control weeds, reduce erosion, improve appearance, and keep the soil from gaining or losing heat too rapidly.

One way to dispose of yard and garden wastes is to haul them to municipal or county composting facilities. Many homeowners, however, find it more convenient and economical to compost these materials in their own backyards. In either case, the finished compost can be mixed with soil or used as a mulch for gardens, landscape beds, or lawns. This publication explains how to build and maintain a compost pile and how to use compost in the yard and garden.

Why Compost?

Gardeners have used compost for centuries. Composting is an efficient method of breaking down organic materials into an end product that is beneficial to soil and plants. Adding yard and garden wastes directly to the soil without first composting them has some undesirable effects. For example, if large quantities of uncomposted leaves are incorporated into the soil, the microbes that work to decompose the leaves will compete with plant roots for soil nitrogen. This competition can result in nitrogen deficiency and poor plant growth. Increased populations of the microbes can also deplete most of the organic matter in the soil, leaving the soil with less structure than before.

When materials such as leaves and grass clippings are composted, however, a microbial process converts them to a more usable organic material. Adding composted material reduces the competition for nitrogen. Composted material is also much easier to handle and mix with soil than uncomposted material because of its finer texture. Furthermore, improvement of the soil's physical properties — such as increased infiltration, better drainage, and greater water holding capacity — usually occurs more rapidly when composted materials are added.

Requirements for Efficient Decomposition

Decomposition of organic material in a compost pile depends on maintaining the activity of decomposer microbes. Any factor that slows or halts the growth of these microbes also slows the composting process. Efficient decomposition occurs when aeration and moisture are adequate, when the particles of waste material are small, and when the proper amounts of fertilizer and lime are added. We will discuss each of these factors in more detail.

AERATION

Microbes require oxygen to decompose organic wastes efficiently. Some decomposition will occur in the absence of oxygen (that is, under anaerobic conditions); however, the process is slow and foul odors may develop. Because of the odor problem, composting without oxygen is not recommended in residential areas unless the process is conducted in a fully closed system (such as the plastic bag method described later under “Composting Structures”). Mixing the pile once or twice a month will provide the necessary oxygen and significantly hasten the composting process. A pile that is not mixed may take three to four times longer to produce useful

compost. A well-mixed compost pile also reaches higher temperatures, helping to destroy weed seeds and disease-causing organisms (pathogens).

MOISTURE

Adequate moisture is essential for microbial activity. Materials in a dry compost pile will not decompose efficiently. If rainfall is limited, the pile must be watered periodically to maintain a steady decomposition rate. Enough water should be added to completely moisten the pile, but overwatering should be avoided. Excessive moisture can lead to anaerobic conditions, slowing down the degradation process and causing foul odors. The pile should be watered enough that it is damp but does not remain soggy. Approximately 50 to 55 percent moisture on a weight basis is a good starting point. The compost is within the right moisture range if a few drops of water can be squeezed from a handful of material. If no water can be squeezed out, the materials are too dry. If water gushes out, they are too wet.

PARTICLE SIZE

The smaller the organic waste, the faster the compost will be ready to use. Smaller particles have much more surface area for a given volume and thus are more rapidly broken down by microbes. Materials can be shredded before they are added to the pile. Shredding is essential if brush or sticks are to be composted. In addition to speeding up the composting process, shredding reduces the volume of the compost pile. A low-cost method of reducing the size of fallen tree leaves is to mow the lawn before raking it or to run the lawn mower over leaf piles after raking. Raked piles should be checked to ensure that they do not contain sticks or rocks that could cause injury during mowing. If the mower has an appropriate bag attachment, the shredded leaves can be collected directly.

FERTILIZER AND LIME

Microbial activity is affected by the ratio of carbon to nitrogen in the organic waste. Because microbes require a certain amount of nitrogen to live and grow, a shortage of nitrogen slows the composting process considerably. Materials high in carbon but low in nitrogen, such as straw or sawdust, decompose very slowly unless nitrogen fertilizer is added. Although tree leaves are higher in nitrogen than straw or sawdust, they still decompose more rapidly when nitrogen fertilizer or wastes that are high in nitrogen

are added. Grass clippings are generally high in nitrogen; when mixed properly with leaves, they speed decomposition. Poultry litter, manure, or blood meal can be used as organic sources of nitrogen. Otherwise, a fertilizer with a high nitrogen analysis (10 to 30 percent) should be used. Other nutrients such as phosphorus and potassium are usually present in adequate amounts.

During the initial stages of decomposition, organic acids are produced and the acidity (pH) of the compost drops. At one time it was believed that adding small amounts of lime in the early stages would maintain and enhance microbial activity during this period. However, lime converts ammonium-nitrogen to ammonia gas, removing nitrogen from the pile. Although adding lime may hasten decomposition, the loss of nitrogen from the pile often offsets the benefits. Lime is not necessary for degradation of most yard wastes. Finished compost is usually alkaline (with a pH between 7.1 and 7.5) without the addition of lime. In many areas, the water used to moisten the compost pile is alkaline and may also help to raise the pH (reduce the acidity) of the compost. If large quantities of pine needles, pine bark, or vegetable and fruit wastes are composted, additional lime may be necessary to reduce acidity.

Materials for Composting

Many organic materials are suitable for composting. Yard wastes such as leaves, grass clippings, straw, and nonwoody plant trimmings can be composted. Leaves are the dominant organic waste in most backyard compost piles. Grass clippings can be composted; however, with proper lawn management, clippings do not need to be removed from the lawn. If allowed to remain, they will decay and release nutrients, reducing the need for fertilizer. (See Cooperative Extension Service publication AG-69, *Carolina Lawns*.) If clippings are used, they should be mixed with other yard wastes; otherwise they may compact and restrict airflow. Branches and twigs greater than 1/4 inch in diameter should be put through a shredder or chipper first. Kitchen wastes such as vegetable scraps, coffee grounds, and eggshells may also be added.

Sawdust may be added in moderate amounts if additional nitrogen is applied. Approximately 1 pound of actual nitrogen (6 cups of ammonium nitrate) is required per hundred pounds of dry sawdust. Wood ashes serve as a lime source; if used, they should be added only in small amounts (no more than 1 cup per bushel or 10 pounds per ton of compost). Excessive amounts result in loss of nitrogen from the pile.

However, wood ashes do contribute high levels of potassium to the compost. Crushed clam or oyster shells, eggshells, and bone meal also tend to reduce the acidity of composts. Ordinary black-and-white newspaper can be composted; however, the nitrogen content is low, slowing the decomposition rate. If paper is composted, it should make up no more than 10 percent of the total weight of the material in the compost pile. It is better to take newspapers to a community recycling center.

Other organic materials that can be used to add nutrients to the pile include blood and bone meal, livestock manure, prunings from nonwoody plants, vegetable and flower garden refuse, fruit and vegetable scraps from the kitchen, hay, straw, and lake plants. Livestock manure and poultry litter can be added to provide nitrogen. About 100 pounds of poultry litter provides 1.8 pounds of nitrogen.

Materials to Avoid in a Compost Pile

Some materials may pose a health hazard or create a nuisance and therefore should not be used to make compost. Human or pet feces should not be used because they can transmit disease. Although animal remains can be safely decomposed in commercial compostors, wastes such as meat, bones, grease, whole eggs, and dairy products should be avoided in home compost piles because they may attract rodents. Most plant disease organisms and weed seeds are destroyed during the composting process because temperatures in the center of the pile reach 150° or 160°F. In most compost piles, however, it is impossible to mix the contents thoroughly enough to bring all wastes to the center. Consequently, adding diseased plants or large amounts of weeds containing seeds can create problems if the compost is to be used in the garden.

Citrus rinds; corn cobs, stalks, and husks; palm fronds; and walnut, pecan, and almond shells break down very slowly and should be avoided unless they are shredded. Charcoal also resists decay and will not decompose in most compost piles. Coal ashes should not be added because they contain levels of sulfur and iron that may be toxic to plants. Automotive petroleum products should be taken to recycling centers, never put into a compost pile.

Although plants that have been treated with herbicides or pesticides should be avoided for composting, small amounts of herbicide-treated plants (for example, grass clippings) can be mixed into the pile as long as adequate time is allowed for thorough decomposition. Ideally, clippings from lawns recently treated with herbicides should be left

Table 1. Persistence of Herbicides in Soil

Common Name	Trade Name	Persistence in Soil (months)
Benefin	Balan, Balfin	4-8
DCPA	Dacthal	4-8
Bensulide	Betasan, Prefar	6-12
Glyphosate	Roundup, Kleenup	Less than 1
2,4-D	(Many formulations)	1-2
MCPP	(Many formulations)	1-3

on the lawn to decompose. Most agrichemicals, both pesticides and herbicides, degrade at varying rates. Table 1 lists common chemicals used on home lawns and gives their degradation rate in soil. Even if some treated grass clippings are used, the chemicals they contain should degrade at least as fast in a properly maintained compost pile as they do in the soil.

Composting Structures

To save space, hasten decomposition, and keep the yard looking neat, the compost pile can be contained in some sort of structure. If the quantity of leaves or garden wastes is limited, starting with a single holding pile constructed as materials are gathered may be the best approach. This method also works if minimizing the composting time is not of great concern.

Composting structures can be made from a variety of materials and can range from very simple to complex. The design can be tailored to individual needs.

Using plastic garbage bags is perhaps the simplest way to make compost. The bags are easy to handle and require little maintenance. Large (30- to 40-gallon) plastic bags should be filled with alternating layers of plant wastes, fertilizer, and lime. About 1 tablespoon of a garden fertilizer with a high nitrogen content (such as 10-10-10) should be used in each bag. Lime (1 cup per bag) helps counteract the extra acidity caused by anaerobic composting. After the bags have been filled, about a quart of water should be added and the bags closed tightly. Set them aside for six months to a year. The bags can be in a basement or heated garage to hasten decomposition during winter months. No turning is required and no water need be added after the bags have been closed. The main advantage of composting in garbage bags is

that very little attention is required. Because the amount of oxygen is limited, however, the process is slow.

The barrel or drum composter generates compost rather quickly and provides an easy mechanism for turning the compost (Figure 1). A barrel of at least 55-gallon capacity with a secure lid is required. Be sure that the barrel was not used to store toxic chemicals. Drill six to nine rows of $\frac{1}{2}$ -inch holes over the length and a few in the bottom of the barrel to allow for air circulation and drainage of excess moisture. Place the barrel upright on blocks to allow air to circulate below it. Fill the barrel three-fourths full with organic waste material and add about $\frac{1}{4}$ cup of a fertilizer high in nitrogen (approximately 30 percent nitrogen). Add water until the compost is moist but not soggy. Every few days, turn the drum on its side and roll it around the yard to mix and aerate the compost. The lid can be removed after

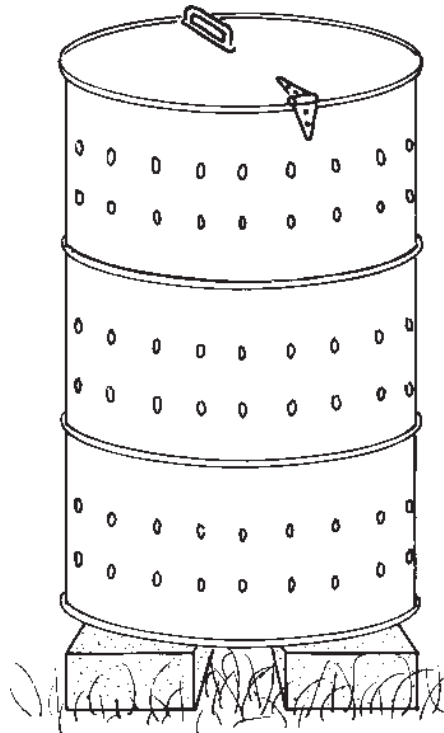


Figure 1. The barrel or drum composter.

turning to allow for air penetration. The compost should be ready in two to four months. The barrel composter is an excellent choice for the city dweller with a relatively small yard.

For larger quantities of organic waste, bins are the most practical composting structure. A circular bin can be made from a length of closely spaced woven-wire fencing held together with chain snaps (Figure 2). The bin should be about 3 to 5 feet in

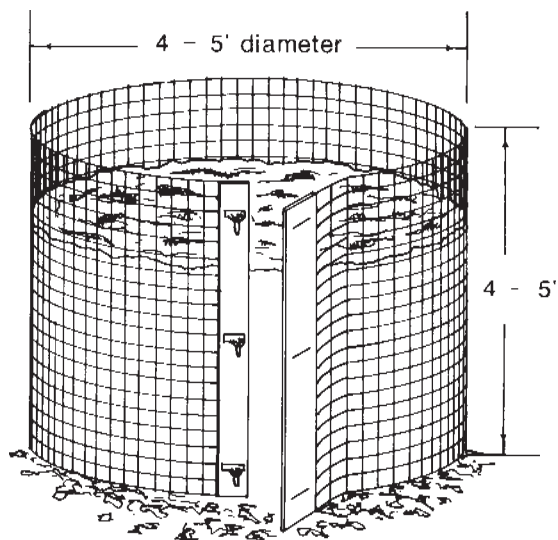
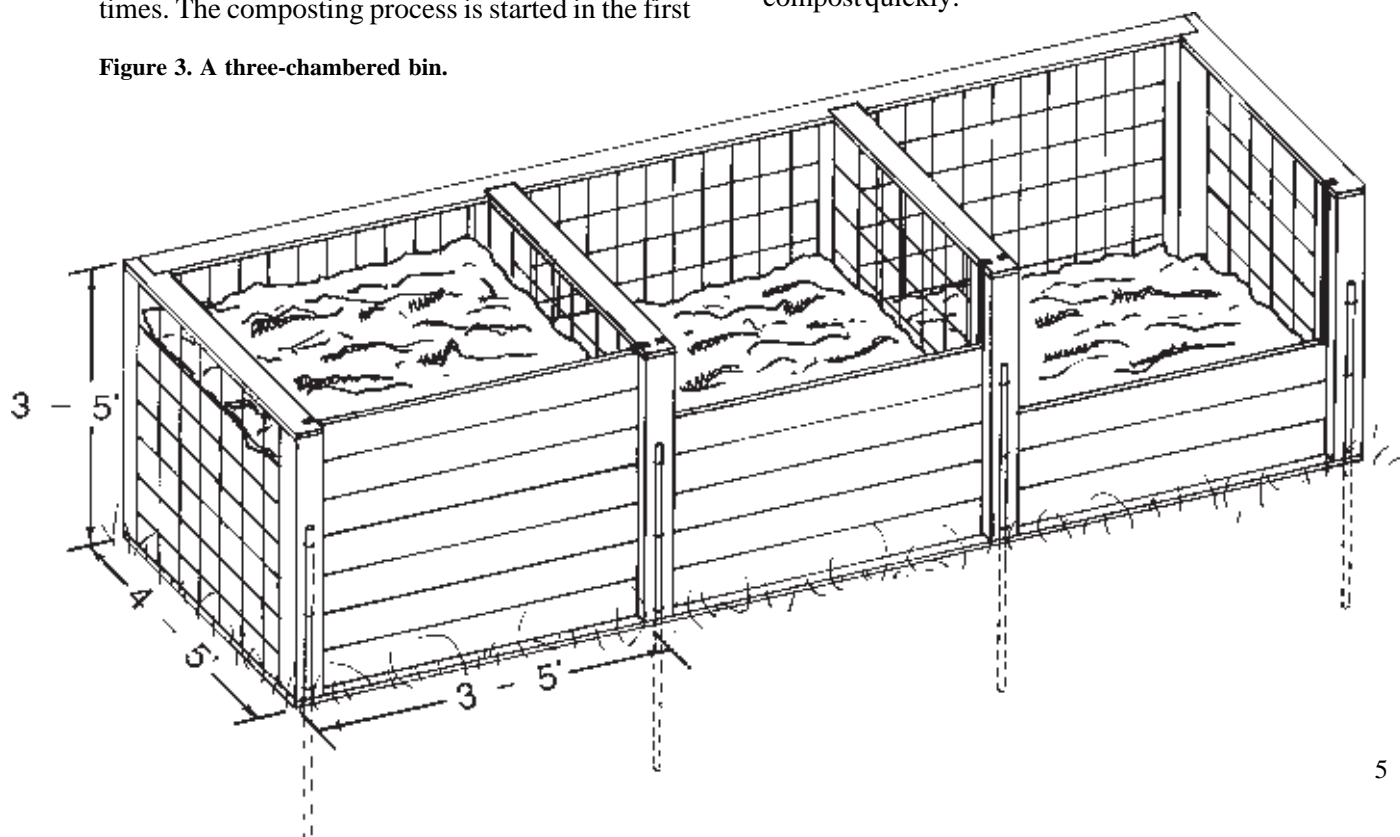


Figure 2. A cylindrical wire bin.

diameter and at least 4 feet high. A stake may be driven in the middle of the bin before adding material to help maintain the shape of the pile and to facilitate adding water. With this design, it is easiest to turn the composting material by simply unsnapping the wire, moving the wire cylinder a few feet, and turning the compost back into it.

A very efficient and durable structure for fast composting is a three-chambered bin (Figure 3). It holds a considerable amount of compost and allows good air circulation. The three-chambered bin works on the assembly line principle. Three batches of compost are in varying stages of decomposition at all times. The composting process is started in the first

Figure 3. A three-chambered bin.



bin; waste material is placed in the bin and allowed to heat for three to five days. Then this material is turned into the middle bin for another four to seven days while a new batch of material is started in the first bin. Finally, the material in the middle bin is turned into the last bin as finished or nearly finished compost. The material in the first bin is turned into the second bin, and new material is once again placed in the first bin.

To make this structure, it is best to use rot-resistant wood such as redwood, salt-treated wood, wood treated with an environmentally safe preservative, or a combination of treated wood posts and metal posts. Unless the wood is treated or rot resistant, it will decompose within a few years. Each bin should be at least 3 to 5 feet in each dimension so that it will hold enough volume to compost properly. Using removable slats in the front of each bin provides easy access to the contents when they must be turned.

Many other structures can be used for composting. No one structure is best, and you may want to invent your own. For a more thorough description of different structures, see *The Complete Book of Composting*, by J. I. Rodale (Rodale Books, Inc., Emmaus, PA, 1971.) If you prefer not to build a structure, you may wish to purchase one of the commercial composting units available through local garden stores or mail-order catalogs. Most of these are similar to the barrel composter described previously and are intended for the city dweller who wants an easy way to make small amounts of compost quickly.

Location

The compost pile should be located near the place where the compost will be used. It should also be placed where it will not offend neighbors or interfere with activities in the yard. Composting is best done in a location screened from your view and that of neighbors. Good locations for the pile are near the garden or in a service area. Do not locate the compost pile near a well or on a slope that drains to surface water, such as a stream or a pond. Locating the pile too close to trees may also create problems, as roots may grow into the bottom of the pile, making turning and handling the compost difficult. The pile will do best where it is protected from drying winds and is in partial sunlight to help provide heat. The more wind and sun the pile is exposed to, the more water it will need.

Preparing the Compost Pile

When a compost pile is started, materials should be added in layers to ensure proper mixing. An example of the layering process is illustrated in Figure 4. Organic wastes such as leaves, grass clippings, and plant trimmings are put down in a layer 8 to 10 inches deep. Coarser materials will decompose faster if placed in the bottom layer. This layer should be watered until moist but not soggy. A nitrogen source should be placed on top of this

layer. Use 1 to 2 inches of livestock manure or a nitrogen fertilizer such as ammonium nitrate or ammonium sulfate at a rate of $\frac{1}{3}$ cup for every 25 square feet of surface area. If these nitrogen sources are not available, 1 cup of 10-10-10 fertilizer per 25 square feet of surface area will suffice. Do not use fertilizer that contains any herbicide or pesticide.

A 1-inch layer of soil or completed compost can be applied on top of the fertilizer layer. One reason for adding soil is to ensure that the pile is inoculated with decomposing microbes. The use of soil in a compost pile is optional, however. In most cases, organic yard wastes such as grass clippings or leaves contain enough microorganisms on the surface to cause decomposition. Studies have shown that there is no advantage in purchasing a compost starter or inoculum. Microbes multiply as rapidly from the soil or from added organic wastes as from the inoculum. The microbes already in the soil and on organic materials are just as efficient in decomposing the waste as those provided by the commercial inoculum. However, one way to ensure that activator microbes are present in the new compost is to mix in some old compost as the pile is prepared. Adding soil does help reduce leaching of mineral nutrients such as potassium released during decomposition. Repeat the sequence of adding organic waste, fertilizer, and soil or old compost (optional) until the pile is completed, remembering to water each section.

Figure 4. Compost pile ingredients.



If only tree leaves are to be composted, layering is not necessary. Fallen leaves can be added as they are collected. The leaves should be moistened if they are dry. Since dead leaves lack adequate nitrogen for rapid decomposition, a high-nitrogen fertilizer (10 to 30 percent) should be added to hasten breakdown. Approximately 5 ounces (about $\frac{1}{2}$ cup) of 10 percent nitrogen fertilizer should be added for every 20 gallons of hand-compressed leaves.

The carbon-to-nitrogen (C/N) ratio determines how long decomposition takes. An initial C/N ratio of about 20 or 30 to 1 is needed for rapid composting. If the initial C/N ratio is above 50, the process will be

Table 2. Approximate Nitrogen Concentration and Carbon-to-Nitrogen (C/N) Ratio of Compost Materials

Material	Nitrogen (% dry weight)	C/N ratio
Grass clippings	2.15	20
Leaves	0.5–1.0	40–80
Sawdust	0.11	511
Wood (pine)	0.07	723
Fruit wastes	1.52	35
Paper	0.25	170
Table scraps	none	15
Livestock manure	1.0	20

considerably slower. The C/N ratio of common organic yard wastes is given in Table 2. Materials can be blended and mixed to achieve an initial C/N ratio of 25 to 30. Over time, the C/N ratio will generally decrease.

Maintaining the Compost Pile

To prevent odors and hasten decomposition, the pile must be turned occasionally. Turning also exposes seeds, insect larvae, and pathogens to lethal temperatures inside the pile. The pile may be turned by inverting segments of the compost or by shifting the pile into another bin. The pile should be kept moist but not waterlogged. Odors may arise either from adding excessive amounts of wet plant materials, such as fruits or grass clippings, or from overwatering. A properly mixed and adequately turned compost pile does not produce objectionable odors. The middle of an actively decomposing pile reaches temperatures of 150° to 160°F. If the pile does not heat sufficiently, it may be too small, there may not be enough nitrogen or oxygen, or it may be too wet or too dry. The pile should be turned when the center begins to feel cool to the touch. Turning the pile introduces oxygen and undecomposed material into the center, regenerating the heating process. Composting is essentially complete when mixing no longer produces heat in the pile.

Small amounts of fresh materials may be added if the pile is turned occasionally. Vegetable wastes should be buried inside the pile to avoid attracting rodents. If enough material is available, it is best to make a new pile instead of combining new material with old compost.

Generally, the compost from a well-managed pile made up of shredded material under warm conditions will be ready in about two to four months. Piles prepared in the late fall will not be ready for use the following spring because the weather is not warm enough to maintain proper decomposing temperatures inside the pile. A pile left unattended or made up of material that has not been shredded may take more than a year to decompose. When the compost is finished, the pile will be about half its original size and will have an earthy smell to it.

Use of Compost to Improve Soil

Compost is used as an organic amendment to improve the physical, chemical, and biological properties of soils. The compost adds air space to the soil, and incorporating it alleviates compacted conditions. Adding compost increases the moisture-holding capacity of sandy soils, reducing drought damage to plants. When added to heavy clay soils, compost improves drainage and aeration. (Note, however, that adding compost cannot solve drainage problems that result from poor surface contours or subsurface conditions. Such problems often must be solved by regrading, berming, or installing drainage tiles.)

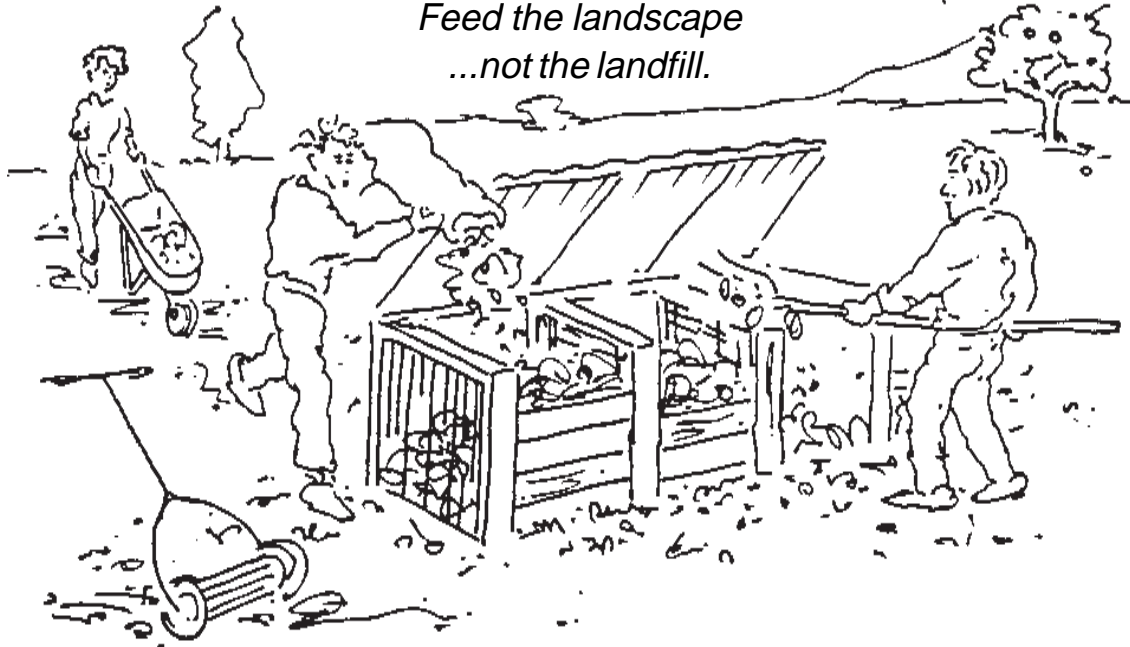
All of these changes create a better environment for root growth. Adding compost increases the ability of the soil to hold and release essential nutrients. The activity of earthworms and soil microorganisms beneficial to plant growth is also promoted. Other benefits include improved seed emergence and water infiltration as a result of reduced soil crusting.

Amending soils with compost may also reduce the incidence of damping off disease and root rots. The microflora present in compost compete with disease microbes for the sugars and nutrients secreted from plant roots, preventing these pathogens from growing and keeping them inactive.

Over time, yearly additions of compost will create desirable soil structure, making the soil much easier to work. To improve the physical properties of the soil, incorporate 1 to 2 inches of well-decomposed compost into the top 6 to 8 inches of soil.

Though compost does enrich the soil, it releases nutrients slowly and often does not contain enough nutrients to supply all the needs of growing plants. Therefore, it is still important to conduct soil tests and fertilize your lawns and gardens accordingly. For more information on soil testing and composting, contact your county Extension Service agent.

*Feed the landscape
...not the landfill.*



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