University of Minnesota
Extension
SERVICE

Composting AND Mulching

A Guide to Managing Organic Yard Wastes

Carl J. Rosen,
Thomas R. Halbach,
and Robert Mugaas

Department of Soil, Water,
and Climate

Composting and Mulching:
A Guide to Managing Organic Yard Wastes

Composting is a microbial process that converts plant materials such as grass clippings and leaves to a more usable organic soil amendment or mulch. Gardeners have used compost for centuries to increase soil organic matter, improve soil physical properties, and supply some of the essential nutrients for plant growth. Mulching refers to the practice of applying a layer of materials such as compost, leaves, or grass clippings to the soil surface in order to modify soil temperature and moisture as well as control weeds and soil erosion.

Because many communities ban outdoor burning and have laws that prohibit dumping of leaves and grass clippings into landfills, composting and mulching have become attractive ways to manage yard waste and recycle natural materials. Grass clippings and leaves can be hauled to city composting areas as one means of disposal. However, many homeowners may find it more convenient and economical to compost these materials in their own backyards. In either case, the finished compost can be used as a mulch or as a soil amendment to improve most garden soils. The information in this bulletin will help you learn how to build and maintain a compost pile as well as how to use the compost in the yard and garden.

Why Compost?

Composting is an efficient way to break down organic materials into an end product that is beneficial to the soil and growing plants. Adding organic materials directly to the soil without first composting may initially have some undesirable effects. For example, if large quantities of noncomposted leaves are incorporated into the soil, microbes will compete with plant roots for soil nitrogen while the leaves decompose. This competition for nitrogen can result in nitrogen deficiency and poor plant growth. Adding mature composted material with a carbon-to-nitrogen ratio of less than 20:1 reduces the competition for nitrogen. Another benefit of composted material is that it is much easier to handle and mix with soil than noncomposted material. Composted material will have fewer weed problems than noncomposted materials.

Requirements for Efficient Decomposition

Decomposition of organic material in the compost pile depends on microbial activity. Any factor that slows or halts microbial growth will also impede composting. Efficient decomposition occurs when the following factors are used to fullest advantage.

AERATION: Microbes need oxygen for efficient decomposition of organic wastes. Some decomposition will occur in the absence of oxygen (anaerobic conditions); however, the process is slow and foul odors may develop. Because of the odor problem, composting without oxygen is not recommended in a residential setting unless the process is conducted in a fully closed system (see plastic bag method on page 5, Composting Structures). The oxygen content inside the pile should ideally range from 16.5% to 20.9%. The key to adequate oxygen is “free air space” within the pile. Initial free air space of 55% to 65% by volume has been proven to work well. Free air space can be measured with a five-gallon bucket and a one-gallon milk jug as shown on page 2.

How to measure free air space in your compost pile: The Five Gallon Bucket Test

Materials needed:

- A five-gallon pail
- A one-gallon plastic milk jug
- Typical mix of materials added to the compost pile (manure, grass clippings, straw, wood chips, shredded bark, etc.)

1. Check the volume of your five-gallon pail by filling the one-gallon jug and emptying it into the five-gallon pail five times. Mark the five-gallon "full line" on the pail.
2. Fill the five-gallon pail one-third full with a typical mix of compost materials and drop the pail ten times from a height of six inches onto a cement floor or sidewalk (being careful to keep all the material in the pail).
3. Add compost to fill the five-gallon pail two-thirds full and drop the pail ten times from a height of six inches onto a cement floor or sidewalk.
4. Add compost to fill the five-gallon pail up to the "full line" and drop the pail ten times from a height of six inches onto a cement floor or sidewalk.
5. Add compost to fill the five-gallon pail to the "full line."
6. Now add and keep track of the amount water you can add to the five-gallon pail before it overflows.
   - If you can add 2.75 to 3.25 gallons of water to the five-gallon pail without it spilling over the top, you have adequate free air space. Your initial free air space is correct.
   - If you cannot add at least 2.75 gallons of water to the five-gallon pail without it spilling over the top, you have inadequate free air space. Add more bulking material like straw, coarse wood chips, or shredded bark.
   - If you can add more than 3.25 gallons of water to the five-gallon pail without it spilling over the top, you have too much free air space and you need to reduce the particle size. This can be done by grinding or shredding the materials or by adding finer materials to the mix.
7. Make the needed corrections and retest until the test shows the correct initial free air space.

MOISTURE: Adequate moisture is essential for microbial activity. Dry yard waste will not decompose efficiently. If rainfall is limited you will need to water the pile periodically to maintain a steady decomposition rate. Add enough water to completely moisten the pile, but avoid overwatering. Excess water can lead to anaerobic conditions that slow down the degradation process and cause foul odors. Water the pile so that it is damp, but does not remain soggy. Approximately 50% to 55% moisture is a good starting point.

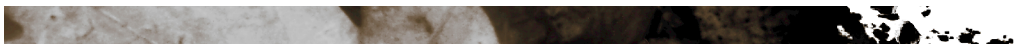
PARTICLE SIZE: Smaller particles have much more surface area that can be attacked by microbes. Organic material larger than 2 inches will be slow to compost. A shredder can be used before putting material in the pile, and is essential if brush or sticks are to be composted. A low-cost method of reducing the size of fallen tree leaves is to mow the lawn before raking. If the mower has an appropriate bag attachment, the shredded leaves can be collected directly. In addition to speeding up the composting process, shredding reduces the volume of the compost pile. The concern for maximum exposed surface area must always be balanced against the need for adequate free air space. Particles shredded too small will tend to pack and exclude oxygen. Initial free air space of 55% to 65% needs to be established. Free air space can be increased by adding larger pieces to the compost material such as wood chips or shredded bark. To reduce free air space, smaller pieces can be added to the mixture or the original material can be reduced in size by grinding or shredding.

NUTRIENTS: Microbial activity is affected by the carbon-to-nitrogen (C/N) ratio of the organic waste. Because microbes need nitrogen for their own metabolism and growth, a shortage of nitrogen will slow down the composting process considerably. Material high in carbon relative to nitrogen, such as straw or sawdust, will decompose very slowly unless nitrogen fertilizer is added. Tree leaves are higher in nitrogen than straw or sawdust, but decomposition of leaves still benefits from an addition of nitrogen fertilizer. Grass clippings are generally high in nitrogen and enhance decomposition when mixed properly with leaves. Manure, cottonseed meal, or blood meal can be used as organic sources of nitrogen. Otherwise use a high nitrogen-containing fertilizer. You need an initial C/N ratio of about 30 parts carbon to 1 part of nitrogen. C/N ratios below 25:1 may give off ammonia odors and above 35:1 will take longer to compost. Other nutrients such as phosphorus and potassium are necessary, but are usually present in adequate amounts for decomposition.

TURNING OR MIXING: Mixing the pile once or twice a month will blend the cold outer edges of the pile into the warmer, more active center of the pile and significantly hasten the composting process. A pile that is not mixed may take three to six times longer before it can be used. A well-mixed compost pile will also reach higher temperatures for longer time periods, which will help destroy more weed seeds and pathogens. Turning a compost pile adds oxygen to the pile, but this effect is often short-lived, lasting from fewer than 24 hours to fewer than 30 minutes. Turning a compost pile simply cannot overcome compost material that does not have enough free air space. To have adequate oxygen in the pile you must have adequate free air space in the material being composted.

During the initial stages of decomposition, organic acids are produced and the pH drops. Some sources suggest adding small amounts of lime to maintain and enhance microbial activity at this time. However, high rates of lime will convert ammonium-nitrogen to ammonia gas, which in turn will lead to the loss of nitrogen from the pile. Research has shown that the loss of nitrogen from the pile often offsets the benefits of lime[1]. In general, lime is not necessary for degradation of most yard wastes. The pH of finished compost is usually slightly alkaline without the addition of lime. In many areas, the water used to moisten the compost pile is alkaline and may also help to increase the pH of the compost. If large quantities of acid materials such as pine needles, spruce needles, or fruit wastes are composted, additional lime may be necessary.

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. The dominant organic waste in most backyard compost piles is leaves. Grass clippings can be composted; however, with proper lawn management, clippings do not need to be removed from the lawn (see Alternatives to Composting Grass Clippings, page 12). If grass clippings are used, it is advisable to mix them with other yard wastes such as leaves or wood chips as a bulking agent to increase free air space. Otherwise, the grass clippings may compact and restrict air flow. Branches, logs, and twigs greater than $1/2$-inch in diameter or more than 8 inches long should be put through a shredder/chipper first. Kitchen wastes such as vegetable scraps, fruit waste, coffee grounds, and eggshells may also be added. Some cities have ordinances that restrict the use of food scraps in compost piles. Check with local authorities about restrictions in your area.

Because they may pose a health hazard or create a nuisance, certain organic materials should not be used to make compost. Adding human, cat, or dog feces cannot be recommended because they may transmit diseases. Meat, bones, grease, whole eggs, and dairy products should not be added because they can attract rodents to the site. Most plant disease organisms and weed seeds are destroyed during the composting process when temperatures in the center of the pile reach 130–150°F for 15 days or longer. However, in most home compost piles, it is very difficult or impossible to mix

efficiently enough to bring all wastes to the center. Consequently, adding large amounts of weeds with seeds or diseased plants may create problems if the compost is used in the garden.

Sawdust may be added in moderate amounts up to a maximum of 10% of the total pile volume, if additional nitrogen is applied and free air space is adequate. Approximately 1–1.5 lb. of actual nitrogen (6–9 cups of ammonium nitrate) is required for 100 lbs. of dry sawdust. Wood ashes act as a lime source and if used should only be added in small amounts (no more than $^1/_2$ cup per five gallon bucket). Excessive amounts of wood ashes will result in loss of nitrogen from the pile. Ordinary black and white newspaper can be composted; however, the nitrogen content is low and paper will therefore slow down the rate of decomposition. If paper is composted, it should not be more than 10% of the total weight of the material in the compost pile. We recommend recycling newspaper through appropriate community recycling centers rather than through backyard composting.

Examples of other organic materials that can be used to add nutrients, especially nitrogen, to the pile include cotton seed meal, blood and bone meal, livestock manure, and lake plants.

Avoid composting plants that have been treated with herbicides or pesticides. Small amounts of herbicide-treated plants (e.g., grass clippings) may be mixed in the pile as long as you are careful to let them decompose thoroughly. Studies have shown that low levels (less than 0.1 parts per million) of 2,4–D, diazinon, and pendimethalin can be detected in well-composted yard trimmings[2]. This level, however, is less than 1% of the level typically found in yard waste mixtures prior to composting and is not considered a risk for using in the garden. Ideally, clippings from lawns recently treated with herbicides should be left on the lawn to decompose (see section on Alternatives to Composting Grass Clippings, page 12). Both pesticides and herbicides are degraded at varying rates. A list of common chemicals used on the home lawn and their degradation rate in soil is provided in **Table 1**. Even if some treated grass clippings are used, the degradation of these chemicals in a properly maintained compost pile should be at least as fast as that in the soil.

Table 1. Persistence of herbicides in soil[3]

Common Name	Trade Names	Persistence in Soil (months)
Benefin	Balan	4–8
DCPA	Dacthal	4–8
Bensulide	Betasan	6–12
Glyphosate	Roundup, Kleenup	Less than 1
2,4–D	(Many Formulations)	1–2
MCPP	(Many Formulations)	1–3
Dicamba	Banvel	3–12

Composting Structures

To save space, hasten decomposition, and keep the yard looking neat, it is recommended that the compost pile be contained in a structure. Composting structures can be made of a variety of materials and made as simple or complex as desired. There are many options available that can be tailored to individual needs. Listed below are a few suggestions for containing the compost.

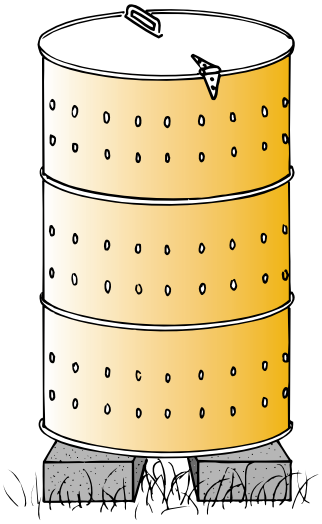


Figure 1

A barrel or drum composter generates compost in a relatively short period of time and provides an easy mechanism for turning **(Figure 1)**. This method requires a barrel of at least 55 gallons with a secure lid. Be sure that the barrel was not used to store toxic chemicals. Drill six to nine rows of 1/2-inch holes over the length of the barrel to allow for air circulation and drainage of excess moisture. Place the barrel upright on blocks to allow bottom air circulation, fill it three quarters full with organic waste material, and add about 1/4-cup of a high nitrogen containing fertilizer. If needed, apply water until moist. 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 turning to allow for air penetration. Ideally, 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.

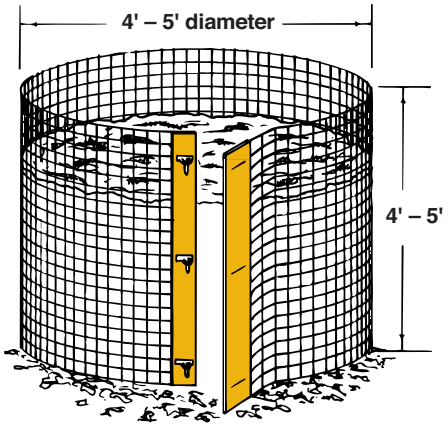


Figure 2

Bin-type structures are the most practical for larger quantities of organic waste. For example, a circular bin can be made by using a length of small spaced woven wire fencing and holding it together with chain snaps **(Figure 2)**. The bin should be about four to five feet in diameter and at least four 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 three-chambered bin is a very efficient and durable structure for fast composting **(Figure 3)**. It holds a considerable amount of compost and allows good air circulation. The three-chambered bin works on an assembly line idea, having three batches of compost in varying stages of decomposition. The compost material is started in the first bin and allowed to heat up for 3 to 6 weeks. Next, it is turned into the middle bin for another 4 to 8 weeks, 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 nearly finished compost and left to cure until finished composting, usually an additional 5 to 16 weeks.

To make this structure, it is best to use rot-resistant wood, such as redwood or cedar, or a combination of wood and metal posts. Unless the wood is rot resistant, it will decompose within a few years. Each bin should be about five feet by three feet and about four to five feet high. This volume is ideal for maintaining heat and at the same time is manageable for turning. Using removable slats in the front offers complete access to the contents for turning.

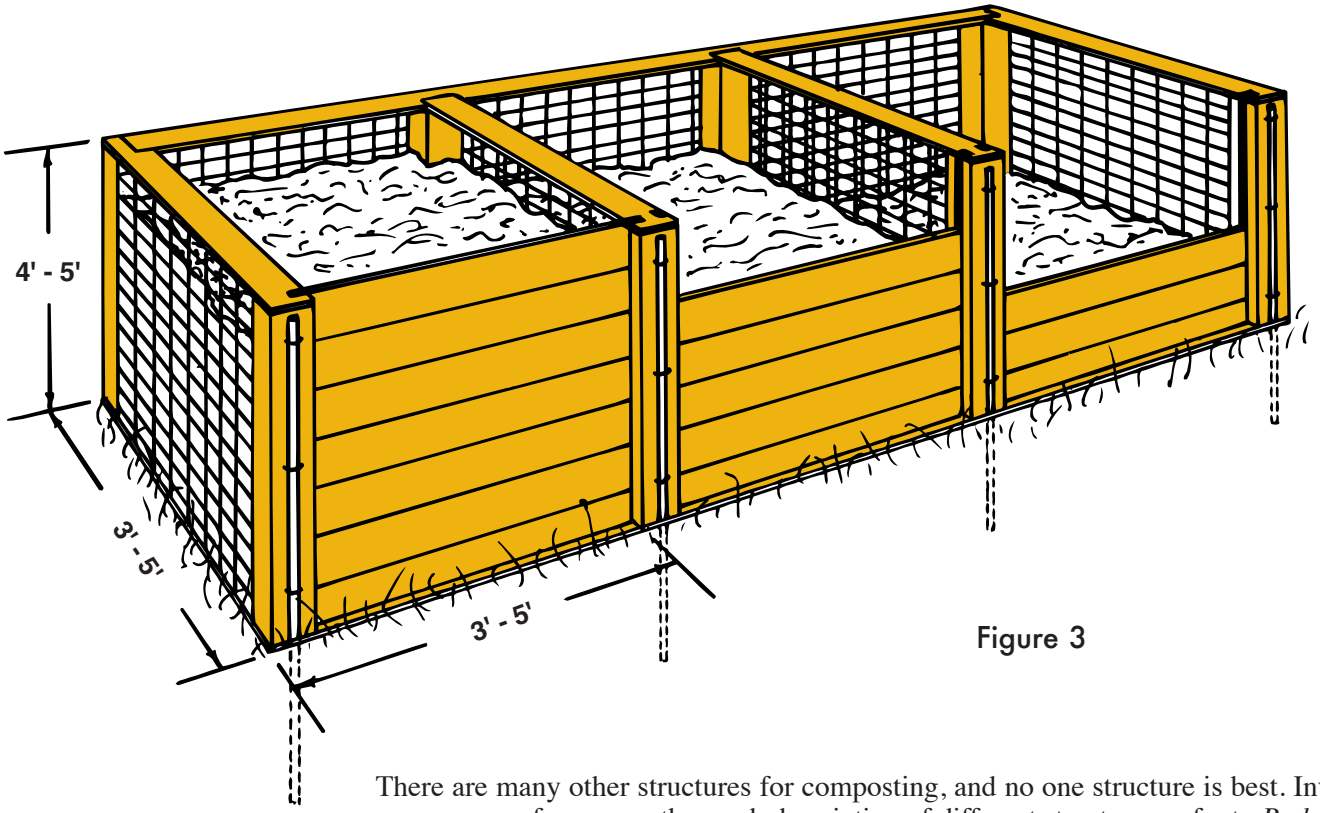


Figure 3

There are many other structures for composting, and no one structure is best. Invent your own, or for a more thorough description of different structures, refer to *Rodale's Complete Guide to Composting*[4]. If you don't want to build a structure, there are several commercial composting units available through local garden stores or mail-order catalogues. Make sure that these units meet the minimum size requirement of one cubic yard or larger in size so that you have a large enough mass to self-heat to 130°F–150°F.

Location

The compost pile should be located close to where it will be used and where it will not interfere with activities in the yard or offend neighbors. Good locations for the pile are near the garden or kitchen, or between the garage and house. The pile will do best where it is protected from drying winds and is in partial sunlight to help heat the pile. The more wind and sun the pile is exposed to, the more water you will need to add to the pile during the composting process.

Preparing and Maintaining the Compost Pile

This information is provided for those who want to make compost quickly. For those who are more patient, simply piling the yard waste with few or no inputs or turning will also work, but the process will take much longer (more than one year).

Layer the compost pile as you add materials to facilitate decomposition by ensuring proper mixing. An example of the layering process is illustrated in **Figure 4**. Each pile ideally should be about five feet high.

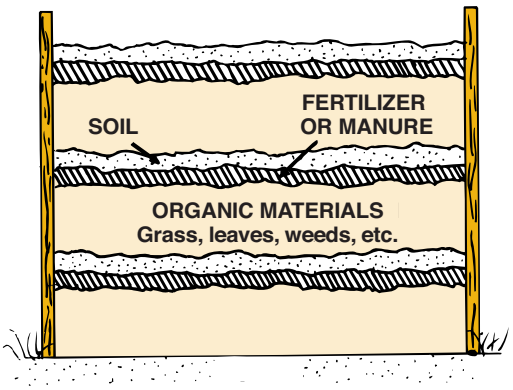


Figure 4

Put down organic wastes such as leaves, grass, and plant trimmings in a layer eight to ten inches deep. Coarser materials like twigs, stalks, and chipped branches will decompose faster if placed in the bottom layer. Water this layer until moist, but not soggy. A nitrogen source should be placed on top of this layer. Use one to two inches of livestock manure, or a nitrogen fertilizer such as ammonium nitrate or ammonium sulfate, at a rate of one third of a cup for every 25 square feet of surface area. If these nitrogen sources are not available, 1/3 cup of 27–3–3 lawn fertilizer per 25 square feet of surface area will also work. **Do not use fertilizer that contains herbicide or pesticide**. Other organic sources of nitrogen that can be used are green grass clippings, lake plants, cottonseed meal, or blood meal. Grass clippings tend to mat and should either be mixed well with other materials, such as wood chips or leaves, or placed in layers only one to two inches thick.

You can apply about a one-inch layer of soil or completed compost on top of the fertilizer layer. One purpose of adding soil is to ensure that the pile is inoculated with decomposing microbes. The use of soil in a compost pile should be considered optional. In most cases, organic yard wastes such as grass clippings or leaves contain enough microorganisms on the surface to effect decomposition. Studies have shown that there is no advantage in purchasing a compost starter or inoculum. Microbes multiply as rapidly from the soil and/or added organic wastes as from the purchased 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. Adding soil, however, will help reduce leaching of mineral nutrients such as potassium released during decomposition. Repeat the sequence of adding organic waste, fertilizer, and soil (optional) until the pile is completed, remembering to water each section to the 50% to 55% moisture level.

The carbon-to-nitrogen (C/N) ratio determines how long decomposition will take. For rapid composting, the initial C/N ratio should be in the range of 25/1 to 30/1, or simply 25 to 30. If the initial C/N ratio is above 35, the process will be considerably slower. The C/N ratio of common organic yard wastes is shown in **Table 2**. Materials can be blended and mixed to achieve an initial C/N ratio of 25 or 30. Over time, the C/N ratio will generally decrease.

Table 2. Approximate concentration of nitrogen and carbon-to-nitrogen (C/N)* ratio of various materials used in municipal and backyard composts[5]

Material	Nitrogen % dry weight	C/N ratio range
Alfalfa	2.5%	12 to 19:1
Grass clippings	2.2%	15 to 25:1
Fruit wastes	1.5%	25 to 45:1
Sugarbeet	0.7%	30 to 40:1
Leaves	0.7%	40 to 80:1
Sawdust	0.2%	100 to 750:1
Wood	0.09%	200 to 1300:1
Paper	0.12%	200 to 800:1
Table scraps	3.0%	11 to 15:1
Livestock manure	2.0%	10 to 30:1

* See text for further explanation.

** C/N ratio will increase as the proportion of bedding increases.

(For more materials refer to Cornell's Website address on page 13.)

To prevent odors and hasten decomposition, the pile should be turned occasionally. Turning also exposes seeds, insect larvae, and pathogens to lethal temperatures inside the pile. Turning may be done by inverting segments of the compost, or by shifting the pile into another bin. The compost pile should be kept moist but not waterlogged. Odors may occur if you add excessive amounts of wet plant materials like fruits or grass clippings, or from over watering — both will cause anaerobic conditions. A properly mixed and adequately turned compost heap will not have objectionable odors. An actively decomposing pile will reach temperatures of 130–150°F in the middle. Low-cost temperature probes are available to help monitor temperature in the pile. Reasons for the pile not heating up may be: too small a pile, not enough nitrogen, lack of oxygen, lack of free air space, too much moisture, or not enough moisture. The pile should be turned when the temperature in the center begins to cool. This will introduce undecomposed edge material into the center and subsequently regenerate heating with a "new" food source for the microbial community. The composting process is essentially complete when mixing no longer produces an increase in heat in the pile.

Small amounts of fresh materials may be added provided that the pile is occasionally turned. 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 with old compost.

Generally, a well-managed compost pile with shredded materials under warm conditions will be ready in about two to four months. A pile of unshredded material, left unattended may take years to decompose. Outdoor piles prepared in the late fall, in Minnesota, will not be ready for use the following spring. When the compost is finished, the pile will be about half its original size and have an earthy smell to it.

Questions sometimes arise about spontaneous combustion in compost piles. Spontaneous combustion is the occurrence of fire without the application of an external heat source and can be caused by chemical, biological, or physical processes. Organic material can ignite spontaneously due to biological activity at moisture contents between 26–46% moisture if the temperature exceeds 200°F. These high temperatures only occur with restricted air flow and piles exceeding a height of seven feet. Spontaneous combustion happens to stored hay or silage and only in rare cases to compost. No documented cases of spontaneous combustion have been reported for compost piles smaller than seven feet. Most reported fires occurring in compost piles are the result of external sources such as matches or the addition of hot ashes. In short, a well maintained compost pile with temperatures less than 150°F will not spontaneously combust. If a compost pile gets too hot — more than 160°F — you can cool it down by 1) reducing the size of the pile; 2) adding water to 55% moisture; or 3) mixing in coarse, bulky material such as wood chips. Compost piles work best at temperatures between 130–150°F.

Other Methods of Yard Waste Decomposition

An alternative to aerobic composting is the use of **plastic garbage bags** as mini-anaerobic digesters. The bags are easy to handle and require minimal maintenance. To break down garden wastes using this method, 30–40 gallon plastic bags should be alternately filled with plant wastes, fertilizer, and lime. About one tablespoon of a garden fertilizer with a high nitrogen content should be used per bag. Lime (one cup per bag) helps counteract the extra acidity caused by anaerobic digestion. After filling, add about 1–2 quarts of water. Dry material may require more than this quantity of water. Close tightly. You may want to double-bag these digesters to keep them as airtight as possible. Set the bag aside for six months to a year. Bags can be set in a basement or heated garage for better decomposition during winter months. Using garbage bags requires no turning or additional water after closing. The main advantage of this system is that it requires little maintenance; however, because oxygen is limited, the process is slow.

Vermiculture refers to using worms to break down and transform yard waste into a useable soil amendment.[6] See reference 6 for more information on vermiculture.

Municipal Composting of Yard Wastes

If building your own compost heap is impractical, there are municipal composting sites available in many counties. Depending on the location, leaves only or leaves and grass clippings may be dropped off at the composting sites. Some city compost programs also have curbside pick up in the fall. Completed compost is sometimes available free of charge from these sites. For information on the nearest composting site, contact your local county extension educator, county solid waste officer, or city recycling coordinator.

There has been concern about using municipal waste compost because of contamination with lead and other trace metals. Contamination may be due to direct exposure of leaves and grass to automobile exhaust or to inclusion of street sweepings (which might contain high levels of lead from automobile exhaust) in the compost pile. A study at the University of Minnesota [7] shows chemicals present in yard waste composts from 11 different sites in the seven-county metropolitan area. The mean and ranges of elemental concentrations in the compost piles over two years are presented in **Table 3**.

Table 3. Chemical characteristics of municipal yard waste composts

Mean of 11 compost sites over 2 years[7]

Chemical Characteristic	Concentration (dry weight basis) Mean	Range
Carbon %	19.3	4.4–41.4
Nitrogen %	1.3	0.3–4.2
Carbon/Nitrogen (C/N)*	15.4	11–25
Phosphorus %	0.19	0.05–0.5
Potassium %	0.39	0.04–2.71
Calcium %	3.02	0.70–8.04
Magnesium %	0.54	0.09–1.34
Iron %	0.25	0.06–0.31
Aluminum %	0.27	0.06–0.31
Manganese mg/kg**	420	223–1261
Sodium mg/kg	154	36–921
Zinc mg/kg	88	39–585
Copper mg/kg	11	3–143
Boron mg/kg	41	7–141
Lead mg/kg	49	1–380
Cadmium mg/kg	0.4	<0.1–1.4
Chromium mg/kg	6.3	1.2–52.5
Nickel mg/kg	7.3	1.7–33.3
pH	7.6	4.5–8.3

Samples for metal analysis were dry ashed and resuspended in 2N HCl. Metals were determined using an inductively coupled plasma spectrometer.

* Ratio of carbon to nitrogen (see page 3 for further explanation)

< means "less than"

**mg/kg = milligrams per kilogram, which is the same as parts per million

The study shows a wide range in lead values from the different sites. The highest concentrations were found in composts produced at sites in the oldest urban areas, with high automobile traffic and a history of use of lead-based paints. Generally it has been considered safe to use garden produce grown in soils with total lead levels less than 300 mg/kg (parts per million). The lead levels in most of the yard waste composts were considerably less than this suggested limit. Other trace metals such as cadmium, nickel, copper, chromium, and zinc are also present in compost in small quantities. Based on US-EPA standards, the Minnesota Pollution Control Agency has established criteria for an exceptional quality compost that takes into account the maximum allowable concentrations of these elements for unrestricted use of composts. The allowable levels in milligrams per kilogram on a dry weight basis are:

Arsenic	41	Zinc	2800
Cadmium	39	Mercury	5
Nickel	420	Lead	300
Copper	1500	Molybdenum	18
Chromium	1200	Selenium	36

Typically, municipal yard waste composts contain far less than the allowable levels of these elements. If you are concerned about the composition of the municipal compost, ask the operators if a recent chemical analysis is available.

Use of Compost as a Soil Amendment

Compost is used as an organic amendment to improve physical, chemical, and biological properties of soils. Adding compost will increase the moisture-holding capacity of sandy soils, thereby reducing drought damage to plants. When added to heavy clay soils, compost will improve drainage and aeration, thereby reducing waterlogging damage to plants. Compost increases the ability of the soil to hold and release essential nutrients and promotes the activity of earthworms and soil microorganisms beneficial to plant growth. Other benefits of adding compost include improved seed emergence and water infiltration due to a reduction in soil crusting.

Over time, yearly additions of compost will create desirable soil structure, making the soil much easier to work. To improve soil physical properties, add and incorporate 1–2 inches of well-decomposed compost in the top 6–8 inches of soil. Use the lower rate for sandy soils and the higher rate for clay soils. To a limited extent, compost is a source of nutrients. However, nutrient release from compost is slow and the nutrient content is often too low to supply all the nutrients necessary for plant growth. As noted in Table 3, there is a wide variation in nutrient content of municipal leaf compost. Differences may be due to several factors, including age of the compost, amount of water added, plant species, and the amount of soil that becomes mixed into the pile during turning.

It is usually necessary to supplement compost with some fertilizer, particularly nitrogen. If the C/N ratio of the compost is less than 20 to 1, nitrogen will tend to be released rather than tied up[5]. For the majority of municipal yard waste composts, the C/N ratio is less than 20 to 1 **(Table 3)**. Thus, while composts may not supply significant amounts of nitrogen, especially in the short run, nitrogen tie-up should not be a major concern with most yard waste composts. Approximately 1 cup of ammonium nitrate (0.15 lb. actual nitrogen) per 3 bushels (100 lbs. compost) is required to provide the additional nitrogen needed by most garden plants. Compost that is immature or not well decomposed should be used primarily as a mulch. Incorporation of immature compost into the soil may result in nitrogen deficiency and poor plant growth. Have your soil tested every few years to determine whether supplemental phosphorus and potassium are required.

The pH of most yard waste composts is usually between 7.0 and 8.0. This slightly alkaline pH of compost should not pose any problems when diluted by mixing into the soil and, in fact, is beneficial to plants growing on acid soils. Because of the alkaline pH, yard waste composts may not be suited for use on acid-loving plants such as azaleas and blueberries.

Use of Compost in Potting Soils

Leaf compost can be used as a component of potting mixes. Generally, no more than one-quarter to one-third by volume of the potting mix should be compost, because over time some of the compost is likely to decompose and the volume of the potting soil will be reduced. In addition, high levels of compost in a potting mix may cause waterlogging and poor aeration for roots.

Although proper composting destroys most weed seeds and disease organisms, some may still survive due to incomplete mixing. To obtain a completely pasteurized leaf compost, it is necessary to heat the material in an oven until the temperature of all the material reaches 160°F and is maintained for 30 minutes or longer. Pasteurization will also kill beneficial organisms in compost, some of which help to suppress certain soilborne diseases. So if your compost doesn't have many weed seeds or disease organisms, there may be an advantage to using it unpasteurized fresh.

Use of Compost as a Mulch

Mulches are used in gardens to suppress weeds, conserve soil moisture, reduce soil erosion, and modify the soil temperature (makes it cooler in the summer, reduces rapid decline and fluctuation in the winter). Yard waste compost makes an ideal mulch for annual and perennial gardens. All you need to do is apply a 2–4 inch layer of compost around the base of the plant. Periodically throughout the summer, you may need to add more compost over the old layers to maintain the benefits of the mulch. The soil environment beneath the mulch is favorable for earthworms, which are valuable for aerating the soil. Organic matter is gradually added to the soil as the mulch decomposes.

For annual gardens, the mulch can be worked into the soil at the end of the season to further improve the soil. For perennials, it may be beneficial to remove the mulch in the spring to allow the soil to thaw out faster. As discussed above, well-decomposed yard waste compost will not tie up nitrogen. Therefore, it is not necessary to add nitrogen beyond that recommended for plant growth. If noncomposted or partially composted leaves are used, one tablespoon of a high nitrogen fertilizer (for example, 27–3–3) should be applied to each five-gallon bucket of mulch.

Alternatives to Composting Grass Clippings

When proper lawn management is used, there is no need to collect grass clippings[8]. As long as the grass is not excessively long and clippings do not thickly cover the lawn surface after mowing, there is normally no need to collect the clippings. Aside from reducing the work involved in lawn maintenance, leaving the grass clippings benefits the turf by returning nutrients and organic matter to the soil. If evenly distributed, clippings left on the lawn can be equivalent to one fertilizer application per year.

To keep your lawn looking healthy and control the amount of clippings generated, several maintenance practices should be followed. It is important that mowing height be properly adjusted. The best cutting height depends on the turfgrass varieties present in the lawn and whether the lawn is in sun, full shade, or a combination of both. Lawns in full sun have the greatest potential for quick recovery after mowing and can therefore be cut shorter. Those in the shade need all the available leaf surface possible for photosynthesis. Thus, grass in the shade should be cut slightly higher than grass in

the sun. Where both conditions are present, an intermediate height is recommended. Some suggested mowing heights for home lawns are listed below.

Fine fescue ..... 2 to 3 inches

Kentucky bluegrass/perennial ryegrass ..... 1 1/2 to 2 1/2 inches

Kentucky bluegrass:

Improved varieties ..... 1 to 2 inches

Common types ..... 1 1/2 to 2 1/2 inches

Kentucky bluegrass/red fescue ..... 2 to 3 inches

Mowing frequency also directly affects the amount of clippings generated. How often to mow depends on the cutting height selected and how fast the grass grows rather than on specific time intervals such as once per week, etc. Ideally, no more than one-third of the leaf surface area should be cut at any one time and the clippings should be no longer than one inch. As an example, a lawn with grass three inches tall should be cut to about two inches. Excessive defoliation in a single mowing can make the lawn more prone to stress and disease problems.

Be careful not to overfertilize your lawn. Overfertilization (primarily with nitrogen) will cause excessive growth and, unless the lawn is cut more frequently, the clippings will be slow to reach the soil and decompose. Reducing excessive thatch levels through lawn renovation will improve infiltration of the grass clippings down to the soil surface. It is best to mow your lawn when it is dry so clippings will be able to filter down to the soil without clumping.

Two types of mowers available to homeowners are reel and rotary. Either will do an acceptable job when sharpened and adjusted properly. Mower blades should always be kept sharp, as dull blades can result in deterioration of the lawn area. Rotary mowers are now available with a mulcher attachment for the blade. Mulchers reduce the size of the clippings left behind and should result in faster decomposition of the grass blades. However, if you are mowing on a regular basis and not removing more than one-third of the grass blades at a time, additional size reduction is not necessary.

If grass growth is excessive you may need to remove the clippings. Lawn clippings can be used in the compost pile as described above or they can be used as a mulch in the garden. If used as a mulch, care should be taken not to over-apply fresh clippings as they tend to inhibit moisture and oxygen penetration into the soil, and may produce offensive odors. Mixing fresh clippings with compost provides an excellent mulching material. Do not use grass clippings as a mulch if the lawn has recently been treated with herbicides. Where herbicides have been applied, it is recommended that the clippings be left on the lawn for at least three mowings. For more information on lawn fertilization and lawn care, contact your local county Extension office.

References

[1] *Reclamation of Municipal Refuse by Composting*. 1953. University of California, Berkeley, Tech. Bull. No. 9, Series 37, Sanitary Engineering Research Project.

[2] Michel, F.C., D. Graeber, L.J. Forney, and C.A. Reddy. 1996. "The fate of lawn care pesticides during composting." *Biocycle,* 37(3) March, 64–66.

[3] Van Der Puy, D., *Characteristics of Herbicides Used in Agronomic Crops*. 1985. North Dakota Cooperative Extension Service Bulletin #W–871.

[4] Rodale, J.I. *The Complete Guide to Composting*. 1971. Rodale Books, Inc. Emmaus, PA, 9th printing.

[5] *Biochemical and Microbiological Aspects of Composting*. 1974. Connecticut Agricultural Experiment Station Bulletin 754.

[6] Appelhof, M. 1997. *Worms Eat My Garbage: How to Set Up and Maintain a Worm Composting System* (2nd Edition). 176 pp.

[7] Schumacher, Nancy, M. DuBois, M. Martindale, C.E. Clapp and J.A.E. Molina. *Composition of Yard Waste Composts Produced at Twin Cities Metropolitan Area Centralized Composting Sites*. Research report submitted to the Legislative Commission for Minnesota Resources, 1987, Attachment D. The State Office Building, St. Paul, MN.

[8] Allen, P. and D. White. 1990. *Lawn Clipping Management*. University of Minnesota Extension Service. AG–FO–3915.

Web References

Composting Council of Canada: http://www.compost.org/

Cornell University Compost Page: http://www.cfe.cornell.edu/compost/Composting_homepage.html
especially "The Science and Engineering of Composting" section.

Louisiana State University: http://www.agctr.lsu.edu/wwwac/compost/index.html

Texas A&M: http://www-horticulture.tamu.edu:8080/search.html
search: compost

University of Florida: http://compost.ifas.ufl.edu/Default.htm

University of Minnesota: http://www.extension.umn.edu/
search: compost

US Composting Council: http://CompostingCouncil.org/
search: Composting Q & A

About the Authors

Carl Rosen, Extension Soil Scientist, Department of Soil, Water, and Climate

Thomas R. Halbach, Extension Waste Management Specialist

Robert Mugaas, Extension Educator, Hennepin County, University of Minnesota Extension Service

Production Editor: Phyllis Unger, Communication and Educational Technology Services, University of Minnesota Extension Service

This project was originally supported by a grant from the Metropolitan Council, 300 Metro Square, 7th and Robert Streets, St. Paul, MN 55101.

www.extension.umn.edu

For ordering information call (800) 876-8636.

Produced by Communication and Educational Technology Services, University of Minnesota Extension Service.

Printed on recycled paper with minimum 10% postconsumer waste.

BU-3296-F
Revised 2000

UNIVERSITY OF MINNESOTA
Extension
SERVICE