

# FIELD GUIDE TO COMPOST USE

The US Composting Council — <http://compostingcouncil.org>

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## **The US Composting Council**

Established in 1990, the US Composting Council is a diverse trade association supporting the needs of the composting industry. Members of the Council include compost producers, marketers, equipment manufacturers, academic institutions, public agencies, nonprofit groups, and consulting/engineering firms. The US Composting Council's mission is to achieve maximum conversion, composting, and utilization of organic materials in an environmentally and economically sustainable manner.

# Introduction

This Field Guide to Compost Use provides compost use instructions that have been verified through research and field experience. It condenses and simplifies 13 currently available, technically-based, compost use guidelines, providing a step-by-step description of compost use in specific applications. Our goal is to promote the proper use of compost products, thereby improving field results and user confidence. This guide also provides important information about the characteristics and benefits of using compost.

## What is Compost?

Compost is the product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth. Compost bears little physical resemblance to the raw material from which it originated. Compost is an organic matter resource that has the unique ability to improve the chemical, physical, and biological characteristics of soils or growing media. It contains plant nutrients but is typically not characterized as a fertilizer.

## How is Compost Produced?

Compost is produced through the activity of aerobic (oxygen-requiring) microorganisms. These microbes require oxygen, moisture, and food in order to grow and multiply. When these resources are maintained at optimal levels, the natural decomposition process is greatly accelerated. The microbes generate heat, water vapor, and carbon dioxide as they transform raw materials into a stable soil conditioner. Active composting is typically characterized by a high-temperature phase, that sanitizes the product and allows a high rate of decomposition, followed by a lower-temperature phase, that allows the product to stabilize while still decomposing at a lower rate. Compost can be produced from many feedstocks. State and federal regulations exist to ensure that only safe and environmentally beneficial composts are marketed.

# 1: Benefits of Compost and its Effect on Growing Systems

As more and more compost is produced and utilized and as the body of end-use related research grows, the benefits of using compost have become more evident and measurable. Because of its many attributes, compost is extremely versatile and beneficial in many applications. Compost has the unique ability to improve the properties of soils and growing media physically (structurally), chemically (nutritionally), and biologically. Although many equate the benefit of compost use to lush green growth, caused by the plant-available nitrogen, the real benefits of using compost are long-term and related to its content of living-organic matter.

**TABLE 1.1 Benefits of Using Compost**

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1.	Improves the soil structure, porosity, and density, thus creating a better plant root environment.
2.	Increases infiltration and permeability of heavy soils, thus reducing erosion and runoff.
3.	Improves water holding capacity, thus reducing water loss and leaching in sandy soils.
4.	Supplies a variety of macro and micronutrients.
5.	May control or suppress certain soil-borne plant pathogens.
6.	Supplies significant quantities of organic matter.
7.	Improves cation exchange capacity (CEC) of soils and growing media, thus improving their ability to hold nutrients for plant use.
8.	Supplies beneficial microorganisms to soils and growing media.
9.	Improves and stabilizes soil pH.
10.	Can bind and degrade specific pollutants.

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## Physical Benefits

### ✓ Improved Structure

Compost can greatly enhance the physical structure of soil. In fine-textured (clay, clay loam) soils, the addition of compost will reduce bulk density, improve friability (workability) and porosity, and increase its gas and water permeability, thus reducing erosion. When used in sufficient quantities, the addition of compost has both an immediate and long-term positive impact on soil structure. It resists compaction in fine-textured soils and increases water holding capacity and improves soil aggregation in coarse-textured (sandy) soils. The soil-binding properties of compost are due to its humus content. Humus is a stable residue resulting from a high degree of organic matter decomposition. The constituents of the humus act as a soil 'glue,' holding soil particles together, making them more resistant to erosion and improving the soil's ability to hold moisture.

### ✓ Moisture Management

The addition of compost may provide greater drought resistance and more efficient water utilization. Therefore, the frequency and intensity of irrigation may be reduced. Recent research also suggests that the addition of compost in sandy soils can facilitate moisture dispersion by allowing water to more readily move laterally from its point of application.

## Chemical Benefits

### ✓ **Modifies and Stabilizes pH**

The addition of compost to soil may modify the pH of the final mix. Depending on the pH of the compost and of the native soil, compost addition may raise or lower the soil/compost blend's pH. Therefore, the addition of a neutral to slightly alkaline compost to an acidic soil will increase soil pH if added in appropriate quantities. In specific conditions, compost has been found to affect soil pH even when applied at quantities as low as 10-20 tons per acre. The incorporation of compost also has the ability to buffer or stabilize soil pH, whereby it will more effectively resist pH change.

### ✓ **Increases Cation Exchange Capacity**

Compost will also improve the cation exchange capacity of soils, enabling them to retain nutrients longer. It will also allow crops to more effectively utilize nutrients, while reducing nutrient loss by leaching. For this reason, the fertility of soils is often tied to their organic matter content. Improving the cation exchange capacity of sandy soils by adding compost can greatly improve the retention of plant nutrients in the root zone.

### ✓ **Provides Nutrients**

Compost products contain a considerable variety of macro and micronutrients. Although often seen as a good source of nitrogen, phosphorous, and potassium, compost also contains micronutrients essential for plant growth. Since compost contains relatively stable sources of organic matter, these nutrients are supplied in a slow-release form. On a pound-by-pound basis, large quantities of nutrients are not typically found in compost in comparison to most commercial fertilizers. However, compost is usually applied at much greater rates; therefore, it can have a significant cumulative effect on nutrient availability. The addition of compost can affect both fertilizer and pH adjustment (lime/sulfur addition). Compost not only provides some nutrition, but often makes current fertilizer programs more effective.

## Biological Benefits

### ✓ Provides Soil Biota

The activity of soil organisms is essential in productive soils and for healthy plants. Their activity is largely based on the presence of organic matter. Soil microorganisms include bacteria, protozoa, actinomycetes, and fungi. They are not only found within compost, but proliferate within soil media. Microorganisms play an important role in organic matter decomposition which, in turn, leads to humus formation and nutrient availability. Microorganisms can also promote root activity as specific fungi work symbiotically with plant roots, assisting them in the extraction of nutrients from soils. Sufficient levels of organic matter also encourage the growth of earthworms, which through tunneling, increase water infiltration and aeration.

### ✓ Suppresses Plant Diseases

Disease incidence on many plants may be influenced by the level and type of organic matter and microorganisms present in soils. Research has shown that increased population of certain microorganisms may suppress specific plant diseases such as pythium and fusarium as well as nematodes. Efforts are being made to optimize the composting process in order to increase the population of these beneficial microbes.

## Additional Benefits of Compost

*Some additional benefits of compost have been identified, and has led to new uses for it. These benefits and uses are described below.*

### ✓ **Binds Contaminants**

Compost has the ability to bind heavy metals and other contaminants, reducing both their leachability and absorption by plants. Therefore, sites contaminated with various pollutants may often be improved by amending the native soil with compost. The same binding affect allows compost to be used as a filter media for storm water treatment and has been shown to minimize leaching of pesticides in soil systems.

### ✓ **Degrades Compounds**

The microbes found in compost are also able to degrade some toxic organic compounds, including petroleum (hydrocarbons). This is one of the reasons why compost is being used in bioremediation of petroleum contaminated soils.

### ✓ **Wetland Restoration**

Compost has also been used for the restoration of native wetlands. Rich in organic matter and microbial population, compost and soil/compost blends can closely simulate the characteristics of wetland soils, thereby encouraging the re-establishment of native plant species.

### ✓ **Erosion Control**

Coarser composts have been used with great success as a mulch for erosion control and have been successfully used on sites where conventional erosion control methods have not performed well. In Europe, fine compost has been mixed with water and sprayed onto slopes to control erosion.

### ✓ **Weed Control**

Immature composts or ones which possess substances detrimental to plant growth (phytotoxins), are also being tested as an alternative to plastic mulches for vegetable and fruit production. While aiding in moisture conservation and moderating soil temperatures, immature composts also act as mild herbicides.

## 2: Compost Use Guidelines

The following Compost Use Guidelines provide detailed instructional data regarding compost use in a specific application. They also include basic specifications for compost products used in that application. The Compost Use Guidelines were developed using documented research from throughout the United States and has been supplemented with practical field experience.

The Compost Use Guidelines (section 13) are condensed versions of more extensive and technically-oriented guidelines published through The Composting Council. A bibliography for each of the guidelines is not included in this Field Guide, but may be obtained from The US Composting Council (see section 14: Literature Cited / References).

### **Important points regarding the Compost Use Guidelines:**

1. The Compost Use Guidelines were written to be generic in terms of compost feedstock. However, comments that are provided specific to particular feedstocks have been included where they are relevant. For instance, specific comments are often made regarding biosolids compost because significant published research is available relevant to its use. Comments should not be considered an endorsement.
2. Each guideline possesses a Preferred Compost Characteristics chart which more specifically describes the desired compost for that particular application. Using a compost that resembles the characteristics outlined on the chart is critical when compost is applied at application rates described in the guidelines. When compost is used at far below recommended application rates, meeting these narrower product specifications is less critical.
3. The term “may vary but must be reported” in the Preferred Compost Characteristics chart found in each guideline refers to your ability to use a compost with a wide range of values relevant to that particular characteristic. For instance, the organic matter content of a compost used as a planting bed amendment may vary widely, but its actual value (e.g., 55%) should be known and reported to you.
4. In the Preferred Compost Characteristics chart found in each guideline, the preferred soluble salt concentration of the soil/compost blend is the maximum suggested soluble salt concentration for the particular group of plants being discussed. However, only lower levels of soluble salts will be tolerated by certain species within each plant group. For instance, the preferred soluble salt concentration in the Compost Use Guideline for vegetable production is 6 dS/m or less. However, although salt-tolerant vegetable species, such as broccoli, can tolerate a salinity level of 6 dS/m, most other vegetable crops cannot. Therefore, it is important to know the soluble salt concentration of your soil/compost blend and the levels that can be tolerated by the crops you intend to grow.

# Compost Use Guidelines

## Landscaping/Turf Management

SOIL AMENDMENT FOR PLANTING BED ESTABLISHMENT

LANDSCAPE MULCH

BACKFILL MIX COMPONENT

TURF ESTABLISHMENT/RENOVATION

UPGRADING MARGINAL SOILS

BLENDED TOPSOIL

## Nursery

GROWING MEDIA COMPONENT

FIELD NURSERY PRODUCTION

NURSERY BED PRODUCTION

## Other

VEGETABLE PRODUCTION

SOIL MULCH FOR EROSION CONTROL

SILVICULTURAL CROP ESTABLISHMENT

SOD PRODUCTION MEDIA

TABLE 2.1 COMPOST USE GUIDELINES - PREFERRED PARAMETERS SUMMARY CHART

# Planting Bed Establishment With Compost

## Soil Amendment for the Establishment of Planting Beds (seed, seedlings, or woody plants)

One of the most popular uses for compost products by horticultural professionals and homeowners is amending planting beds for the establishment of various ornamental plants. Plant growth benefits are typically substantial when using compost because existing soils around homes and commercial sites are typically of poor quality due to the practice of soil stripping before construction. The addition of compost improves the physical structure of the soil, which in turn, promotes root development and heightens a plant's resistance to stress. Compost also adds organic matter, beneficial microbes, and vital nutrients, all of which store and maintain soil fertility.

### Preferred Compost Characteristics\* Planting Bed Establishment

Parameter	Value Range
pH .....	5.5 - 8.0
Moisture Content .....	35% - 55%
Particle Size.....	Pass through 1-inch screen or smaller.
Stability .....	Stable to highly stable, thereby providing nutrients for plant growth
Maturity/Growth .....	Must pass maturity tests or demonstrate its ability to enhance plant growth
Soluble Salt .....	May vary but must be reported; 2.5 dS/m (mmhos/cm) or less is the preferred salt content for the soil/compost blend

### Other Important Characteristics Include:

Nutrient content, water-holding capacity, bulk density, and organic matter content. Their actual values may vary but should be reported. Compost should also be weed free, contain only minimal natural or man-made materials, and meet federal and state health and safety regulations.

\* More in-depth information regarding compost characteristics/parameters can be found in Section 4.

### What has field experience with compost shown us?

- Lower application rates can be used when composts possessing higher organic matter contents are used or where soil quality is moderate. Excessively coarse-textured (sandy) or fine-textured (clay, clay loam) soils will require higher application rates. Soil test results are helpful in establishing application rates.
- Lower compost application rates may be necessary for salt-sensitive crops such as geraniums or where composts with higher salt levels are used. The soluble salt concentration of the amended soil should not exceed approximately 1.25 dS/m where seeds, young seedlings, or salt-sensitive crops are to be planted. Although salt-related injury is not common, thorough watering at the time of planting can further reduce potential problems. Care should be given when using composts possessing a high pH near acid-loving species.

## Instructions for Compost Used as a Soil Amendment for: Planting Bed Establishment

Step 1:



Evenly apply compost at a rate of 135-270 cubic yards per acre (1-2 inch layer) or 3-6 cubic yards per 1,000 square feet. Rates range from 90-400 cubic yard (2/3-3 inch layer) or 2-9 cubic yards per 1,000 square feet. Application rates will vary depending upon soil conditions, climate, compost characteristics, and plant species to be established.<sup>1</sup>

Step 2:



Apply compost by hand, using rakes or shovels, or mechanically with a front-end loader, grading blade, manure spreader, York rake, or other appropriate equipment.

Step 3:



Incorporate the compost to a depth of 6-8 inches by hand or mechanically using a rototiller or other appropriate equipment until the compost is uniformly mixed.

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<sup>1</sup> Compost and fertilizer application rates and pH adjustment requirements are influenced by plant selection, soil/media and site characteristics, compost quality and feedstock, and other factors. For best results, before planting have your compost, soil, and soil/compost blend tested by a reputable laboratory and discuss the results of the tests with a trained professional.

**Step 4:**



Establish a smooth planting bed by raking or dragging the soil surface.

**Step 5:**



Plant transplants or woody plants into the amended soil and firm them in place. Seeds should be applied and lightly incorporated into the soil surface using a rake.

**Step 6:**



Water to assure proper establishment and fertilize as necessary

(see Section 10 Fertilizer Application).<sup>2</sup>

*Photos:* DK Recycling Systems, Inc., Lake Bluff, IL

<sup>2</sup> Compost and fertilizer application rates and pH adjustment requirements are influenced by plant selection, soil/media and site characteristics, compost quality and feedstock, and other factors. For best results, before planting have your compost, soil, and soil/compost blend tested by a reputable laboratory and discuss the results of the tests with a trained agricultural professional.

# Compost as a Landscape Mulch

## Mulch for Garden Beds & Tree and Shrub Planting

Depending on a particular compost's physical properties, it may be a good alternative to standard organic mulch products such as fir, pine, shredded hardwood, cypress bark, pine straw, etc. Yard trimmings and biosolids derived composts are commonly used as mulches by landscape professionals and homeowners. Aside from fulfilling the cultural functions of a mulch, compost also has the ability to provide plant nutrients.

### Preferred Compost Characteristics\*

#### Landscape

Parameter	Value Range
pH.....	5.5 - 8.0
Moisture Content.....	35% - 55%
Particle Size.....	May vary but must be reported; acceptable size is based on customer preference and mulching objectives
Stability .....	Moderately to highly stable, thereby providing nutrients for plant growth
Maturity/Growth .....	Must pass maturity tests or demonstrate its ability to enhance plant growth
Soluble Salt.....	May vary but must be reported

#### Other Important Characteristics Include:

Nutrient content, water-holding capacity, bulk density, and organic matter content. Their actual values may vary but should be reported. Compost must also be weed free, contain only minimal natural or man-made materials, and meet federal and state health and safety regulations.

\* More in-depth information regarding compost characteristics/parameters can be found in Section 4.

#### What has field experience with compost shown us?

- For most, the aesthetic characteristics, i.e., texture and color, or "look" of a mulch is the most important feature. Since this feature is very subjective, it is important to understand customer preferences and regional trends. Typically, aesthetically acceptable mulches are consistent in appearance, contain no man-made materials (e.g., rocks, trash), and have minimal odor.
- Coarser-textured compost mulches may be more effective in reducing weed growth and preventing wind erosion, compared to finer products. The stability of the compost used may vary widely, as everything from fine, well-composted bark products to uncomposted wood chips are used as mulch. Although not verified by research at this time, some believe that the use of unstable or raw wood mulches may compete with plants for nitrogen, potentially causing plant stunting and chlorotic foliage.
- Composts containing high salt levels, high ammonium levels, or other phytotoxins should not be used if crops exist on the site or are to be established on the site soon after application. However, composts possessing these characteristics may be ideal on sites where plant establishment is not planned immediately, or where the mulch is specifically used for weed suppression. Composts possessing a high soluble

salt concentration can be detrimental to salt-sensitive species. Thorough irrigation may help to leach excess salts. Where soluble salt levels of the soil are problematic, repeat applications of biosolids compost should not exceed one inch per year. Care should be given when using composts possessing a high pH near acid-loving species.

# Instructions for Compost Used as a: Landscape Mulch

**Step 1:**



Evenly apply compost at a rate of 135-400 cubic yards per acre (1-3 inch layer) or 3-9 cubic yards per 1,000 square feet. Generally, biosolids composts should not be applied at a depth greater than 2 inches, while most yard trimmings composts can be applied to a depth of 3 inches. Salt sensitive species, however, may react negatively to application rates greater than 1 inch.<sup>3</sup>

**Step 2:**



Compost can be spread from a wheelbarrow or dump truck. For small projects, the use of bagged compost may be more convenient.

**Step 3:**



Carefully apply the compost around the base of trees, shrubs, and other plant materials using a shovel, rake, or blower unit. Avoid placing mulch against the plant's trunk or stem to avoid potential disease and insect damage.

**Step 4:**



Smooth and further distribute compost with a rake or by hand to create a solid

**Step 5:**



For singular trees and shrubs, mulch is typically applied from near its trunk or stem

**Step 6:**



Once applied, the mulch may be watered to help keep it in place. To improve weed

<sup>3</sup> Compost and fertilizer application rates and pH adjustment requirements are influenced by plant selection, soil/media and site characteristics, compost quality and feedstock, and other factors. For best results, before planting have your compost, soil, and soil/compost blend tested by a reputable laboratory and discuss the results of the tests with a trained agricultural professional.

mulch layer.

to the drip line. A soil rim or berm may be formed around the tree trunk before mulching to help capture water.

control, plastic mulches, landscape fabric, newspaper, or herbicides may be applied prior to mulching.

The use of stable, nutrient rich compost may reduce or eliminate the need for fertilizer application during the first twelve months following compost application.<sup>‡</sup> This effect may occur in annual beds after one application, whereas the effects may only occur after repeat application for woody, deep rooting plants. Additional nutrients and nitrogen, in particular, may be necessary where less stable or woody composts are used. On annual beds, at the end of the season, the compost mulch layer can be incorporated into the bed. In perennial beds or around trees and shrubs, where the compost mulch has not been incorporated, use a rake or shovel to break up the existing layer of mulch, ensuring that a crust layer has not formed before applying new mulch.

*Photos:* Ronald Alexander, Cary, NC

# Compost as a Backfill Mix Component

## Component to Backfill Mixes for the Establishment or Planting of Various Trees and Shrubs

The use of compost and other organic amendments as a component to backfill mixes is a popular practice even though there is little quantifiable data showing its long-term benefit. Research has shown, however, that early improved root growth (proliferation) can be attributed to backfill amendment. Some researchers believe that juvenile plants benefit from backfill amendment more than mature plants. Other researchers and industry professionals believe that amending the backfill mix encourages plant establishment and survivability, and may even reduce soil-borne disease damage. All agree that plants transplanted in poor soils benefit from using quality organic amendments.

### Preferred Compost Characteristics\* Backfill Mix Component

Parameter	Value Range
pH .....	5.5 - 8.0
Moisture Content .....	35% - 55%
Particle Size.....	Pass through 1-inch screen or smaller
Stability .....	Stable to highly stable, thereby providing nutrients for plant growth
Maturity/Growth .....	Must pass maturity tests or demonstrate its ability to enhance plant growth
Soluble Salt .....	May vary but must be reported; 3.0 dS/m (mmhos/cm) or less is the preferred salt content for the soil/compost blend

### Other Important Characteristics Include:

Nutrient content, water-holding capacity, bulk density, and organic matter content. Their actual values may vary but should be reported. Compost should also be weed free, contain only minimal natural or man-made materials, and meet federal and state health and safety regulations.

\* More in-depth information regarding compost characteristics/parameters can be found in Section 4.

### What has field experience with compost shown us?

- Nutrient, and specifically, nitrogen-rich composts are preferred, while the use of unstable or immature compost is discouraged. Care should be given when using composts possessing a high pH near acid-loving species.
- Although soluble salt related plant injury should not be a significant problem with most woody ornamentals, or in most soil conditions, care should be given when bare root or salt-sensitive species such as ericaceous crops (e.g., rhododendrons, azaleas), specific conifers (e.g., narrowleaf species), and dogwoods are planted. The soluble salt concentration of the amended soil must be compatible with the plant's maximum tolerance levels.

## Instructions for Compost Used as a: Backfill Mix Component

### Step 1:



Compost can be used at an inclusion rate of 25%-50%, blended with native soils, with the most common inclusion rate being 33%.<sup>4</sup> Inclusion rates will vary depending upon soil conditions, climate, compost characteristics, and plant species to be established.

### Step 2:



Dig a planting hole slightly shallower than the rootball and two to four times its width. In dense or poor draining soils, the planting hole can be dug only 2/3 the depth of the rootball. The sides of the planting hole should be "roughed up" with a shovel to encourage root penetration.

### Step 3:



Place the plant in the planting hole and blend the stockpiled soil with the compost until uniform.

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<sup>4</sup> Compost and fertilizer application rates and pH adjustment requirements are influenced by plant selection, soil/media and site characteristics, compost quality and feedstock, and other factors. For best results, before planting have your compost, soil, and soil/compost blend tested by a reputable laboratory and discuss the results of the tests with a trained agricultural professional.

#### Step 4:



Apply the amended soil around the rootball, firming it occasionally to remove air pockets and to assure a firm footing. Tamping or watering may be used to firm the plant.

#### Step 5:



Larger trees should be anchored or supported.

#### Step 6:



Construct a soil berm circling the root ball to help capture and hold water. Water the plant well, then mulch around the plant and bermed area. Irrigate with one-inch of water per week until established.

Fertilizer and pH adjusting agents (e.g., lime and sulfur) should be applied after planting, if necessary. The use of stable, nutrient rich composts may eliminate initial fertilizer application. If fertilizer application is made at planting, only slow-release forms should be used. Where salt-sensitive ornamental crops are planted, apply half the recommended fertilizer rate.<sup>5</sup>

*Photos: Ronald Alexander, Cary, NC*

<sup>5</sup> Compost and fertilizer application rates and pH adjustment requirements are influenced by plant selection, soil/media and site characteristics, compost quality and feedstock, and other factors. For best results, before planting have your compost, soil, and soil/compost blend tested by a reputable laboratory and discuss the results of the tests with a trained agricultural professional.

# Turf Establishment With Compost

## Soil Amendment for the Establishment of Turfgrass (seed, sod, or sprig)

Composts of various feedstocks have been used successfully in turf establishment and renovation. Soils that are low in organic matter, or possess low nutrient or water holding capacity will greatly benefit from the addition of compost. Recent research has even shown that the use of quality compost, at proper rates, can degrade commonly applied turf pesticides over time, making them less likely to impact water quality. Quality compost may also suppress specific soil-borne diseases and plant pathogens.

### Preferred Compost Characteristics\* Turf Establishment

Parameter	Value Range
pH .....	5.5 - 8.0
Moisture Content .....	35% - 55%
Particle Size.....	Pass through 1-inch screen or smaller
Stability .....	Stable to highly stable, thereby providing nutrients for plant growth
Maturity/Growth .....	Must pass maturity tests or demonstrate its ability to enhance plant growth
Soluble Salt .....	May vary but must be reported; 4 dS/m (mmhos/cm) or less is the preferred salt content for the soil/compost blend

### Other Important Characteristics Include:

Nutrient content, water-holding capacity, bulk density, and organic matter content. Their actual values may vary but should be reported. Compost should also be weed free, contain only minimal natural or man-made materials, and meet federal and state health and safety standards.

\* More in-depth information regarding compost characteristics parameters can be found in Section 4.

### What has field experience with compost shown us?

- Lower application rates can be used when composts possessing higher organic matter contents are used or where soil quality is moderate. Excessively coarse-textured (sandy) or fine-textured (clay, clay loam) soils will require higher application rates. Soil test results are helpful in establishing application rates.
- The use of coarse composts in turf establishment may be problematic if substantial amounts of coarse particles are left on the soil surface; as they will impede seed-to-soil contact. Acceptable compost particle size depends on the quality of turf to be established, (e.g., utility vs. sports turf).

## Instructions for Compost Used as a Soil Amendment for: Turf Establishment

### Step 1:



Evenly apply compost at a rate of 135-270 cubic yards per acre (1-2 inch layer) or 3-6 cubic yards per 1,000 square feet.<sup>6</sup> Application rates will vary depending upon soil conditions, climate, compost characteristics, and turf species to be established.

### Step 2:



Apply compost with a front-end loader, grading blade, manure spreader, York rake, or other appropriate equipment.

### Step 3:



Incorporate the compost to a depth of 5-7 inches, resulting in a compost inclusion rate of 20%-30% by volume, using a rototiller, rotovator, or disc until the compost is uniformly mixed. Compost application rates should be adjusted depending upon the anticipated tillage depth.

Pre-plant fertilizers and pH adjusting agents (e.g., lime and sulfur) may be applied before compost incorporation, as necessary. The use of stable, nutrient rich composts may reduce or eliminate pre-plant fertilizer application.

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<sup>6</sup> Compost and fertilizer application rates and pH adjustment requirements are influenced by plant selection, soil/media and site characteristics, compost quality and feedstock, and other factors. For best results, before planting have your compost, soil, and soil/compost blend tested by a reputable laboratory and discuss the results of the tests with a trained agricultural professional.

**Step 4:**



Establish a smooth seed bed by raking or dragging the soil surface; roll if necessary. Rake to remove any clumps of soil/vegetation, larger rocks, or debris.

**Step 5:**



Seed may be applied using a hydroseeder, culti-pack seeder, or it may be broadcast over the soil surface, then lightly incorporated using a drag mat or rake.

Vegetation may also be established by sprigging into or sodding onto the modified soil, followed by rolling as necessary.

Apply a starter fertilizer as necessary and water to assure proper turf establishment.<sup>7</sup>



*Photos:* Dr. William Mitchell, West Lebanon, NH

<sup>7</sup> Compost and fertilizer application rates and pH adjustment requirements are influenced by plant selection, soil/media and site characteristics, compost quality and feedstock, and other factors. For best results, before planting have your compost, soil, and soil/compost blend tested by a reputable laboratory and discuss the results of the tests with a trained agricultural professional.

# Upgrading Marginal Soils with Compost

## Upgrading Compacted, Disturbed, Unirrigated, Low-Maintenance Sites, or Marginal Soils for the Establishment of Various Crop Species

In all areas of the country, there are sites where the soils are of such poor quality that it is extremely difficult to establish most plant or crop species. Some sites may be void of nutrition or organic matter, compacted, lacking any actual topsoil, or simply under-maintained. On these sites, practical experience and research has shown that the addition of quality organic matter, in sufficient quantities, can make marginal soils productive. The addition of compost to such soils supplies both beneficial microbes and nutrition, allowing for an on-going nutrient cycle to be established.

### Preferred Compost Characteristics\* Upgrading Marginal Soils

Parameter	Value Range
pH.....	5.5 - 8.0
Moisture Content .....	35% - 55%
Particle Size.....	May vary but must be reported
Stability .....	Moderately to highly stable. Less stable composts may be used if planting is delayed
Maturity/Growth .....	Must pass maturity tests or demonstrate its ability to enhance plant growth
Soluble Salt .....	May vary but must be reported; will be highly dependent upon the crop to be established

### Other Important Characteristics Include:

Nutrient content, water-holding capacity, bulk density, and organic matter content. Their actual values may vary but should be reported. Compost should also be weed free, contain only minimal natural or man-made materials, and meet federal and state health and safety standards.

\* More in-depth information regarding compost characteristics/parameters can be found in Section 4.

### What has field experience with compost shown us?

- Lower application rates can be used when composts possessing higher organic matter contents are used or where soil quality is moderate. Excessively coarse-textured (sandy) or fine-textured (clay, clay loam) soils will require higher application rates. Soil test results are helpful in establishing application rates.
- Various amounts of compost have been used successfully in upgrading marginal soils. Research has shown that inclusion rates as low as 4%-17% have been beneficial in specific circumstances, when applied along with fertilizer for 2-3 consecutive years. Marginal soils have even been transformed into productive agricultural soils using compost. Some sites may benefit from deep cultivation prior to compost application.

- Since marginal sites may possess a very high or very low pH, pH adjustment must be carefully considered along with compost addition. In soils possessing a pH of 7.0 or higher, where compost having an elevated ammonium level (has an ammonia scent) is used, delay seeding or planting for 1-2 weeks. This is because ammonium will be converted to ammonia under these circumstances and ammonia can be toxic to young plants and seedlings.

## Instructions for Compost Used as a Soil Amendment for: Upgrading Marginal Soils

### Step 1:



Evenly apply compost at a rate of 135-400 cubic yards per acre (1-3 inch layer).<sup>8</sup> Application rate will vary depending upon soil conditions, climate, compost characteristics, and crop species to be established.

### Step 2:



Apply compost with a front-end loader, bulldozer, grading blade, manure spreader, York rake, blower, or other appropriate equipment.

### Step 3:



Incorporate compost to a depth of approximately 6 inches, resulting in a compost inclusion rate of 20%-50% by volume, using a rototiller, rotovator, plow, or disc until the compost is uniformly mixed. Compost application rates should be altered depending on the anticipated tillage depth.

Pre-plant fertilizers or pH adjusting agents (e.g., lime or sulfur) may be applied before compost incorporation, as necessary. The use of stable, nutrient rich composts may reduce or eliminate pre-plant fertilization.

<sup>8</sup> Compost and fertilizer application rates and pH adjustment requirements are influenced by plant selection, soil/media and site characteristics, compost quality and feedstock, and other factors. For best results, before planting have your compost, soil, and soil/compost blend tested by a reputable laboratory and discuss the results of the tests with a trained agricultural professional.

**Step 4:**



Establish an appropriate seed or planting bed by raking or dragging the amended soil surface, as necessary.

**Step 5:**



Seed may be applied using a hydroseeder, culti-pack seeder, or it may be broadcast over the soil surface, then lightly incorporated using a drag mat or rake. Turf sprigs or sod, other ornamental and forest species, and agricultural crops may also be planted, based on the intended use of the soil.

**Step 6:**



Apply a starter fertilizer as necessary and water to assure proper crop establishment.<sup>9</sup>

*Photos:* Compost America, Doylestown, PA

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<sup>9</sup> Compost and fertilizer application rates and pH adjustment requirements are influenced by plant selection, soil/media and site characteristics, compost quality and feedstock, and other factors. For best results, before planting have your compost, soil, and soil/compost blend tested by a reputable laboratory and discuss the results of the tests with a trained agricultural professional.

# Compost as a Blended Topsoil Component

## Component to Blended or Manufactured Topsoil for the Establishment of Various Crops

The production and sale of blended or manufactured topsoils is on the rise as more people are finding it difficult to obtain quality topsoil. Many buyers realize that much of the material sold as topsoil is actually subsoil or sand that is deficient nutritionally, organically, and structurally. Some buyers prefer a soil rich in organic matter for specific planting projects, or desire a soil darker in color. For these reasons, more topsoil dealers are using compost to create organic soil blends, while others are creating products equivalent or superior to native topsoil using subsoil or sand and compost.

### Preferred Compost Characteristics\* Blended Topsoil Component

Parameter	Value Range
pH .....	5.5 - 8.0
Moisture Content .....	35% - 55%
Particle Size.....	May vary but must be reported; particle size is based on the producers ability to screen and specific use of the soil blend
Stability .....	Moderately to highly stable. Less stable composts may be used if at low inclusion rates or if the topsoil blend is aged
Maturity/Growth .....	Must pass maturity tests or demonstrate its ability to enhance plant growth
Soluble Salt .....	May vary but must be reported; 6 dS/m (mmhos/cm) or less is the preferred salt content for the media blend

### Other Important Characteristics Include:

Nutrient content, water-holding capacity, bulk density, and organic matter content. Their actual values may vary but should be reported. Compost should also be weed free, contain only minimal natural or man-made materials, and meet federal and state health and safety regulations.

\* More in-depth information regarding compost characteristics/parameters can be found in Section 4.

### What has field experience with compost shown us?

- Lower application rates can be used when composts possessing higher organic matter content are used or where soil quality is moderate. Excessively coarse-textured (sandy) or fine-textured (clay, clay loam) soils will require higher application rates. Soil test results are helpful in establishing application rates.
- Different types of soils will benefit from different types of compost. Therefore, a variety of compost types are used in topsoil blending in order to match the varying soil characteristics. Also, since finer-textured soils, those containing more silt and clay, generally possess a higher cation

exchange and buffering capacity, they can better accept composts with a wide range of characteristics. Although not typically a concern, composts containing large quantities of very fine particles (less than one millimeter) may reduce soil porosity.

- Salt related plant injury is unlikely in most compost amended soils, but it is important to understand that all crops have maximum salt tolerance levels. Maximum salt tolerance for most vegetables and fruits is 6 dS/m, 4 dS/m for most turf species, and 3 dS/m for many ornamental species. Within all of these crop groups, there are salt sensitive species that may only tolerate 1 dS/m. Therefore, when blending custom soil blends, it is helpful to test all components for soluble salt concentration, then test the finished blend. The pH of the finished blend must also be compatible with the plant species to be established.

## Instructions for Compost Used as a: Blended Topsoil Component

### Step 1:



Determine blended topsoil components and inclusion rates. A common soil test or a more in-depth physical/chemical analysis of the components may be beneficial.

Aside from the compost and soil, peat, bark, sand, and other materials may be used as topsoil components. Product combinations are based on their function within the blend, such as water and nutrient retention, pH, aeration and drainage. A compost inclusion rate of 20%-30% is recommended, although extremely poor soils, subsoils, or soil-like aggregate by-products may benefit from higher rates. Inclusion rates of 10%-50% compost are commonly used in the industry.<sup>10</sup>

### Step 2:



Mix the soil blend components using rotating drum-type mixer, front-end loader, auger, or soil shredder. Various other amendments or additives may also be added at the time of blending. Where soil shredders are used, pre-mixing the blend components to some degree before shredding will allow for more thorough mixing.

### Step 3:



Screen the soil blend, where appropriate, to meet customer requirements using standard screening units or a soil shredder.

<sup>10</sup> Compost and fertilizer application rates and pH adjustment requirements are influenced by plant selection, soil/media and site characteristics, compost quality and feedstock, and other factors. For best results, before planting have your compost, soil, and soil/compost blend tested by a reputable laboratory and discuss the results of the tests with a trained agricultural professional.

**Step 4:**



Stockpile or load the finished product.

*Photos:* Kurtz Bros. Compost Services, Inc., Akron, OH and E&A Environmental Consultants, Inc., Cary, NC

# Compost as a Growing Media Component

## Component of Growing Media (horticultural substrate) for the Production of Various Containerized Crops

The use of compost as a commercial growing media component is one of the most researched areas of compost utilization. Aside from industry staples such as composted bark products, biosolids-based composts have probably been the most studied and used composts on a commercial basis in the United States. The use of compost as a growing media component has, in general, been shown to reduce fertilizer and liming requirements, improve crop vigor, increase the number of flowers per plant, reduce the need for fungicidal drenches, and improve root growth.

Compost is usually used as part of the organic fraction of growing media; however, products possessing a coarser fraction will also improve media drainage.

### Preferred Compost Characteristics\* Growing Media Component

Parameter	Value Range
pH .....	5.5 - 8.0
Moisture Content .....	35% - 55%
Particle Size.....	Pass through 1/2-inch screen or smaller, acceptable particle size is based on pot/container size
Stability .....	Stable to highly stable, thereby providing nutrients for plant growth and assuring no substantial shrinkage
Maturity/Growth .....	Must pass maturity tests or demonstrate its ability to enhance seed germination and plant growth
Soluble Salt .....	May vary but must be reported; 3 dS/m (mmhos/cm) or less is the preferred salt content for the media blend

### Other Important Characteristics Include:

Nutrient content, water-holding capacity, bulk density, and organic matter content. Actual values may vary but should be reported. Compost should also be weed free, contain only minimal natural or man-made materials, and meet federal and state health and safety standards.

\* More in-depth information regarding compost characteristics/parameters can be found in Section 4.

### What has field experience with compost shown us?

- Due to the cash value of ornamental crops, small test plots should be established before full-scale compost usage is initiated. The inclusion rate of compost in a growing media is based largely upon compost characteristics and the crop to be grown. Less compost should be used on more sensitive crops, such as bedding plants.

- Compost used in nursery applications must be consistent, stable, and low in salts. The preferred soluble salt concentration of the finished media blend should be less than 3.0 dS/m (mmhos/cm). The majority of greenhouse and container crops can be grown in a media possessing a soluble salt level of 2.5 dS/m or under. Elevated soluble salts can be reduced through leaching and dilution. Since the media pH must be adjusted to meet crop requirements, typically 6.2-6.8, or 5.0-5.8 for acid tolerant species, composts produced using liming agents (e.g., hydrated lime, ash) should only be used with specific crops. It is important to know the calcium level of the compost due to its effect on buffering pH and binding phosphorous. Although rarely a concern, the content of trace metals, especially ones known to be phytotoxic, such as boron and manganese, should also be low.
- Research and field experience has shown that the typical factors limiting the inclusion rate of compost are its pH, soluble salt concentration, maturity and stability levels, and particle size. Research on the use of MSW and yard trimmings-based composts as a potting media component is currently limited.

## Instructions for Compost Used as a: Growing Media Component

### Step 1:



Determine media components and inclusion rates.

Aside from compost, peat, bark and sawdust, vermiculite, perlite, styrofoam, sand, and other materials may be used as components. Product combinations are based on their function within the media, such as water retention, aeration, nutrient retention, pH, etc. MSW compost has been used successfully at inclusion rates of 20%-50%, biosolids composts at 20%-33%, and yard trimmings composts at 33%-47%.<sup>11</sup> Successful crop production has also been achieved using rates greater than those specified.

### Step 2:

Blend the media components using a rotating drum-type mixer, flail-type manure spreader, front-end loader, or by hand. Do not use a mixer that tends to grind the compost, especially those composts containing wood or brush remnants. This may cause the compost to re-heat. Do not add water to the media before blending, as it may increase the physical breakdown of the wood remnants. pH adjusting agents, surfactants, and fertilizer may be added before blending.

### Step 3:



Fill containers/pots with growing media by hand or mechanically with a potting machine.

<sup>11</sup> Compost and fertilizer application rates and pH adjustment requirements are influenced by plant selection, soil/media and site characteristics, compost quality and feedstock, and other factors. For best results, before planting have your compost, soil, and soil/compost blend tested by a reputable laboratory and discuss the results of the tests with a trained agricultural professional.

**Step 4:** Plant the individual plant, firming around its base to provide physical support.

**Step 5:**



Fertilizer may be applied after blending, in a topdressing application, if not applied earlier. If using a stable biosolids or manure compost, nitrogen fertilizers should not be applied during the first two to three weeks of plant growth. Stable composts produced from feedstocks other than biosolids or manure, typically need no nitrogen fertilizer during the first week or two following potting. Most composts will supply adequate amounts of micronutrients when used at recommended rates. Media containing composts that are less stable, regardless of feedstock, will need supplemental nutrition, especially nitrogen and phosphorus, immediately following potting.

**Step 6:**



Thoroughly water the plants soon after planting. Fungicidal drenches can often be eliminated when compost is used. Water and fertilize as necessary to assure proper growth. Supplemental fertilizer applications may be applied through the irrigation system or as a topdress using slow-release fertilizers.<sup>12</sup>

*Photos: E&A Environmental Consultants, Inc., Cary, NC*

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<sup>12</sup> Compost and fertilizer application rates and pH adjustment requirements are influenced by plant selection, soil/media and site characteristics, compost quality and feedstock, and other factors. For best results, before planting have your compost, soil, and soil/compost blend tested by a reputable laboratory and discuss the results of the tests with a trained agricultural professional.

# Field Nursery Production With Compost

## Soil Amendment for the Field Production of Various Ornamental Crops

Since larger trees and shrubs are frequently used by the landscape industry, nurserymen undertake the lengthy process of field production. The process allows a younger or smaller plant to be grown until it reaches the proper size. Often, nursery soils are enhanced over time through the growth and incorporation of cover crops. However, in the short-term, this method allows for only a modest addition of organic matter and can be employed only if nursery acreage is taken out of production. Alternately, compost can be applied following harvest or before planting making it virtually unnecessary to take fields out of production. Research has shown that by amending nursery fields with compost, higher quality plants can often be produced in a shorter length of time.

### Preferred Compost Characteristics\*

#### Field Nursery Production

Parameter	Value Range
pH .....	5.5 - 8.0
Moisture Content .....	35% - 55%
Particle Size .....	Pass through 1-inch screen or smaller.
Stability .....	Stable to highly stable. Less stable composts may be used if planting is delayed
Maturity/Growth .....	Must pass maturity tests or demonstrate its ability to enhance plant growth
Soluble Salt .....	May vary but must be reported; 3 dS/m (mmhos/cm) or less is the preferred salt content for the soil/compost blend

#### Other Important Characteristics Include:

Nutrient content, water-holding capacity, bulk density, and organic matter content. Their actual values may vary but should be reported. Compost should also be weed free, contain only minimal natural or man-made materials, and meet federal and state health and safety standards.

\* More in-depth information regarding compost characteristics/parameters can be found in Section 4.

#### What has field experience with compost shown us?

- Only stable compost should be used if immediate planting is to follow compost incorporation. Less stable composts have been used successfully where aging in the field was allowed before planting. Although salt-related damage is unlikely, lower compost application rates are recommended for salt-sensitive species. Higher application rates are possible where early incorporation or leaching practices are utilized.
- Lime dewatered biosolids compost should not be used on salt sensitive crops, such as dogwoods, specific conifers (e.g., narrowleaf evergreens) and ericaceous crops. Lime dewatered biosolids should only be used to grow crops with a preferred pH range of 6.5 and above, or if the native soil pH is very low (pH of 5.0 or below) and in need of upward adjustment. Maximum salt tolerance levels are crop and species dependent. Salt damage is not likely to occur on most woody trees and shrubs, however, salt sensitive species should be closely monitored to avoid potential

damage. Salt damage to crops is more likely to occur in sandy soils with a low organic matter content and low cation exchange capacity. Young seedlings/liners and bare root plants are also more susceptible to salts, ammonia, and other phytotoxic compounds. Delay planting salt-sensitive species until rainfall or irrigation can thoroughly leach the soil and reduce the salt concentration to acceptable levels. Deeper incorporation of the compost may be used to reduce soluble salt concentrations through dilution.

# Instructions for Compost Used as a Soil Amendment for: Field Nursery Production

## Step 1:



Evenly apply compost at a rate of 135-270 cubic yards per acre (1-2 inch layer) or 50-100 tons per acre over the entire field.<sup>13</sup> Successful application rates have ranged from approximately 25-250 tons per acre (1/2-4 inch layer). Biosolids compost application should not exceed 100 tons per acre (1-2 inch layer), while yard trimmings compost has been applied at rates as high as 250 tons per acre (2-4 inch layer). Higher rates have been applied in split applications, for instance 100 tons two years in a row, to condition poor soils before planting a new field. Limited research has been completed on MSW compost. However, application rates of 50-100 tons per acre appear to be acceptable for many plants.

Deep tillage and rough discing of the field soil prior to initial compost application is recommended.

## Step 2:



Apply compost throughout the field or in the row where the plants are to be established using a manure spreader, grading blade, York rake, or other appropriate equipment. If applied only in the planting rows (band applications), the volume of compost needed to treat each acre will be substantially reduced (refer to Section 8.0, *Compost Use Estimator*).

**Step 3:** Incorporate compost to a depth of 6-10 inches, with deeper tillage necessary for high application rates, using a plow, disc, or other appropriate equipment. For application rates greater than 100 tons per acre, an incorporation depth of 12-14 inches is suggested.

<sup>13</sup> Compost and fertilizer application rates and pH adjustment requirements are influenced by plant selection, soil/media and site characteristics, compost quality and feedstock, and other factors. For best results, before planting have your compost, soil, and soil/compost blend tested by a reputable laboratory and discuss the results of the tests with a trained agricultural professional.

**Step 4:**



Prepare soil for planting and establish the planting rows.

**Step 5:**



Plant young trees and shrubs in the planting row following normal planting procedures.

**Step 6:** Fertilize and water as necessary to assure proper growth. With the use of stable biosolids composts, additional fertilizer application should not be required during the first year of production. Other nutrient rich composts may yield the same results. Only apply half the recommended fertilizer rate if growing salt-sensitive crops.<sup>14</sup>

*Photos: Klyn Nurseries, Perry, OH*

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<sup>14</sup> Compost and fertilizer application rates and pH adjustment requirements are influenced by plant selection, soil/media and site characteristics, compost quality and feedstock, and other factors. For best results, before planting have your compost, soil, and soil/compost blend tested by a reputable laboratory and discuss the results of the tests with a trained agricultural professional.

# Nursery Bed Production With Compost

## Soil Amendment for the Production of Various Ornamental Crops in Raised or Ground Nursery Beds

Compost can be used in the production of various shrubs, herbaceous perennials, and ornamental grasses in nursery beds. Whether production takes place in a raised bed or ground (liner) bed, research and field experience have shown that amending the bed with compost results in higher quality plants and often in a shorter period of time. Typically, the plants possess an enhanced root system and more intense color. Current use of compost in this application is limited, but it is increasing.

### Preferred Compost Characteristics\* Nursery Bed Production

Parameter	Value Range
pH .....	5.5 - 8.0
Moisture Content .....	35% - 55%
Particle Size.....	Pass through 1-inch screen or smaller
Stability .....	Stable to highly stable, thereby providing nutrients for plant growth
Maturity/Growth .....	Must pass maturity tests or demonstrate its ability to enhance plant growth
Soluble Salt .....	May vary but must be reported; 3 dS/m (mmhos/cm) or less is the preferred salt content for the soil/compost blend

### Other Important Characteristics Include:

Nutrient content, water-holding capacity, bulk density, and organic matter content. Their actual values may vary but should be reported. Compost must be weed free, contain only minimal natural or man-made materials, and meet federal and state health and safety standards.

\* More in-depth information regarding compost characteristics/parameters can be found in Section 4.

### What has field experience with compost shown us?

- Although salt-related damage is not likely, lower compost application rates are recommended for salt-sensitive species. Higher compost application rates are possible where early incorporation or leaching practices are utilized. Higher compost application rates have been used successfully in the Northwestern region of the United States. This is likely due to the high rainfall and heavy soils being able to compensate for any excess soluble salts. Only light applications of biosolids compost should be used in the production of conifer seedlings.
- Only stable composts should be used if immediate planting is to follow compost incorporation. Lime dewatered biosolids compost should only be used to grow crops with a preferred pH range of 6.5 and above, or if the inherent soil pH is very low (pH of 5.0 or below) and in need of upward adjustment. Lime dewatered biosolids compost should not be used on salt sensitive crops, such as dogwoods, specific conifers (e.g., narrowleaf evergreens) and ericaceous crops. A soluble salt concentration of 3 dS/m (mmhos/cm) or less for the compost amended soil is preferred where transplants or seedlings/liners are to be established, and approximately half that level where seeds are to be planted.

Maximum salt tolerance levels are species dependent. Salt damage is not likely to occur on most woody trees and shrubs, however, salt sensitive species should be closely monitored to avoid potential damage. Young seedlings, liners, bare root plants, and seeds are more susceptible to salts, ammonia, and other phytotoxic compounds. Delay planting salt-sensitive species until rainfall or irrigation can thoroughly leach the soil and reduce the salt content to acceptable levels.

## Instructions for Compost Used as a Soil Amendment for: Nursery Bed Production

### Step 1:



Evenly apply compost at a rate of 135-270 cubic yards per acre (1-2 inch layer) or 50-100 tons per acre over the entire field.<sup>15</sup> Successful application rates have ranged from approximately 30-200 tons per acre (1/2-3 inch layer). Biosolids compost application should not exceed 100 tons per acre, while yard trimmings compost has been applied at rates as high as 200 tons per acre. Little experience exists at this time with the use of MSW compost in nursery bed production.

**Step 2:** Apply compost throughout the field or in the row where the nursery bed will be created using grading blade, manure spreader, York rake, or other appropriate equipment. If applied only in the bed area, the volume of compost needed to treat each acre will be substantially reduced (refer to Section 8.0, *Compost Use Estimator*).

**Step 3:** Incorporate the compost to a depth of 6-10 inches, with deeper tillage necessary for high application rates, using a plow, disc, or other appropriate equipment.

Incorporation of biosolids compost into conifer seed beds prior to sowing may result in reduced seedling populations. However, applying stable and mature biosolids compost at a 1 inch rate as a mulch after the seedlings are 2-3 inches tall has been successfully demonstrated. This technique has been effective as a means to reduce moisture loss, supply slow-release nutrients, and moderate soil temperatures, which tends to cause heaving of seedling crops during winter months. Once the young plants are harvested, typically in 1-3 years, the compost mulch is incorporated into the soil, and new beds are established and mulched again.

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<sup>15</sup> Compost and fertilizer application rates and pH adjustment requirements are influenced by plant selection, soil/media and site characteristics, compost quality and feedstock, and other factors. For best results, before planting have your compost, soil, and soil/compost blend tested by a reputable laboratory and discuss the results of the tests with a trained agricultural professional.

**Step 4:**



Raised beds may be established using a bedding machine, if desired.

**Step 5:**



Plant seedlings in the bed following normal planting procedures and mulch. If seeds are planted, do not mulch until seedlings are 2-3 inches tall.

**Step 6:**



Fertilize and water as necessary to assure proper growth. The use of stable, nutrient rich composts will likely reduce fertilizer requirements during the first year of production, while the use of less nutrient rich, or less stable composts will require greater rates. Only apply half the recommended fertilizer rate if growing salt-sensitive crops.<sup>16</sup>

*Photos:* Klyn Nurseries, Perry, OH and BFI Organics, Oberlin, OH.

<sup>16</sup> Compost and fertilizer application rates and pH adjustment requirements are influenced by plant selection, soil/media and site characteristics, compost quality and feedstock, and other factors. For best results, before planting have your compost, soil, and soil/compost blend tested by a reputable laboratory and discuss the results of the tests with a trained agricultural professional.

# Vegetable Production With Compost

## Soil Amendment for the Production of Various Vegetable Crops (seed and transplant)

For thousands of years, agricultural by-products have been used to enhance soils for crop production. More recently, a greater emphasis has been placed on the use of composted agricultural and municipal by-products by farmers. Both research and field experience have shown that the use of compost can improve irrigation and fertilizer efficiency, and may suppress soil-borne diseases and nematodes; often reducing system inputs while improving yield.

### Preferred Compost Characteristics\* Vegetable Production

Parameter	Value Range
pH .....	5.5 - 8.0
Moisture Content .....	35% - 55%
Particle Size.....	Pass through 1-inch screen or smaller
Stability .....	Stable to highly stable. Less stable composts may be used if planting is delayed
Maturity/Growth .....	Must pass maturity tests or demonstrate its ability to enhance plant growth
Soluble Salt .....	May vary but must be reported; 6 dS/m (mmhos/cm) or less is the preferred salt content for the soil/compost blend

### Other Important Characteristics Include:

Nutrient content, water-holding capacity, bulk density, and organic matter content. Their actual values may vary but should be reported. Compost should also be weed free, contain only minimal natural or man-made materials, and meet federal and state health and safety standards.

\* More in-depth information regarding compost characteristics/parameters can be found in Section 4.

### What has field experience with compost shown us?

- A wide range of compost application rates have been used by farmers growing vegetables. Rates as low as 1-2 tons per acre are common practice primarily because of economic factors. Although rates as high as 50-60 dry tons per acre can be effective, such high rates are rarely used. Soil test results are helpful in establishing compost application rates.
- Although salt damage to crops is not common in most agricultural soils, it is more prone to occur in arid zones and where sandy soils exist. To avoid crop damage and yield reduction, the soluble salt concentration of the amended soil must be compatible with crop requirements. Salinity-effect thresholds have been established for various vegetable crops and information regarding them can be obtained from agricultural specialists and literature. For added protection, water the crop thoroughly after planting and/or apply compost to the field several weeks before planting to allow natural rainfall to leach out excess salts. Care should be given in areas where salt build-up problems are common, especially where plastic mulches are utilized.

- It is feasible to use less stable or less mature compost products in vegetable production, as long as they are incorporated sufficiently in advance of planting. For instance, in Florida's sandy soils and warm climate, an unstable MSW compost took approximately 100 days to field stabilize. Composts that are lower than the specified moisture content (35%-55%) will be easier to spread in certain types of equipment. However, they will also likely generate significant dust. The application of biosolids or MSW compost on edible crops may be restricted by some states and usage must be consistent with US EPA Part 503 regulations.

# Instructions for Compost Used as a Soil Amendment for: Vegetable Production

## Step 1:



Evenly apply compost at a rate of 10-60 dry tons per acre.<sup>17</sup> Application rates will vary depending upon soil conditions, compost characteristics, and crop species.

## Step 2:

Compost can be applied throughout the field or in the row where raised beds or planting rows will be created. Apply compost with a front-end loader, grading blade, manure spreader, York rake, or other appropriate equipment.

## Step 3:



Incorporate the compost to an approximate depth of 6 inches using a chisel plow, disc, or other appropriate equipment.

Pre-plant fertilizers and pH adjusting agents (e.g., lime and sulfur) may be applied before incorporation, as necessary. The use of stable, nutrient rich composts may reduce or eliminate pre-plant fertilizer application.<sup>17</sup>

## Step 4:



Raised beds may be established using a bedding machine, then mulched using

## Step 5:



Plant seed or transplants through the mulch layer by hand or mechanically, then

## Step 6:



Fertilize and water as necessary to assure proper growth.

<sup>17</sup> Compost and fertilizer application rates and pH adjustment requirements are influenced by plant selection, soil/media and site characteristics, compost quality and feedstock, and other factors. For best results, before planting have your compost, soil, and soil/compost blend tested by a reputable laboratory and discuss the results of the tests with a trained agricultural professional.

organic materials or covered with a plastic mulch, for weed control.

If drip irrigation is used, the trickle tubing should be laid before the mulch is applied. Fumigation of the beds is done in conjunction with laying the plastic, although it may be reduced or eliminated by using specific compost products.

water thoroughly.

*Photos:* E&A Environmental Consultants, Inc., Cary, NC and University of Florida, IFAS, SFREC, Immokalee, FL

# Compost as a Soil Mulch For Erosion Control

## Soil Mulch or Cover for Erosion Control

Relatively new and promising application for compost is as an erosion control material. Research has even shown that compost can often outperform conventional slope stabilization methods. European gardeners have successfully been using compost to stabilize steep slopes in vineyards for many years. Research has further shown that stable, relatively dry yard trimmings compost is capable of filtering and binding pollutants from storm water.

### Preferred Compost Characteristics\* Erosion Control Material

Parameter	Value Range
pH .....	5.5 - 8.0
Moisture Content .....	May vary but must be reported
Particle Size.....	May vary but must be reported
Stability .....	May vary but must be reported; highly stable product is recommended if binding pollutants is a goal
Maturity/Growth .....	Testing not required on unvegetated sites
Soluble Salt .....	May vary but must be reported

### Other Important Characteristics Include:

Nutrient content, water-holding capacity, bulk density, and organic matter content. Their actual values may vary but should be reported. Compost should contain only minimal natural or man-made materials and meet federal and state health and safety regulations.

\* More in-depth information regarding compost characteristics/parameters can be found in Section 4.

### What has field experience with compost shown us?

- Compost containing particles of 1/2 inch in size or greater are preferred, although composts of varying particle sizes are acceptable. Composts containing particles that range in size will produce a more stable mat. Very coarse composts should be avoided if the slope is to be landscaped or seeded, as it will make planting and crop establishment more difficult. Fine composts may be more eroded by wind, but will absorb water better than coarse compost. Lower application rates can be used where less severe slopes are treated.
- When using nutrient-rich compost products in or adjacent to environmentally sensitive areas or where water quality concerns exist, caution should be employed. It is suggested that only yard trimmings compost, uncontaminated wood by-product based materials, or well stabilized biosolids compost be used until research is completed on other feedstocks. Biosolids composts that contain nitrogen in a primarily water-insoluble form and are low in nitrates should be used. Dry composts (40% moisture content or under) should also be used when possible, although they are likely to be dusty. Dry composts can more effectively bind the elements contained in the compost, reducing their leachability.

- Composts that are stable and mature, having a higher humic acid content, resist releasing potential pollutants and aid in the removal of pollutants, pesticides, heavy metals, and petroleum-based materials from the storm water. It appears that the pollution reduction capabilities of the compost are directly related to their stability and maturity. Stable and mature compost, low in nutrients and pollutants, may be most beneficial for use in environmentally sensitive areas.

## Instructions for Compost Used as a Soil Mulch for: Erosion Control

Step 1:



Evenly apply compost at a rate of 400-540 cubic yards per acre (3-4 inch layer) over the soil surface.

Step 2:



Prior to applying the compost, the slope should be horizontally tracked (compacted) with a bulldozer, not smoothed.

Step 3:



Apply compost using a slinger or blower-type unit, bulldozer, grading blade, or backhoe. Dry compost should not be applied in windy conditions and should be watered into place. Horizontally track the compost layer, especially on heavier soils, to prevent water from moving between the soil-compost interface.

#### Step 4:



To prevent rill formation, apply compost layer approximately 3 feet over the top of the slope or mesh it into existing vegetation.

#### Step 5:



For best results, place a sediment fence or compost filter berm at the base of the slope.

If used, sediment fence fabric should be laid on the soil surface with the lip facing the slope. A 1 1/2 foot high by 3 foot wide berm of compost should then be placed at the base of the sediment fence and over the fabric lip. The compost will serve as a pre-filter for the sediment fence. Placing the compost over the fabric fence lip eliminates the need to trench and bury the fabric. Alternately, a compost berm (mound) may be placed at the base of the slope in lieu of the sediment fence. The berm may be up to 2 feet high by 4 feet wide depending upon the severity of the slope. As an alternative to silt fencing or constructing a berm, a toe could be constructed. A toe is a shallow ditch at the base of the slope backfilled with crushed stone or gravel.

#### Step 6:



Vegetate the slope where desired. If the compost product is woody in nature or unstable, it should be field stabilized (aged) before seeding or seeded with a special seed mix (e.g., clover, crown vetch). Seeded sites should be watered if possible. If not actively vegetated, natural re-vegetation will occur over time.

*Photos:* BFI Organics, Portsmouth, NH. Pictures illustrate various erosion control projects.

# Silvicultural Crop Establishment With Compost

## Soil Amendment for the Establishment and Production of Forest Tree Species

Municipal by-products, namely biosolids/sludge, have been used in reforestation and pulp wood production resulting in accelerated tree growth and increased pulpwood production. In a 16-year study, the use of MSW/biosolids compost increased stem wood production of slash pines up to 170%. They also found compost was especially beneficial in increasing the nutrient and organic matter content of soils.

### Preferred Compost Characteristics\* Silvicultural Crops

Parameter	Value Range
pH	5.5 - 8.0
Moisture Content	35% - 55%
Particle Size	May vary but must be reported
Stability	Stable to highly stable. Less stable compost may be used if planting is delayed
Maturity/Growth	Must pass maturity tests or demonstrate its ability to enhance plant growth
Soluble Salt	May vary but must be reported; will be highly dependent upon the crop to be established

### Other Important Characteristics Include:

Nutrient content, water-holding capacity, bulk density, and organic matter content. Their actual values may vary but should be reported. Compost should also be weed free, contain only minimal natural or man-made materials, and meet federal and state health and safety standards.

\* More in-depth information regarding compost characteristics/parameters can be found in Section 4.

### What has field experience with compost shown us?

- Lower application rates can be used when composts possessing higher organic matter content are used or where soil quality is moderate. Excessively coarse-textured (sandy) or fine-textured (clay, clay loam) soils will require higher application rates. Soil test results are helpful in establishing application rates.
- The use of less stable or immature composts are possible if applied to the site sufficiently in advance of planting to allow field stabilization (aging). If not stabilized, the microbes degrading the compost will compete with the forest seedlings for nutrition, causing possible stunting, yellowing, or death of seedlings. The use of composts that may have an elevated level of contaminants (e.g., heavy metals or organic pollutants) may even be usable, where allowed, since re-application of compost on such sites is unlikely. This is because lengthy crop rotation of forest species, from 20-50 years, would make it unlikely for contaminants to accumulate.

## Instructions for Compost Used as a Soil Amendment for: Silvicultural Crop Establishment

### Step 1:



Evenly apply compost at a rate not to exceed 100 dry tons per acre.<sup>18</sup> Application rates will vary depending on soil conditions and compost characteristics. The use of compost derived from feedstocks other than MSW or MSW/biosolids has not been studied.

### Step 2:

Apply compost with a front-end loader, grading blade, manure spreader, blower, York rake, or other appropriate equipment. Compost can be applied throughout the entire site, in planting rows, or in specific planting locations where stands currently exist.

### Step 3:



Incorporate the compost to an approximate depth of 6 inches, using a rototiller, rotovator, or disc until the compost is uniformly mixed.

Pre-plant fertilizers and pH adjusting agents (e.g., lime and sulfur) may be applied before compost incorporation, as necessary. The use of stable, nutrient rich composts may reduce or eliminate pre-plant fertilizer application.

<sup>18</sup> Compost and fertilizer application rates and pH adjustment requirements are influenced by plant selection, soil/media and site characteristics, compost quality and feedstock, and other factors. For best results, before planting have your compost, soil, and soil/compost blend tested by a reputable laboratory and discuss the results of the tests with a trained agricultural professional.

**Step 4:**



In wetter areas, where shallow water tables exist, the amended soil should be formed into 6-12 inch high raised beds using a bedding machine.

**Step 5:** Tree seedlings should be planted at proper spacing distances within the raised bed or rows throughout the site.

**Step 6:**



Irrigation should be applied to assure establishment. Additional fertilizer applications based on a soil analysis are suggested for established stands during mid-rotation.<sup>19</sup> Weeds should be managed during the first year after planting to reduce competition with tree seedlings.

*Photos:* University of Florida, Center for Biomass Programs

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<sup>19</sup> Compost and fertilizer application rates and pH adjustment requirements are influenced by plant selection, soil/media and site characteristics, compost quality and feedstock, and other factors. For best results, before planting have your compost, soil, and soil/compost blend tested by a reputable laboratory and discuss the results of the tests with a trained agricultural professional.

# Compost as Sod Production Media

## Growing Media for the Production of Sod on a Restricted Root Surface

Extensive research has demonstrated the benefits of using compost in sod production. Although not yet practiced to a large degree by the industry, research has shown that compost use can improve turf quality and create a lighter sod in a shorter period of time. Excellent results have been demonstrated where compost has been incorporated into sod fields. However, when considering the economics of sod production, the use of compost as the growing media for sod probably provides the greatest promise. A patented system exists for producing a marketable sod using compost as a growing media in 10 weeks. Tall fescue sods have been harvested in as little as 7 weeks after sowing.

### Preferred Compost Characteristics\* Sod Production Media

Parameter	Value Range
pH .....	5.5 - 8.0
Moisture Content .....	35% - 55%
Particle Size.....	Pass through a 3/8-inch screen or smaller
Stability .....	Stable to highly stable, thereby providing nutrients for plant growth
Maturity/Growth .....	Must pass maturity tests or demonstrate its ability to enhance plant growth
Soluble Salt .....	3 dS/m (mmhos/cm) or less is preferred

### Other Important Characteristics Include:

Nutrient content, water-holding capacity, bulk density, and organic matter content. Their actual values may vary but should be reported. Compost must also be weed free, contain only minimal natural or man-made materials, and meet federal and state health and safety regulations.

\* More in-depth information regarding compost characteristics/parameters can be found in Section 4.

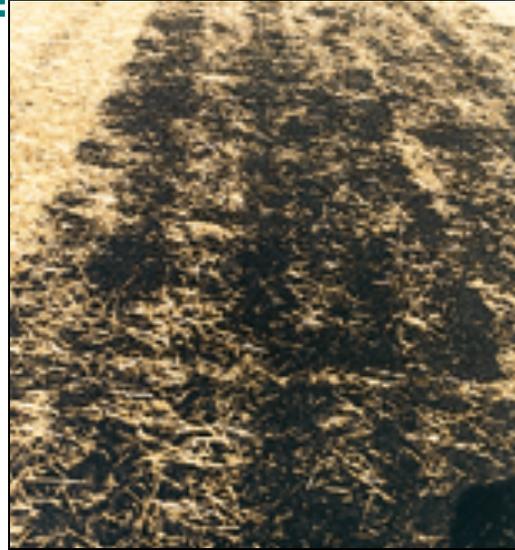
### What has field experience with compost shown us?

- High quality compost must be used in this application since the system was designed to grow "fast sod." The compost must be mature, stable, and low in soluble salts and any other phytotoxins. The composts utilized should possess a pH acceptable to the turf species being grown and a high quantity of organic matter. Composts possessing greater amounts of organic matter often contain greater quantities of nutrition and have a higher water-holding capacity. Finer-textured composts are required to assure seed-to-soil contact.
- Optimum irrigation and fertilization must be maintained to increase turf growth and sod establishment. Irrigation must be carefully applied since the compost will be prone to drying and overwatering can cause anaerobic conditions that are detrimental to the sod. Initially working with test plots is highly recommended.

## ***Instructions for Compost Used as a: Sod Production Media***

**Step 1:** Plastic sheeting is unrolled on a firm surface that is, ideally, slightly sloping to promote good drainage. The plastic sheets must overlap to create a continuous layer. On more permeable soils, holes can be punched in the plastic to allow for drainage.

**Step 2:**



Evenly apply compost onto the plastic at a rate of 50-270 cubic yards per acre using a manure spreader, blower, or other specialty equipment. Superior results may be achieved using the low rate of compost applied over a layer of straw. The straw should be applied on the film plastic sufficiently thick so the plastic can no longer be seen (approximately 1-2 inch layer).

**Step 3:**



Seeds or sprigs can be incorporated with the compost, or sown or sprigged in the growing medium after spreading.

**Step 4:**



The growing medium is watered carefully from germination to harvest. Usually it is irrigated more heavily during the first few weeks. After the seedlings are well rooted, irrigation is slowly reduced. Nutrients are applied through the irrigation system or with a broadcast spreader as needed. Typically, few or no pesticides are required for sod production over plastic.

**Step 5:**



Once tightly knitted, the sod can be cut and rolled using specialized equipment.

*Photos:* Buckeye Bluegrass Farms, Ostrander, Ohio

**TABLE 2.1 Compost Use Guidelines – Preferred Parameters Summary Charts**

Parameter <sup>20</sup>	pH	Soluble Salt Concentration	Moisture Content	Particle Size	Stability	Growth Screening	Trace Elements/Heavy Metals
<b>Turf</b>	5.5 - 8.0	must report, 4 dS/m max. for soil blends	35% - 55%	1" minus	stable to highly stable	must pass	must meet US EPA Part 503, Exceptional Quality Concentration Limits
<b>Vegetable Crop</b>	5.0 - 8.0	must report, 6 dS/m max. for soil blends	35% - 55%	1" minus	stable to highly stable	must pass	must meet US EPA Part 503, Exceptional Quality Concentration Limits
<b>Silviculture</b>	5.5 - 8.0	must report	35% - 55%	must report	moderately to highly stable	must pass	must meet US EPA Part 503, Exceptional Quality Concentration Limits
<b>Marginal Soils</b>	5.5 - 8.5	must report	35% - 55%	must report	moderately to highly stable	must pass	must meet US EPA Part 503, Exceptional Quality Concentration Limits
<b>Planting Beds</b>	5.5 - 8.0	must report, 2.5 dS/m max. for soil blends	35% - 55%	1" minus	stable to highly stable	must pass	must meet US EPA Part 503, Exceptional Quality Concentration Limits
<b>Field Nursery</b>	5.5 - 8.0	must report, 3 dS/m max. for soil blends	35% - 55%	1" minus	stable to highly stable	must pass	must meet US EPA Part 503, Exceptional Quality Concentration Limits
<b>Nursery Beds</b>	5.5 - 8.0	must report, 3 dS/m max. for soil blends	35% - 55%	1" minus	stable to highly stable	must pass	must meet US EPA Part 503, Exceptional Quality Concentration Limits
<b>Growing Media</b>	5.5 - 8.0	must report, 3 dS/m max. for soil blends	35% - 55%	1/2" minus	highly stable	must pass	must meet US EPA Part 503, Exceptional Quality Concentration Limits
<b>Blended Topsoil</b>	5.5 - 8.0	must report, 6 dS/m max. for soil blends	35% - 55%	must report	moderately to highly stable	must pass	must meet US EPA Part 503, Exceptional Quality Concentration Limits
<b>Backfill Mix</b>	5.5 - 8.0	must report, 3 dS/m max. for soil blends	35% - 55%	1" minus	stable to highly stable	must pass	must meet US EPA Part 503, Exceptional Quality Concentration Limits
<b>Sod Production</b>	5.0 - 8.0	must report, 3 dS/m max. for compost	35% - 55%	3/8" minus	stable to highly stable	must pass	must meet US EPA Part 503, Exceptional Quality Concentration Limits
<b>Landscape Mulch</b>	5.5 - 8.0	must report	35% - 55%	must report	moderately to highly stable	must pass	must meet US EPA Part 503, Exceptional Quality Concentration Limits
<b>Erosion Control</b>	5.5 - 8.0	must report	must report	must report	must report	test not required	must meet US EPA Part 503, Exceptional Quality Concentration Limits

<sup>20</sup> For all of these end uses, nutrient content, water- holding capacity, bulk density, and organic matter content levels may vary, but must be reported. Refer to Test Methods for the Examination of Composting and Compost for the appropriate analytical procedures (<http://tmecc.org/>) .

# 3: Compost Source Materials (feedstocks)

Quality composts are being produced from many different materials or *feedstocks*. Typical feedstocks include agricultural by-products, yard trimmings, biosolids (sludge), food by-products, industrial by-products, and municipal solid waste. Some of these feedstocks, such as biosolids must be blended with wood chips, sawdust, paper, biodegradable packaging, etc. to enhance the composting process. The majority of composters in the United States primarily compost agricultural by-products, yard trimmings, or biosolids. If prepared properly, composts produced from various feedstocks will be somewhat similar in nature and function. However, composts produced from certain feedstocks do possess some unique characteristics.

**Agricultural By-Products:** Agricultural by-products can include manure and bedding from various animals, animal mortalities, crop residues, cull fruits and vegetables, and processing/packaging by-products. Composts produced from agricultural by-products, especially manures, are known for generally possessing higher nutrient concentrations as well as elevated salinity levels. They are typically low in contaminants and commonly available in both bulk and bagged form.

**Yard Trimmings:** Yard trimmings compost consists of grass clippings, leaves, weeds, twigs, brush, tree and shrub pruning, Christmas trees, and other vegetative matter from land clearing activities and from residential, commercial, and institutional properties. The compost generated may contain one or all of these source materials. Yard trimmings composts are also referred to as “yard waste”, “yard debris”, or “green waste” composts. Yard trimmings composts are typically lower in nutrients and contaminants. The soluble salt concentration is typically low, but may be elevated where the feedstock is collected unbagged or uncontainerized in areas where road salts are commonly used. Yard trimmings composts are popular with both professional users and homeowners and are often marketed in both bulk and bagged form.

**Biosolids (sewage sludge):** Biosolids are the organic solid residue derived from residential, commercial or pre-treated industrial wastewater processing. Biosolids are treated to reduce pathogens and contain only minimal levels of heavy metals and organic contaminants. Only biosolids that meet a “Class A grade” (exceptional quality) as outlined in the US EPA’s 40 CFR Part 503 regulations can obtain permits for general distribution. See the section 15: Appendix for Part 503 contaminant parameters. Compost produced from biosolids that contain greater levels of contaminants may be usable, depending upon state regulations, on a restricted use basis. Biosolids composts are fairly rich in plant nutrients and typically possess a pH between 6.0 and 7.5. Some biosolids used to produce compost have been treated with liming agents which can affect pH, buffering capacity, and soluble salts level, thus limiting their horticultural use to a degree.

**Food By-Products:** Food by-products can be obtained from various sources, including food processors and restaurants or institutions which separate the food by-products from the general waste stream. Although food by-product composting

is increasing in popularity, it is currently only a small percentage of the composting industry. Food by-products that are commonly composted include culled or damaged fruits and vegetables, coffee grounds, egg shells, fish residues, bakery items, among others. Composts produced from food by-products are typically rich in plant nutrients, but may also possess elevated salinity levels.

**Industrial By-Products:** Many corporations that produce organic residues have begun recycling these materials through composting. Industrial by-products may include wood processing by-products, paper goods, biodegradable packaging materials, pharmaceutical by-products, paper mill sludges, forestry by-products, brewery residuals, and so forth. These materials are typically unique in nature and may possess some excellent properties for plant growth or environmental improvement. Their overall characteristics will vary widely based on their feedstock.

**Municipal Solid Waste (MSW):** MSW is typically considered to be mixed residential or commercial refuse that has not been source-separated for the removal of specific recyclable items such as paper, glass, plastics, and so forth. However, in most cases, mixed municipal solid waste that is intended for composting will be processed after collection to have recyclables and household hazardous wastes removed by mechanical or hand separation. MSW composts, especially those containing significant quantities of paper, possess a lower quantity of nutrients and higher pH (7.5-8.0). Because MSW tends to be rich in paper, its compost often has a higher water holding capacity. Communities that source-separate residential waste usually have lower contaminants and the compost has a higher plant nutrient content.

**As** composting grows and becomes a better understood science, more and more organic by-products will be used as feedstocks. Although end users will have their own personal preferences regarding the type of product they utilize, it is important to stress that high-quality compost products have been produced from all of the feedstocks described. We urge you to try different types of composts to better determine which product you prefer, based on performance, and which products may be best suited for a specific application. It should be understood that the qualities of a particular compost are not indicative of the quality and characteristics of all products produced from that same feedstock. For instance, if you purchase a yard trimmings compost that is not fully stabilized and robs available nitrogen from the soil, you should not assume that all yard trimmings-based composts will have the same effect. As far as quality and usefulness of compost are concerned, it is typically more an issue of the completeness of processing than it is an issue of feedstock.

# 4: Compost Characteristics/Parameters

Compost characteristics or parameters that are important in compost quality evaluation are described in this section. These parameters represent the basic chemical, physical, and biological data needed to assure successful compost use and overall satisfaction. The parameters are also necessary to assist you in determining which compost products possess the characteristics needed for your specific application or are of particular importance to you. We should urge our compost suppliers to provide us with this data.

Since growing conditions and plant needs differ, we can benefit greatly from accurate characterization data pertaining to the compost products we use. This data will allow us to use compost in a way that best meets our particular need or specific situation. Specific characteristics of a compost dictate how and in which applications it can best be used. By obtaining accurate characterization data, we can obtain a compost that is appropriate for a specific application and use it in a way that best meets our particular need.

The following table lists important compost parameters and their rationale for inclusion. In the table, the term “necessary for system management” means the specific value associated with each parameter will allow end users to more effectively manage the “plant growing system.” For instance, specific crops grow best within a certain pH range. Composts possess a specific pH and when used in specific quantities, can influence soil or media pH. Therefore, by knowing the compost pH, users can better estimate its influence and more easily manage the system. Soil or media testing can assist in this endeavor.

The compost parameters are characterized as quantified, qualified and unspecified. Quantified parameters are described using numerical values and qualified parameters are described using a qualifying statement, whereas unspecified parameters may be described either quantitatively or qualitatively once industry standard test methods are established.

**TABLE 4.1 Compost Parameters.**

<b>Compost Parameters<sup>21</sup></b>	<b>Rationale for Inclusion:</b>
▪ pH	Necessary for system management, effect on pH adjustment.
▪ Soluble Salt Concentration	Necessary for system management, potential toxicity, effect on watering regime, effect on fertilizer application rate.
▪ Nutrient Content (N-P-K, Ca, Mg)	Necessary for system management, effect on fertilizer requirements.
▪ Water Holding Capacity	Necessary for system management, effect on watering regime.
▪ Bulk Density	Product handling and transportation (lbs/yd <sup>3</sup> ) issue, estimation/conversion of application rates.
▪ Moisture Content	Product handling and transportation issue.
▪ Organic Matter Content	Necessary for system management, relevant in determining application rates. Some use as a basis to measure cost effectiveness.
▪ Particle Size	Necessary for system management, effect on porosity. May determine usability in specific applications.
▪ Trace Elements / Heavy Metals	Necessary for system management, effect on fertilizer requirements, potential toxicity. Necessary to address and reduce public concern.
▪ Stability	Necessary for system management, effect on nutrient availability (nitrogen), odor generation.
▪ Growth Screening	Necessary for system management, effect on seed germination/plant growth.

<sup>21</sup> Test methods for parameters are provided in the US Composting Council's "Test Methods for the Examination of Composting and Compost" (<http://tmecc.org>).

## Quantified Parameters

It is suggested that quantitative data (e.g. compost possesses a pH of 6.0-6.7), with respect to the eight qualified parameters, be routinely provided to compost users to help assure successful compost use and overall satisfaction.

**pH:** pH is the numerical measure of acidity (or alkalinity), or hydrogen ion concentration of a material. The pH scale ranges from 0-14, with a pH of 7.0 indicating neutrality. Compost typically possesses a pH between 5.0 and 8.5. Specific plant species can flourish when grown within a specific pH range, and based on typical compost application rates, it is understood that the addition of compost can affect the pH of soil and growing media. Therefore, to estimate the effect, which in turn will affect maintenance practices or system management, pH is a necessary parameter. pH is adjusted through the use of such materials as lime, to increase alkalinity, and sulfur, to increase acidity.

- Liming agents are sometimes used in the production of compost. Although the addition of lime in the composting process may not dramatically affect the compost's pH, it will have a pronounced effect on calcium levels.
- Therefore, pH adjustment of these composts is much more difficult due to the compost's higher buffering capacity, and for that reason may not be appropriate for specific applications.

**Soluble Salts (salinity):** Soluble salts concentration is the concentration of soluble ions in a solution, which is measured by the ability of a medium to conduct an electric current. Excess soluble salts can be phytotoxic (damaging) to plants, yet many nutrients are supplied to plants in salt form. Some soluble salts, such as sodium and chloride, are more detrimental to plants than others. Most plant species have a salinity tolerance rating and maximum tolerable quantities are known. Soluble salts are measured in dS/m or mmhos/cm. Compost may contribute to, or dilute, the cumulative soluble salts concentration of a growing medium or soil. Manure compost tends to be higher in soluble salts, while soluble salt concentrations in biosolids and yard trimmings composts are more variable. Reduction in soluble salts concentration can sometimes be achieved through heavy watering (leaching). However, management practices for leaching will be dependent on the salinity of the irrigation water. Most composts produced from municipal feedstocks possess a soluble salt concentration of 10 dS/m (mmhos/cm) or below.

**Nutrient Content:** Nitrogen (N), phosphorous (P), and potassium (K) are the three nutrients used by plants in the greatest quantities (macronutrients), and are the nutrients most often applied through commercial fertilizers. These nutrients are measured and expressed on a dry weight basis as a percent (%). The percent of plant available phosphorous and potassium are expressed as  $P_2O_5$  and  $K_2O$ , respectively. Nitrogen in compost is predominantly in the organic form and must be mineralized to available forms ( $NO_3$  and  $NH_4$ ) for use by plants. Nitrate and ammonium levels in stable compost are generally low. The total nitrogen content should be expressed and the amount of water soluble ( $NO_3$  and  $NH_4$ ) and insoluble nitrogen forms should be known. The content of these nutrients, as well as magnesium and calcium, should be known to allow users to make correct decisions regarding supplemental nutrition and pH adjustment. Calcium (Ca) and

Magnesium (Mg) may be applied through fertilizer application or pH adjustment (e.g., lime, gypsum). Providing data relative to the content of other nutrients can also be helpful, and may be necessary for specific applications or crops.

**Water Holding Capacity:** Water holding capacity is the ability of a compost to hold water. Water holding capacity is measured as a percent of dry weight. Water holding capacity measures the potential benefit of reducing the required frequency of irrigation, as well as gross water requirements for the crop. The water holding capacity should be known to allow users to monitor, or estimate, the compost's effect on their watering regime. Most composts produced from municipal feedstocks possess a water holding capacity of 75%-200% of their dry weight.

**Bulk Density:** Bulk Density is the weight per unit volume of compost. Bulk density is used to convert compost application rates from tonnage to cubic yards. In a field application, cubic yards per acre would subsequently be extrapolated to express an application rate represented as a depth in inches (e.g., 1 inch application rate). Bulk density is also used to determine the volume of compost that may be transported on a given vehicle. Bulk density is typically measured in grams per cubic centimeter, then converted to pounds per cubic yard. Most composts possess a bulk density of 700-1,200 pounds per cubic yard; most would consider 800-1,000 pounds per cubic yard as preferred.

**Moisture Content:** Moisture content is the measure of the amount of water in a compost product, expressed as a percent of total solids. The moisture content of compost affects its bulk density and, therefore, will affect transportation costs. Moisture content is also relevant because it affects product handling. Compost that is dry (35% moisture or below) can be dusty and irritating to work with, while compost that is wet can become heavy and clumpy, making its application more difficult and delivery more expensive. Most composts possess a moisture content of 30%-60%, while 40%-50% is preferred for product handling.

**Organic Matter Content:** Organic matter content is the measure of carbon-based materials in a compost. Organic matter content is typically expressed as a percent of dry weight. Being aware of a product's organic matter content may be necessary for determining compost application rates on specific applications, such as turf establishment. In this application, standard agricultural soil tests may be used to determine the recommended application rate of compost. However, these application rates are specified as the quantity of organic matter needed per acre. Therefore, the organic matter content of compost must be known to convert the application rate to a usable form. Most composts possess an organic matter content of 30%-70%, with 50%-60% being preferred.

**Particle Size:** The specificity in which compost particle size is measured should be based on the products intended use or other customer requirements. For most applications, merely specifying the product's maximum particle size or the screen size through which the compost passes is sufficient. However, for specific applications, such as a component of potting media, a full particle size distribution may be required. A compost's particle size distribution will affect the porosity of the media to which it is added. Porosity is related to the ability of a potting mix to resist water logging, and low media oxygen

levels. Particle size distribution measures the amount of compost meeting a specific size. Particle size distribution figures are expressed as the percent of material retained per sieve size. A compost product's particle size may also determine its usability in specific applications. For example, a yard trimmings compost screened through a 1/4 inch screen would probably not be appropriate to use as a mulch, whereas the same product screened through a 1 inch screen could be acceptable.

## Qualified Parameters

It is suggested that qualitative data, with respect to trace elements/heavy metals, be routinely provided to compost users, where appropriate, based on feedstock.

Initially, it is suggested that only qualitative data be provided to customers pertaining to trace element/heavy metals, as well as other regulated contaminants. This approach is suggested because providing an all-inclusive chemical analysis to most end users is confusing, impractical, and would not be necessary in most situations. Instead, a quality assurance statement could be offered in its place, for example, "our product meets the Federal EPA's definition for an exceptional quality product" or "our product is approved for unlimited distribution and, therefore, can be used on...". It is further suggested that quantitative data describing trace element concentrations be made available upon users request. This data may be necessary to assist specific users to adjust their fertilizer programs to avoid phytotoxicity.

**TABLE 4.2 Typical Characteristics of Municipal Feedstock-Based<sup>22</sup> Composts**

<b>Parameter</b>	<b>Typical Range</b>	<b>Preferred Range for Various Applications and Average Field Conditions</b>
pH	5.0 - 8.5	6.0 - 7.5
Soluble Salts	1 - 10 dS/m (mmhos/cm)	5 dS/m (mmhos/cm) or below
Nutrient Content (dry weight basis)	<i>N</i> 0.5 - 2.5% <i>P</i> 0.2 - 2.0% <i>K</i> 0.3 - 1.5%	N 1% or above P 1% or above
Water Holding Capacity (dry weight basis)	75 - 200%	100% or above
Bulk Density	700 - 1,200 lbs/yd <sup>3</sup>	800 - 1,000 lbs/yd <sup>3</sup>
Moisture Content	30 - 60%	40 - 50%
Organic Matter Content	30 - 70%	50 - 60%
Particle Size	-	Pass through 1" screen or smaller
Trace Elements/ Heavy Metals	-	Meet US EPA Part 503 Regulations
Growth Screening	-	Must pass seed germination, plant growth assays
Stability	-	Stable to highly stable

<sup>22</sup> Municipal feedstock-based composts are primarily derived from yard trimmings, biosolids, municipal solid waste, or food by-products, or a combination of one or more of these feedstocks.

**Trace Elements/Heavy Metals:** Heavy metals, are so named for their location on the Periodic Table of the Elements. Heavy metals are trace elements whose concentration are regulated due to the potential for toxicity to humans, animals, or plants. The quantity of these elements are measured on a dry weight basis and expressed in parts per million (ppm) or milligrams per kilogram (mg/kg). Regulations governing the heavy metal content of composts derived from specific feedstocks have been promulgated on both the state and federal levels. Trace elements, also referred to as heavy metals, are arsenic, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, selenium, and zinc. **The mere presence of these elements does not mean that the product is unsafe. Rather, some of these elements are essential in the diets of plants, animals, and humans and many are included in common vitamin supplements.** Therefore, measuring the concentration of these elements, as well as other plant nutrients, will provide valuable management data relevant to the nutrient requirements of plants, and subsequent fertilizer application rates. Certain heavy metals and trace elements are known to cause phytotoxic effects in plants, and some plant species are more sensitive than others. These elements are boron, manganese, molybdenum, nickel, and selenium. Although detrimental quantities of these elements are not typically found in compost, some can accumulate in the root zone over time. To avoid potential plant damage, these elements should be monitored. Potential damage is unlikely, however, since minimal amounts of trace elements are actually available to plants because they are tightly bound within the compost's organic matter.

In many ways, the concern surrounding the use of *waste derived* composts has been unwarranted, especially in recent years, since great effort has been placed in the reduction of contaminants in the waste streams. The United States Environmental Protection Agency, with assistance from the United States Department of Agriculture, has studied this issue extensively using a full scale risk assessment and has developed a series of regulatory limits. This risk assessment data is the basis for federal and many state regulations, and has helped assure the safety of the products being produced.

## Unspecified Parameters

Unspecified parameters are compost parameters not classified as quantitative or qualitative because of a current lack of industry consensus regarding definitions, test methodologies, or correlation of data. Yet these parameters are important and will be included as quantitative or qualitative parameters in the future. Producers should measure these parameters using one or more test methodologies.

**Growth Screening:** The growth screening test is an indicator of the absence or presence of phytotoxic substances, including volatile fatty acids, alcohol, soluble salts, some heavy metals, or ammonia. Many scientists use the term “maturity” specifically to relate to the absence or presence of volatile fatty acids. Any of these substances may cause delayed seed germination, seed or seedling damage, plant damage or death. The growth screening test is not intended to identify the growth inhibiting compounds, but rather a general measure of acceptability. Growth screening tests include germination, root elongation, and pot tests. It is important to note that a compost that passes initial growth screening tests may fail a similar test later if stored improperly. This is because specific growth inhibitors, such as volatile fatty acids and alcohol, may form in compost stored under anaerobic conditions. Therefore, we should ask vendors how their compost is stored in order to avoid buying compost that has gone anaerobic.

**Stability:** Stability is the level of biological activity in a moist, warm, and aerated compost pile. Unstable compost consumes nitrogen and oxygen in significant quantities to support biological activity and generates heat, CO<sub>2</sub>, and water vapor. Stable compost consumes little nitrogen and oxygen and generates little CO<sub>2</sub> or heat. Unstable, active compost demands nitrogen when applied to soil and growing media. This can cause nitrogen deficiency and be detrimental to plant growth, even causing death to plants in some cases. If stored improperly and left unaerated, unstable compost can become anaerobic and give rise to nuisance odors.

Until industry standards are developed, it is important that growth screening, maturity indices and stability tests be performed and used for process control and to qualify these parameters. There is a great need to standardize test methods for maturity and stability, and to develop industry standard definitions for the terms. Only then can we develop a full and measurable understanding of their effects on specific crops and in specific situations.

## Other

It should be noted that this list of *compost parameters* was developed to represent a wide variety of compost applications and composts produced from various feedstocks. It is difficult to include each parameter of specific importance to every user, or relevant to composts produced from every feedstock. Other compost characterization data may need to be provided for certain composts or for specific uses. For example, porosity and weed seed viability may be important to nurserymen, while flowability, odor presence, ash content, or calcium carbonate equivalence may be important to landscapers and turf managers. Also, where quantifying the concentration of man-made materials, such as glass, plastic, and metal, may be appropriate for MSW or yard trimmings compost, it may not be appropriate for biosolids or food by-product compost. The presence of man-made materials may be an issue of worker safety and also a significant aesthetic issue that can affect the product's acceptability. Aside from these other issues, the compost must also be properly composted to assure it has been sanitized, thus destroying any potentially harmful organisms.

# 5: Compost Selection

Compost produced from different feedstocks and with different levels of refinement may have different uses. For example, compost produced from municipal solid waste will generally possess a greater water holding capacity than other composts because the feedstock from which it is produced typically contains paper and paper products. Therefore, this compost may be more suitable to use in areas where drought conditions exist (e.g., sandy soils) or low maintenance occurs (e.g., roadsides), or perhaps for erosion control. Understanding that no two composts or applications are exactly the same will help you select a compost that best meets your specific requirements. At the same time, one product may be versatile enough to use for a number of different applications. In selecting a compost, it is important that you purchase from firms who test regularly and supply data to their customers. The section entitled “Compost Characteristics/Parameters” provides a discussion on the compost characterization data we should be provided to help us use compost properly. Aside from working with a company that manufactures a compost which meets your requirements and provides characterization data, you must be assured that they are capable of producing a consistent product. Only the production and use of a consistent product can assure uniform results. Even a compost product that is mediocre in quality, but is consistent in nature, can be used successfully as long as all parties understand its attributes and limitations.

As more compost is produced and marketed, users will have the task of evaluating suppliers. Increased competition for your business should improve the quality and variety of available compost, stabilize prices, and improve customer satisfaction.

# The Compost Supplier

It is critical to find a reputable supplier. A supplier should have a history of providing good customer service, reliability, and a consistent compost. A good supplier is always open to suggestions and will work to satisfy your particular needs. Bear in mind that there is a cost involved in responding to customer needs and addressing quality-related issues. Buying an inferior compost for a superior price is no deal. If a supplier can provide you with technical assistance and service your needs, don't be afraid to pay for it.

Whether your compost supplier is a facility or a broker, they must be able to provide compost when needed. This requirement is accentuated due to the seasonality of the green industry. To assure product availability, it is helpful to know the production cycles and storage capacity of your supplier. Other issues to consider include: how the compost will be delivered, site hours, and whether the vendor can arrange for trucking and payment terms.

Remember, every compost is different, every supplier is different, and so is every customer. Seek out the ones that best suits your company's needs.

## Important Attributes of a Compost Supplier

- ✓ **Produce compost possessing attributes/characteristics that meet end user or application requirements**
- ✓ **Supplies/Produces a consistent product**
- ✓ **Has implemented an on-going quality assurance or testing program**
- ✓ **Can supply current compost characterization data (quantifying and qualifying their product's attributes)**
- ✓ **Provides good overall customer service, employs a "service minded" staff**
- ✓ **Can assure prompt and reliable delivery (size of truck and mode of unloading are also important)**
- ✓ **Possesses adequate storage to ensure availability**
- ✓ **Can provide technical assistance regarding end use**

# 6: Comparing Compost to Other Horticultural/Agricultural Products

Comparing compost to other horticulture/agriculture products is not an easy task. The variability of the particular compost and the need to compare effectiveness in a specific application makes comparisons difficult. Within this section is a discussion of various horticultural and agricultural products that are used in conjunction with or instead of compost. This section is included for reference purposes only and as a means to compare the general characteristics of compost to these materials. Following are descriptions of these other horticultural/agricultural products.

[Note: A great portion of the text within this section was obtained from a University of Maryland Bulletin authored by Dr. Francis Gouin.]

**Peat Moss** is derived from Sphagnum which grows in bogs and becomes covered with water when it dies. Because of the cold wet climate in which it grows, peat moss accumulates to great depths undergoing partial anaerobic decomposition. Over the years, peat moss has changed both physically and chemically due to harvesting methods and location. Coarse chunky peat with a pH above 5.0 is seldom available. In its place is a finer material that possesses a pH between 3.3-3.5. This finer peat moss shrinks rapidly and requires twice, and sometimes three times more, limestone to neutralize its acid concentration than in previous years. Although peat moss initially starts with a high cation exchange capacity, it decreases with time, thus reducing its ability to hold nutrients as the aging process continues.

**Sedge Peat or Native Peat** generally consists mostly of sedges and grasses that grow in bogs. When these grasses and sedges die, their tops sink into the water and undergo partial anaerobic decomposition. Since these plants are high in cellulose and contain little lignin, they decompose more rapidly than peat moss and contain few fibers. Although sedge peat and native peat can be used as a substitute for peat moss, they are generally not as satisfactory in certain nursery applications. Also, they are highly variable from bog to bog and can be equally as acidic as peat moss. The cation exchange capacity of sedge peat and native peat is similar to peat moss.

**Softwood Bark** has become a major source of organic matter for the ornamental horticultural industry. Products such as pine, fir, hemlock, redwood, and cypress barks are used throughout specific regions of North America. Because they are low in cellulose and high in lignins, they can be used either fresh or composted and do not decompose rapidly. Cypress and redwood sawdust is also low in cellulose and can be used in much the same way. However, only coniferous barks with less than 10% cellulose can be used fresh. Coniferous bark with 10% or more cellulose must be composted. For optimum growth, when used as a soil amendment or growing media component, the bark products should be milled to particle sizes no larger than 1/2-inch diameter. Unlike peat moss, sedge peat, or native peat, the cation exchange

capacity of bark improves with age. However, not all barks are the same and their availability is diminishing in certain regions. The landscaping industry not only uses ground coniferous bark as a soil amendment but coarser materials are popular as decorative mulches.

**Hardwood Bark, Sawdust, Shavings, or Wood Chips** should never be used in blending potting media unless they have been thoroughly composted. These materials are high in cellulose and low in lignins; therefore, they shrink rapidly and will rob plants of nitrogen. The competition for nitrogen may not be effectively offset by supplying additional nitrogen in a fertilizer program. It is important to note that the use of these materials in field applications should be limited to areas where planting will not occur for several months. Using a fine-textured and well-aged or composted hardwood bark will minimize the negative effects.

**Topsoil** is defined as “the surface or upper part of the soil profile.” Individuals who use topsoil often define it as a naturally produced medium consisting of sand, silt, and clay, organic matter, trace amounts of nutrients, and other inerts capable of supporting plant growth. However, in many parts of the country, even in agricultural areas known for their productive soils, many of the soils purchased as topsoil and used for horticultural applications are not true topsoils. Many of the materials purchased and used as topsoil are mineral soils obtained from below the true topsoil layer. These subsoils are often devoid of organic matter and essential plant nutrients and do not possess the physical structure required for optimum plant growth. These materials are typically processed to remove debris before marketing. In some areas, sand and muck-type materials are sold as topsoils. Neither of these materials possess properties essential for optimum plant growth. Most topsoils that can be purchased today contain less than 2% organic matter.

**Manures** from a variety of livestock have been used as a source of nutrients and organic matter on agricultural soils for centuries. Typically, these materials have been applied in a fresh form, but are currently available for agricultural and horticultural usage in aged, dehydrated, or stabilized form. Common manure feedstocks include beef and dairy cattle, chicken, turkey, and horse manures. Raw manures are typically more odorous than composted manures, and may still contain viable pathogens and weed seeds. When raw manures are applied, it is suggested that planting be delayed two-to-four weeks after application and incorporation to allow for stabilization. Since raw manure has not been stabilized, the nitrogen is often readily available and subject to leaching. Its organic matter is also subject to more rapid degradation. Composted manures will contain a more stable form of nitrogen and a lower content of organic matter than will raw manures.

**TABLE 6.1 General Comparison of Compost to Other Horticultural/ Agricultural Products**

	Compost	Canadian Peat	Native Peat	Mineral Topsoil	Fresh Manure	Ground Pine Bark
Macronutrients	medium-high	very low	very low	low	high	low
Mirconutrients	medium-high	very low	very low	low-medium	medium-high	low
Soluble Salts	low-medium	very low	very low	low	high-very high	low
pH	medium	low-very low	low-very low	medium	medium	low
Bulk Density	medium	low	low	high	high	low
Moisture Holding Capacity	medium	very high	high	low	low-medium	low
Organic Matter Content	medium-high	very high	high	low	medium- high	medium-high
Stability in Soil	good-excellent	excellent	excellent	n/a	low-medium	good-excellent
Microbial Population	good-excellent	poor	poor	poor-good	good	good-excellent

n/a = not applicable \*Note: These are general guidelines. Individual products may vary widely.

**TABLE 6.2 Actual Comparison of Compost to Other Horticultural/ Agricultural Products**

	Compost <sup>1</sup>	Organic Soil <sup>2</sup>	Native Peat <sup>3</sup>	Canadian Peat <sup>4</sup>	Aged Chicken Manure
Organic Matter (%)	46.00	12.00	74.00	97.00	43.00
pH	7.40	7.50	5.20	4.20	–
Soluble Salts (mmhos/cm)	2.23	0.64	0.31	0.07	15.10
Bulk Density (lbs/ft <sup>3</sup> )	32.16	70.22	14.26	6.98	39.32
Moisture-Holding Capacity (%)	227.00	53.00	428.00	1,307.00	166.00
Cation Exchange Capacity (meg/100g)	17.30	13.60	4.00	3.10	–

1 = represents a biosolids/yard trimmings compost; 2 = represents an organic Florida muck soil; 3 = represents a Florida reed sedge peat; 4 = represents a Canadian sphagnum peat moss.

Source: E&A Environmental Consultants, Inc. in-house data.

# 7: Compost Use Estimator

## Cubic Yards of Compost Required to Cover a Specific Area

*Formula:* Specific area to cover (expressed as square feet) x amount of compost to apply (expressed as depth in inches) x 0.0031 = equals cubic yards of compost to cover a specific area.

$$(\text{___ ft}^2 \times \text{___ inches of compost} \times 0.0031 = \text{___ yd}^3)$$

*Example:* We are interested in determining the amount of compost necessary to cover 5,000 ft<sup>2</sup> with a one-half inch layer of compost.

$$(5,000 \text{ ft}^2 \times 0.5 \text{ inches of depth} \times 0.0031 = 7.75 \text{ yd}^3)$$

**TABLE 7.1 Cubic Yards of Compost Required to Cover Specific Areas**

	To Cover 1,000 Square Feet	—	To Cover One [1] Acre
0.25-inch layer	— Approximately 0.75 cubic yards	—	approximately 34 cubic yards
0.50-inch layer	— Approximately 1.5 cubic yards	—	approximately 67 cubic yards
1.00-inch layer	— Approximately 3.0 cubic yards	—	approximately 134 cubic yards
1.50-inch layer	— Approximately 4.5 cubic yards	—	approximately 201 cubic yards
2.00-inch layer	— Approximately 6.0 cubic yards	—	approximately 269 cubic yards
2.50-inch layer	— Approximately 7.5 cubic yards	—	approximately 335 cubic yards
3.00-inch layer	— Approximately 9.0 cubic yards	—	approximately 402 cubic yards

**TABLE 7.2 Approximate Number of Pots Filled by One Cubic Yard of Compost Amended Media**

Pot Size	# Filled
4 inch	1,210
1 gallon (6 inches)	225
2 gallon (8 inches)	120
3 gallon (10 inches)	80
7 gallon (14 inches)	38
15 gallon (17 inches)	14

**TABLE 7.3 Suggested amounts of compost for band applications.**

<b>Cubic Yards per Row</b>										
		<b>1" Application Depth</b>			<b>2" Application Depth</b>			<b>3" Application Depth</b>		
		<b>Band Width</b>			<b>Band Width</b>			<b>Band Width</b>		
<b>Row Length</b>		<i>1'</i>	<i>2'</i>	<i>3'</i>	<i>1'</i>	<i>2'</i>	<i>3'</i>	<i>1'</i>	<i>2'</i>	<i>3'</i>
50'		0.15	0.31	0.46	0.31	0.62	0.93	0.46	0.93	1.39
100'		0.31	0.62	0.93	0.62	1.23	1.85	0.93	1.85	2.78
200'		0.62	1.23	1.85	1.23	2.47	3.70	1.85	3.70	5.56
300'		0.93	1.85	2.78	1.85	3.70	5.56	2.78	5.56	8.33
400'		1.23	2.47	3.70	2.47	4.94	7.41	3.70	7.41	11.11
500'		1.54	3.09	4.63	3.09	6.17	9.26	4.63	9.26	13.89
600'		1.85	3.70	5.56	3.70	7.41	11.11	5.56	11.11	16.67
700'		2.16	4.32	6.48	4.32	8.64	12.96	6.48	12.96	19.44
800'		2.47	4.94	7.41	4.94	9.88	14.81	7.41	14.81	22.22
900'		2.78	5.56	8.33	5.56	11.11	16.67	8.33	16.67	25.00
1,000'		3.09	6.17	9.26	6.17	12.35	18.52	9.26	18.52	27.78
2,000'		6.17	12.35	18.52	12.35	24.69	37.04	18.52	37.04	55.56

<b>Cubic Yards per Acre<sup>23</sup></b>										
		<b>1" Application Depth</b>			<b>2" Application Depth</b>			<b>3" Application Depth</b>		
		<b>Band Width<sup>24</sup></b>			<b>Band Width</b>			<b>Band Width</b>		
<b>Road Width<sup>25</sup></b>		<i>1'</i>	<i>2'</i>	<i>3'</i>	<i>1'</i>	<i>2'</i>	<i>3'</i>	<i>1'</i>	<i>2'</i>	<i>3'</i>
4'		26.89	44.81	57.62	53.78	89.63	115.24	80.67	134.44	172.86
5'		22.41	38.41	50.42	44.81	76.83	100.83	67.22	115.24	151.25
6'		19.21	33.61	44.81	38.41	67.22	89.63	57.62	100.83	134.44
7'		16.81	29.88	40.33	33.61	59.75	80.67	50.42	89.63	121.00
8'		14.94	26.89	36.67	29.88	53.78	73.33	44.81	80.67	110.00
9'		13.44	24.44	33.61	26.89	48.89	67.22	40.33	73.33	100.83
10'		12.22	22.41	31.03	24.44	44.81	62.05	36.67	67.22	93.08
11'		11.20	20.68	28.81	22.41	41.37	57.62	33.61	62.05	86.43
12'		10.34	19.21	26.89	20.68	38.41	53.78	31.03	57.62	80.67

<sup>23</sup> Assumes a square acre, Row Length = 209'

<sup>24</sup> Plants are established in centers of bands, *SOURCE: Tyler, R.W., "The Promise of Compost," American Nurseryman, July 1993.*

<sup>25</sup> The "road width" column in the bottom table designates the width of the roadway between each row of trees, measured from the edge of one compost band to the edge of the next. If staggering row widths, use an average of the road widths to determine necessary compost volumes. For instance, if staggering row widths of 10 and 12 feet, the average road width is 11 feet. See TABLE 7.3 for Suggested amounts of compost for band applications.

## 8: Soil/Media Testing

The most accurate way to obtain data on the pH and nutritional status of your soil or media is by having it analyzed by a reputable agricultural laboratory. Testing can also provide data on the salt concentration, organic matter content, and other characteristics of your soil/media. In addition to providing data on soil/media status, agricultural laboratories also provide recommendations regarding fertilizer application and pH adjustment for crops you intend to grow. Although several suggestions are provided throughout this document regarding the application of fertilizer and pH adjusting agents, the application of these materials should be based on quantitative test data.

The most accurate method of determining soil status and plant requirements is to obtain soil samples one week or more after compost addition (incorporation). This delay allows amended soils to stabilize. Instructions on how to collect soil samples can be obtained through your State's Land Grant University, Cooperative Extension Service, or private agricultural laboratories.

# 9: Compost Application

The method in which compost is applied is typically based on the compost's characteristics, type of application, the size of the project, and field conditions. For small planting or mulching projects, compost may be obtained in bags and spread by hand using a rake. For larger projects, compost may be obtained in bulk, transported to the site in a dump truck or wheelbarrow and spread by hand or by using tractor drawn equipment. Where slopes are being mulched for decorative purposes or erosion control, or compost is being applied to sites which are difficult to access, blower-type units have been used to propel the compost up to 200 feet. Smaller blower-type units have also been developed which propel the compost through a wide hose, that can be directed around plants and other objects. A more common method to apply compost for various applications is with a manure spreader or topdressing unit. A manure spreader uses rotating flails (paddles) to project the compost into the air, whereas a topdressing unit uses a rotating, cylindrical brush to project the compost down towards the soil surface. Both units may be calibrated to apply lower (1/4-1/2 inch layer) or higher rates (1 inch layer) of compost; however, the application of higher rates is slow and may take more than one pass over the site. Often, when rates of 1 inch or more are applied, piles of compost are strategically placed throughout the site and a grading blade, York rake, or front-end loader/bull-dozer blade is used to spread the compost. With experience and care, accurate application rates are achievable. The agricultural community, and companies marketing compost, have developed efficient methods of applying compost. Side discharge manure spreaders have been used to apply compost inside planting rows and tractor trailers have been fitted with flails to allow large volumes to be spread. Equipment has even been developed to apply compost to depths of 1/2-1 inch over a raised nursery bed.

Continued innovations in compost application equipment will increase compost usage. For that reason, equipment is now available for purchase or rental to allow users to more efficiently apply compost. It is important to note that the moisture content and particle size of the compost will affect its spreadability. Standard "box spreaders" and agricultural or commercial fertilizer/lime spreaders often have difficulty spreading coarse or wet compost.

# 10: Fertilizer Application

As discussed in earlier sections, although compost is not typically considered a fertilizer, it can supply a variety of macro- and micronutrients. The quantity and availability of these nutrients is based on the soil type, climate, compost's constituents, its feedstocks, as well as its stability. Source-separated food by-products, biosolids, and manure composts are known for being richer in nitrogen than are yard trimmings and municipal solid waste composts. When incorporated into the soil or a growing medium, composts that are carbon-rich or less stable (less thoroughly composted) may cause nitrogen depletion for a period of time or consume its own supply of available nitrogen. Because all composts contain different quantities of nutrients and plant-available nutrients, it is important to obtain current soil test data. The total nitrogen content should be known, as should the content of water-soluble ( $\text{NO}_3$  and  $\text{NH}_4$ ) and insoluble nitrogen forms. Plant available forms of nitrogen, phosphorous and potassium are expressed as  $\text{NO}_3$ ,  $\text{P}_2\text{O}_5$  and  $\text{K}_2\text{O}$ , respectively. Performing a soil test is also important to allow for proper fertilizer application, as well as data regarding the plant's nutrient requirements. Completing a soil test a week or so following compost incorporation will allow for more accurate soil test results.

All fertilizer programs should be designed to meet the requirements of the plant species being grown and complement the nutritional content of the compost being used. Often, chemical fertilizer programs are not altered, even though it is known that the compost that was applied supplies considerable quantities of plant-available nutrients. Performing a soil test on the amended soil will aid in determining appropriate fertilizer application rates and reduce potential over fertilization and pollution. Where the plant-available nitrogen, phosphorus, and potassium in the compost are adequate, pre-plant fertilizers incorporated into the soil, raised bed, or growing media may be eliminated or reduced. Often supplemental nutrition, primarily nitrogen, is necessary during the spring and fall seasons because nitrogen in the compost may not be available (mineralized) at rates sufficient to meet immediate crop requirements. Research has shown, however, that it is possible to meet the nitrogen requirements of many plant species by applying compost in successive years, since the quantity of available nitrogen is cumulative. Marginal or low-quality soils are likely to need

greater fertilizer applications unless high rates of stable compost are used. The addition of compost at prescribed rates will supply nutrients after the first year of application. It is estimated that the nitrogen content of compost is released for five or more years following application, with quantities of available nutrients declining each subsequent year. Therefore, compost's slow feeding nature will allow end users to reduce fertilizer application to some degree.

Since nutrients are supplied to plants in the form of salts, a good rule of thumb is to apply only half of the recommended fertilizer rate specified when compost is used on known salt-sensitive plant species. However, completing a soil test is the most accurate method to determine nutritional requirements or soluble salts concentration.

Where stable biosolids composts are used at prescribed rates, as a component to growing media, nitrogen fertilizers should not be applied during the first 2-3 weeks of plant growth, and the addition of micronutrients to the mix should not be necessary. Composts produced from feedstocks other than biosolids and considered stable typically do not need nitrogen fertilizers during the week or two following potting. The need to apply micronutrients will likely be eliminated when using compost at suggested rates in potting media. Composts that are less stable, regardless of the feedstock, will need supplemental nutrition, especially nitrogen and phosphorus, immediately following potting.

If unstable compost is used in field applications, it should be allowed to age in the field before any planting takes place to avoid stunting, potential plant damage, or reduced crop yields. Depending on the compost's degree of instability and time of year, field aging could take a few weeks to a few months or longer. Alternatively, or in conjunction with field aging, fertilizer may be added to help compensate for any nitrogen immobilization. Stunted growth or yellowing vegetation is a symptom of nitrogen immobilization.

# 11: Nutrient Loading Estimator

The following information is provided to estimate the amount of macronutrients found in a specific quantity of compost. By determining the quantity of macronutrients, proper fertilizer application can be made and environmental impact minimized.

## Steps/Formulas:

1. Convert compost application rates from cubic yards to pounds, as necessary:  
$$\text{compost application rate (yd}^3\text{/area)} \times \text{compost bulk density (lbs/cubic yard)}$$
$$= \text{lbs of compost/specific area}$$
2. Determine compost application rate (per area) on a dry-weight basis:  
$$\text{application rate (lbs/specific area)} \times \text{dry solids content of compost (percent)}$$
$$= \text{lbs of dry compost applied}$$
3. Determine nutrient loading rate:  
$$\text{lbs. of dry compost applied} \times \text{content (total) of specific nutrient to estimate (percent)}$$
$$= \text{lbs (total) of specific nutrient applied}$$

## Example:

We are interested in determining the amount of total nitrogen applied per 1,000 ft<sup>2</sup> of area.

- **Compost has an analysis of 1% nitrogen**
- **Compost is 55% dry solids (45% moisture)**
- **Compost has a bulk density of 1,000 lbs. per yd<sup>3</sup>**
- **Suggested application rate per 1,000 ft<sup>2</sup> is 4.5 yd<sup>3</sup>**

1. compost bulk density = 1,000 lbs/yd<sup>3</sup> = 0.5 yd<sup>3</sup>/ton (2,000 lbs/ton)

$$\begin{aligned} & 4.5 \text{ yd}^3 \text{ (compost application rate per 1,000 ft}^2\text{)} \times 0.5 \text{ yd}^3/\text{ton} \\ & = 2.25 \text{ tons}/1,000 \text{ ft}^2. \quad 2.25 \text{ tons} \times 2,000 \text{ lbs/ton} \\ & = 4,500 \text{ lbs}/1,000 \text{ ft}^2 \end{aligned}$$

2. 4,500 lbs/1,000 ft<sup>2</sup> x 55% (dry solids content) = 2,475 lbs dry compost/1,000 ft<sup>2</sup>

3. 2,475 lbs x 1% (total nitrogen content) = 24.75 lbs/1,000 ft<sup>2</sup> (total nitrogen applied)\*

\*This figure does not represent Plant Available Nitrogen, only total nitrogen.

Once the quantity of total nitrogen is determined, an estimate of actual or available nitrogen can be made (see bottom of next page). The quantity of nitrogen available to plants is based on the quantity mineralized. The mineralization rate of nitrogen in compost is based on soil type, climactic conditions, and the stability of the compost.

## Rules of Thumb:

- ✓ Nitrogen mineralization rates (availability) of stable composts are greatest the first year following application, and rates reduce each year until they reach background levels. Rapid mineralization occurs in the first 4-8 months following application, then it decreases and drops to a more constant level.
- ✓ Nitrogen mineralization rates are greater in coarse-textured (sandy) soils and less in fine-textured (clay, clay loam) soils.
- ✓ Nitrogen mineralization rates are increased as ambient temperatures and humidity increase; rates are greater in tropic and semi-tropic zones.
- ✓ Stable composts contain more plant-available nitrogen.
- ✓ Unstable composts can cause nitrogen immobilization, and some of its nitrogen content may be lost through volatilization of ammonia.
- ✓ Nitrogen immobilization is less influenced by feedstock than by the compost's characteristics (stability/rating, form of nitrogen).

Although compost nitrogen mineralization rates have been studied for many years, they are difficult to estimate because they are site and compost specific. With this in mind, research suggests that the nitrogen mineralization rate of stable composts during the first year following application is 5%-25%, based on soil type and climactic conditions. Mineralization rates of 20%-25% may occur in deep southern states, while in far northern states rates of 5%-10% are more likely. Many researchers believe a common mineralization rate for stable compost in large portions of the United States is 10%-15% the first year following compost application. The second year following application, the

mineralization rate should be estimated as half of the first season, and the third year, the mineralization rate will be half that of the second year.

For example, research on stable biosolids composts completed at the USDA's research station in Beltsville, Maryland found nitrogen mineralization rates of:

<b>First Season</b>	<b>10%</b>
<b>Second Season</b>	<b>5%</b>
<b>Third Season</b>	<b>2%-3%</b>

Therefore, if a compost has a mineralization rate of 10% the first year and compost is reapplied the next year, the cumulative mineralization rate of the compost is 15%.

Using the example from the previous page, if a compost containing 1% nitrogen was applied at 4.5 cubic yards per 1,000 square feet for two successive years, a total of 3.71 pounds of nitrogen will be available during the second season. From the total, 2.475 pounds (10% of 24.75 lbs.) is supplied by the compost applied the second season, and 1.24 pounds (5% of 24.75 lbs.) is supplied by the compost applied the first season.

Research completed by the University of Minnesota on MSW compost found that greater nitrogen mineralization rates may occur the season following application when using unstable composts.

# 12: pH Adjustment

All plants possess a specific pH range in which they grow and flourish. Knowing this, *green industry professionals* and homeowners adjust the pH of their soils or growing media to meet the requirements for specific plants. pH is typically increased with lime and decreased with a sulphur-based products. Growing plants in their desired pH range allows for optimal growth and proper plant nutrition. A list of desired pH ranges for various plant species can be obtained from agricultural specialists or agricultural/horticultural reference literature.

The addition of compost at recommended rates will usually affect the pH of soils and growing media. The extent to which the pH is influenced depends on the pH of the soil being treated, the pH of the compost, the quantity of compost applied, and the soil type. In most field situations, the addition of compost will increase the pH of soil or growing medium, except when the soil is already alkaline in nature. In alkaline soils, pH may increase gradually with repeat application if the compost pH is greater than that of the soil. Since most finished composts possess a pH of 6.0-7.5, the use of compost does not typically raise soil/medium pH above 6.5, unless the compost or its feedstock contains lime. Often, less stable municipal solid waste composts that are rich in cellulose possess an elevated pH. This will cause a short-term rise in soil/medium pH until the compost stabilizes, then the pH will decrease again. Compost also improves the cation exchange capacity (CEC) of soils, thereby improving its buffering capacity, making it more resistant to pH change. Therefore, the addition of compost can have a long-term effect on stabilizing pH. Keep in mind that it is easier to alter the pH of sandier soils than clay or organic soils because sandy soils possess a very low CEC.

An interesting phenomenon occurs in relation to organic matter content and soil pH. It has been shown that as the organic matter of soil increases, the importance of meeting the plants' preferred pH range becomes less relevant. This is because organic matter, and the humic acid it contains, more effectively binds and releases nutrients, making them more available to plants. One of the main reasons for maintaining a desirable pH is to assure that roots are capable of

obtaining optimal nutrients. This phenomenon has been well-illustrated in the production of excellent-quality rhododendrons, an acid-bearing species, in soil with a pH of above 6.0 where compost has been used as an amendment.

Although it is impossible at this point to estimate what effect a particular compost product will have on a particular soil, several general statements can be made:

### **Rules of Thumb:**

- ✓ In most acidic soils, compost will increase soil pH.
- ✓ The greater the calcium and magnesium content of the compost, as well as its CEC, the more it will influence soil/media pH.
- ✓ Research and practical experience has shown that the incorporation of 10-50 dry tons per acre of compost will increase soil pH on acidic soils from 0.5-1.0 unit; whereas, its effect on slightly alkaline soils may be negligible. Therefore, increasing a soil's pH from 5.5-6.0 can typically be achieved through the addition of compost at recommended rates.
- ✓ Where a greater upward pH adjustment is required, compost should be used in conjunction with a liming agent. Preferably, adjust the soil pH to near the preferred value using liming agents, then apply the compost to modify it the rest of the way.
- ✓ Where a downward pH adjustment is required, adjust the soil pH with sulphur to the desired level, then add the compost (it will modify the pH upward to a small degree).

# 13: Health/Environmental Issues

Concerns over potential health and environmental related issues have peaked since the use of municipally generated compost feedstocks (e.g., biosolids, municipal solid waste) has become common. These concerns are understandable and have been addressed through research. Unfortunately, even though excellent research exists pertaining to health and environmental risks, it is often ignored and negative opinions regarding specific composts are formed based on fear and stigmas.

## The Facts

### ✓ Pathogens

Certain compost ingredients or feedstocks such as biosolids, septage, municipal solid waste, yard trimmings food by-products, and animal manures can contain plant and animal pathogens. However, specific processes and management techniques have been developed to effectively destroy these pathogens. These processes and techniques are based on a known *time-temperature relationship*. Simply, all living organisms can be killed when exposed to a specific temperature for a specific length of time. The greater the temperature, the shorter the length of time necessary. The time-temperature criteria for controlling potentially harmful pathogens in biosolids were identified and verified back in the 1970's by the United States Department of Agriculture (USDA) and the United States Environmental Protection Agency (USEPA) when they were heavily involved in biosolids composting research. The time-temperature criteria is also valid for destroying pathogens in other feedstocks, and is effective in destroying other organisms such as nematodes, insects, as well as weed seeds. Since the 1970's, over 250 biosolids and municipal solid waste composting facilities have been in operation, and there has never been a documented case of disease or illness caused by the use of these products. The composting process is very effective for disinfection or pasteurization.

## ✓ Heavy Metals

Certain municipal (e.g., biosolids and municipal solid waste) and industrial compost feedstocks typically contain low levels of heavy metals. In order to guarantee public safety, a tremendous amount of research has been performed on a national level regarding heavy metals. Heavy metals, so called because of their location on the Periodic Table of the Elements, are trace elements whose concentrations are regulated due to potential toxicity to humans, animals, and/or plants. Similar to the pesticides we use everyday, the mere presence of these elements does not pose a risk. These trace elements are inherently found in almost everything and are only deemed a health risk when we are exposed to them in relatively large quantities. **Keep in mind that many of the trace elements referred to as heavy metals are purchased by the horticultural industry as micronutrients and applied to their crops, because they are necessary for plant growth. Many of these elements are also found in typical fertilizers in greater quantities than that found in composts, and some of these elements are found in human vitamin supplements.** It should be noted that products containing biosolids and MSW are heavily scrutinized, while many other soil amendments and fertilizers containing these same trace elements may be produced and marketed with minimal to no regulation and scrutiny. It is important to keep the heavy metal issue in perspective, because only compost derived from feedstocks that are low in heavy metals may be distributed with little or no restrictions. It should also be understood that a landmark health-related risk assessment was recently completed by the USDA and the US EPA that developed parameters for heavy metals content in biosolids compost. These national minimum standards, listed in 15: Appendix, provide an extra layer of safety that can provide end users with a greater sense of confidence.

## ✓ Nitrogen Loading

Much concern exists regarding the over-use of nitrogen and its effect on the environment. The improper use of nitrogen has caused nitrate runoff and leaching concerns, which are a serious threat to our water resources. The composting industry takes these concerns seriously, as does the USDA and the USEPA, and that is why specific regulations have been developed to address them. To assure that over-fertilization does not occur, maximum compost application rates should be based on the plant's annual plant-available nitrogen requirement. Plant-available nitrogen requirements for plant species are known values and are obtainable through agricultural and horticultural specialists. Plant-available nitrogen content is different from the total nitrogen content of a compost and is generally considered to be between 5%-25% available during the first growing season. The quantity of nitrogen available to plants on an annual basis from compost is based on climatic and soil conditions. Most state regulations include methods for determining the nitrogen availability of composts. For instance, the USDA estimated that nitrogen availability (mineralization) from biosolids compost in Maryland was approximately 10% the first year and 5% the second year. That means that the maximum allowable amount of nitrogen that can be supplied to a crop, which has an annual plant available nutrient requirement of 100 pounds per acre, is 1,000 pounds. The nutrient loading estimator found in Section 12 illustrates a methodology to determine total nitrogen loading and a discussion on mineralization rates.

## ✓ Other

There is some concern over man-made materials or "foreign" materials contained in compost that may cause lacerations. For this reason, several states are restricting the size and quantity of foreign materials allowed in compost. The content of these foreign materials are not considered a major hazard to workers. Wearing gloves during planting if your compost contains "sharps" should eliminate such concerns. Also, if the compost is excessively dry when applied (like lime and other agricultural/horticultural products), dust may be produced that can be irritating to eyes and respiratory tract. Protective eyewear and a dust mask should eliminate any such nuisance.

# 14: Literature Cited / References

A bibliography of research articles/papers used to develop the thirteen (13) compost use guidelines is not enclosed in this booklet. However, a full bibliography for each of the guidelines can be found in "Suggested Compost Parameters & Compost Use Guidelines," published by the Composting Council, Alexandria, Virginia.

## Literature Cited

- The US Composting Council. 1995. Glossary of Composting and Compost. Edition 2, Draft 4.0. The US Composting Council, <http://compostingcouncil.org>.
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- The US Composting Council. 1995. Suggested Compost Parameters and Compost Use Guidelines. The US Composting Council, <http://compostingcouncil.org>.
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- Tyler, R.W. 1993. The Promise of Compost. American Nurseryman, July 1993.

## Suggested Reading/Resources

- Van Horn, Mark. 1995. Compost Production and Utilization, A Growers Guide. California Division of Agriculture and Natural Resources and the California Department of Food and Agriculture. Publication 21514.
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- On-Farm Composting Handbook. 1992. Northeast Regional Agricultural Engineering Service, Cooperative Extension. Publication NRAES-54.
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To obtain additional copies of this document, or other quality compost related documents, contact: The US Composting Council *Business Office*  
[info@compostingcouncil.org](mailto:info@compostingcouncil.org)

# 15: Appendix

## Part 503 Sewage Sludge (Biosolids) Regulations

**TABLE 15.1 Summary Of Limits For Land Application<sup>26</sup>** (mg/kg, dw basis)

<i>Pollutant</i>	1. Ceiling Concentration	2. Cumulative Pollutant Loading Rate	3. Pollutant Concentration	4. Annual Pollutant Loading Rates
	(mg/kg, dw basis)	(kg/ha, dw basis)	(mg/kg, dw basis) ▪ <b>Exceptional Quality</b>	(kg/ha/365-day period)
Arsenic	75	41	41	2
Cadmium	85	39	39	1.9
Copper	4,300	1,500	1,500	75
Lead	840	300	300	15
Mercury	57	17	17	0.85
Molybdenum <sup>27</sup>	75	–	–	–
Nickel	420	420	420	21
Selenium	100	100	100	5
Zinc	7,500	2,800	2,800	140
Applies To:	All biosolids that are land applied	Bulk biosolids and bagged biosolids <sup>28</sup>	Bulk biosolids	Bagged biosolids <sup>28</sup>

### Definitions:

1. Ceiling Concentration - the maximum content of heavy metals allowed if the product is to be sold, given away, or otherwise land applied. If any one value is surpassed, then the product cannot be land applied.
2. Cumulative Pollutant Loading Rate - the maximum lifetime loading limit of heavy metals permissible in the soil on a given site.
3. Pollutant Concentrations - the maximum allowable heavy metal content for a compost to be called an "Exceptional Quality" product. Exceptional Quality products may be used in any application, including food crops, as far as the US EPA is concerned. Some states, however, do not allow the use of biosolids compost on edible crops.
4. Annual Pollutant Loading Rates - maximum annual loading limit of heavy metals permissible on a given site.

<sup>26</sup> Table 2-4 Pollutant Limits from A Plain English Guide to the EPA Part 503 Biosolids Rule

<sup>27</sup> As a result of the February 25, 1994, Amendment to the rule, the limits for molybdenum were deleted from Tables 2, 3 and 4 of the Part 503 rule pending EPA reconsideration.

<sup>28</sup> Bagged biosolids are sold or given away in a bag or other container.

# Disclaimer

Data outlined in the Field Guide to Compost Use describes processes used successfully by end users and demonstrated effective through research in specific situations and with specific compost products. Data was developed to provide general assistance relative to the use of compost, and the guide should not be considered as formal recommendations for any specific product or project. It should be understood that all compost products, climatic conditions, crop requirements, and field situations are different and may require specific recommendations from experts familiar with those specific field conditions, crops, or compost products. Consultation should be supplied by compost producers and their technical staff and may also be obtained from agricultural institutions and the Cooperative Extension Service of the USDA.

Although the compost application rates outlined within the Field Guide have been used successfully with specific products and in particular situations, specific application rates for your field conditions and compost feedstock should be provided by the compost producer or local experts. Since compost application rates and successful usage are based on specific soil characteristics and compost quality, obtaining characterization data pertaining to the compost and soil is helpful, and in many cases, necessary. Performing a soil test is strongly suggested. It should also be understood that although suggested application rates are found within each guideline, states may possess specific regulations regarding compost utilization. These regulations should be consulted to identify the maximum allowable application rates in your state or specific situation, or allowable for specific crops. Maximum compost application rates are based on the treated crops annual available nitrogen requirement, as well as soil loading limits and compost content of specific contaminants. Compost suppliers should also be able to provide relevant data on these issues.

It is recommended that when using compost for the first time in a specific application, or when using a specific type or source of compost for the first time, that it be tested on a small scale. It should be understood that compost use guidelines are evolutionary documents, based on current research and experience and will be upgraded as additional relevant research is completed or field experience is obtained.

Reference to a company product name or technique does not imply approval or recommendation of the product by E&A Environmental Consultants, Inc., Hakoda Design, The University of Hawaii, the U.S. Department of Agriculture, The Composting Council, the State of Florida, the Clean Washington Center, or any of this document's reviewers, to the exclusion of others that may also be suitable.