Compost – A Guide for Evaluating and Using Compost Materials as Soil Amendments

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Compost is defined as the product resulting from the controlled biological decomposition of organic material. Compost can be derived from a number of feed stocks including yard trimmings, biosolids (sewage sludge), wood by-products, animals manures, crop residues, biodegradable packing, and food scraps. Mature compost has little resemblance in physical form to the original biodegradable from which it is made. Compost is valued for its organic matter content, and it typically used as a soil amendment to enhance the chemical, physical and biological properties of soil. Compost is typically not a fertilizer, although when used at normal rates it can reduce the amount of required fertilizer.

Compost can increase the water holding capacity of sandy textured soils, and can improve structure and water movement through heavier textured soils that are high in silt and clay content. By increasing the organic content of the soil, biological activity can be enhanced. Water and nutrient holding capacity can be improved in some soils. Some composts have the ability to suppress fungal diseases; research in this area is ongoing.

Due to the diverse nature of feed stock and composting processes, the quality of available compost materials can vary widely. Successful use of compost relies on evaluating the soil to be amended followed by an evaluation of available compost materials, and then determining the best material and rate to meet the desired objectives.

Soil testing is a first step in evaluating soils slated for landscape use. A standard horticultural soil test will usually include determinations of soil pH, salinity, sodium hazard, boron hazard, lime content, organic matter and soil texture. Most laboratories will also determine available nutrient levels. A laboratory will usually suggest organic and/or chemical amendments. Non-routine testing may be required if there is a suspicion of soil sterilants (under asphalt or in right-of-ways) or contamination.

COMPOST QUALITY PARAMETERS

A number of important compost parameters can also be determined by laboratory testing. Table 1 lists suggested parameters for high quality compost.

Gradation

Gradation or particle size is determined by passing the compost through a set of sieves and then determining the weight fraction retained on each sieve size. For turf or landscape establishment all the particles should pass a one-inch screen with a minimum of 90% of the material by weight passing a ½ inch screen. Although a fine textured compost is generally preferred, excessive dust fraction (particles less than 500 micron) can cause difficulties in handling and can also be an indication of low organic content.

Organic content

Organic matter is the measure of carbon based materials in the compost. High quality compost will usually have a minimum of 50% organic content based on dry weight. Another means of expressing organic content is to list the weight of organic matter per unit volume of compost. Most high quality composts will have a minimum of 250 pounds of organic material per cubic yard.

Carbon to nitrogen ratio

The carbon to nitrogen ratio is a parameter used to determine if a compost is nitrogen stable. Composts that are derived primarily from wood by-products have high carbon to nitrogen ratios unless additional nitrogen is added during the composting process. Biosolids and manures generally have low carbon to nitrogen ratios since these materials are nitrogen rich. In general, a carbon to nitrogen ratio of 35 or lower is preferred if the material is claimed to be nitrogen stablilized. At higher carbon to nitrogen ratios, nitrogen can be tied as the compost further decomposes. Nitrogen is then less available to plant material, and high levels of nitrogen fertilization are required to maintain optimum plant color and growth. Products with low carbon to nitrogen ratios (less than 20) can supply significant quantities of nitrogen as they decompose.

pH

pH is a numerical measure of the acidity or alkalinity of the soil. The pH scale ranges from 0 to 14 with a pH or 7 indicating neutrality. Most compost has a pH between 6 and 8. Products derived from wood residuals or peat moss can have pH values as low as 4.5, while manures are frequently alkaline (pH 8.0-8.5). Since specific plant species sometimes prefer a specific pH range, knowledge of both soil and compost pH can be important. pH can be further adjusted through the use of such materials as lime (to increase pH) and sulfur or iron sulfate (to decrease pH). Composts with very low pH (<4.0) should be used with caution since the low pH can be an indication or poor

composting practices which result in the formation of potentially toxic organic acids.

Soluble salts (salinity)

Soluble salt concentration is the concentration of soluble ions in solution. It is usually expressed as electrical conductivity (dS/m or millimhos per centimeter) of a saturated extract of either soil or compost. Soluble salt levels in compost can vary considerably, depending of feed stock and processing. Compost may therefore contribute to or dilute the accumulative soluble salt content in the amended soil. Knowledge of soil salinity, compost salinity, and plant tolerance to salinity is necessary for the successful establishment of plant material. For most turf and landscape plantings the final salinity (EC) of the amended soil should be less than 4.0 dS/m. Higher soluble salt levels would likely require leaching irrigations. Table 1 can be used to estimate the maximum allowable EC of compost.

Soluble nutrients, particularly potassium, calcium and nitrogen typically account for most of the salinity in compost products. Sodium is an undesirable soluble salt. This element should ideally account for less than 25% of the total soluble salts in compost.

Moisture content

Moisture content based on as received weight should be between 35% and 60%. The moisture content of compost affects its bulk density and therefore may affect transportation cost. Moisture content can also affect product handling. Compost which is too dry can be dusty and irritating to work with while compost which is excessively wet can be heavy and difficult to uniformly apply.

Contaminants

Compost materials used for horticultural application should be as free as possible of inert contaminants such as glass, metal and plastic.

Maturity and Stability

Maturity is the degree to which the compost is free of organic phytotoxic substances that can adversely affect seed germination on plant growth. Maturity and stability also relate to the level of biological activity in compost. Stable compost consumes almost no nitrogen or oxygen and generates little carbon dioxide or heat. Maturity and stability are difficult parameters to evaluate. Physical characteristics that are suggestive of a mature compost include a dark brown to black color and a soil-like or musty odor. There should be little or nor recognizable grass or leaves. Compost that has a sour or putrid smell should not be accepted. If the delivered compost is very hot (120F) or if the pile becomes very hot after rewetting, then the product is not stable.

Nutrient content

Although the nutrient content of compost is low compared to synthetic fertilizer products, compost is usually applied at greater rates and therefore nutrient contribution can be significant. The most commonly required nutrients are nitrogen, phosphorus and potassium. Composts are often analyzed for total and available nutrients. Wood residuals have relatively low nutrient content. Manure products are typically high in phosphorous and potassium. Yard waste products are often high in potassium. Materials derived from biosolids often have substantial nitrogen.

Heavy metal trace elements

Heavy metals are trace elements whose concentration are regulated by the EPA due to the potential for toxicity to humans, animals, and plants. Regulations governing the heavy metal derived from specific feed stocks have been promulgated on both the State and Federal levels. Trace elements referred to as heavy metals include arsenic, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, selenium, and zinc. Many of these elements are actually needed by plants for normal growth. Commercial compost producers are required to routinely test for heavy metals. This data is usually available from compost producers upon request.

Weed and disease

Commercial production of compost usually entails high temperature aerated composting which kills most weed seed along with diseases of animal and plant concern. Some yard waste compost can contain malva, burclover, and other weeds that are tolerant to heat. Compost producers and users need to be careful not to reintroduce weed seed into compost prior to use. If compost is properly processed, there has been very little evidence of plant disease carryover. In fact, there has been considerable interest in the ability of compost to suppress soil-borne plant diseases. Large compost producers are required to periodically check for diseases which are a concern from a human health standpoint. This data should be available from your compost supplier.

FEED STOCK CHARACTERISTICS

Yard waste

Yard waste is derived primarily from shrub and tree prunings, but can also include leaves, grass clippings, weeds, and ground Christmas trees. The material is derived from residential, commercial, and institutional landscaping activities. The feed stock is usually ground and composted in windrow configuration with frequent turning and water

addition. The finished compost is often screened and cured. The coarse product is sold as a surface mulch while the fines are sold as a soil amendment for incorporation. Compost derived from yard trimmings is usually near neutral in reaction. Salinity can be variable but will generally fall in the range of 3.5-10 dS/m. Organic content is often high, averaging approximately 70%. Yard waste composts are often high in available potassium and may also contain moderate quantities of phosphorus and calcium. Nitrogen content can be variable and depends on the amount of leafy material or grass in the original feed stock. Plastic, glass, and weeds are potential concerns. Heavy metals are typically low.

Biosolids

Biosolids or sludge-based composts are usually produced by combining digested sludge with an organic bulking agent. Yard trimmings and wood residuals are the most common bulking agents. Biosolids themselves are high in nitrogen content and are often very fine in texture. The composition of the compost produced depends greatly on the type and rate of bulking agent used. Salinity can be variable, with much of the soluble salt often attributed to soluble nitrogen. There is considerable work being done on the potential of sludge-based products for disease suppression. Heavy metal content and human pathogen presence are strictly regulated. Organic content can be variable but is generally greater than 50% in bulked products.

Manures

Cow or poultry manures are typically alkaline in reaction. Most are relatively high in soluble salts with potassium often very high. These products can also be high in available phosphorus. Most are nitrogen stable. Most manures are fine in texture.

Stable bedding

There are several compost producers which utilize stable bedding as the primary feed stock. The stable bedding is usually derived from wood shavings with or without straw. The stable sweepings include manure and urine. Composted stable bedding is usually of low density but is high in organic content. Salinity is variable, depending on the percentage of manure. These products are typically high in potassium and are usually alkaline in reaction.

Wood by-products

Many wood-based products would not fall in the compost classification since they are seldom thoroughly composted prior to sale. Traditional amendments have been redwood and fir sawdust, and fir, pine, or redwood bark. These are by-products of the lumber industry. These species have generally been used because they are relatively resistant to decomposition. All require the addition of nitrogen in order to counteract the potential nitrogen draw. The bark materials can contain moderate levels of potassium, while the wood products are usually low in nutrient value. Salinity is usually low and the pH of this material is usually acid. Iron is often added to darken the materials.

Wood or shavings derived from pine or hardwood make inferior soil amendments due to rapid decomposition and potential for nitrogen draw.

Other organic materials

Composts derived from rice hulls, mushroom growing media, coconut fiber, cotton gin trash, municipal solid waste and grape pumice are also available. These materials need to be evaluated prior to use.

USE RATES

The optimum compost application rate will vary depending on soil conditions, compost characteristics, and the type of landscape planting. When amending poor soils that are low in organic content, typical compost rates will be three to six cubic yards per 1,000 square feet. This corresponds to a 1-2 inch layer which is then incorporated to an approximate depth of 4-6 inches. This results in an inclusion rate of 20-30% compost by volume.

Factors which limit the rate of addition include salinity, ammonium, and heavy metals. Products that are typically high in salinity, like many manures, should be limited to approximately one cubic yard per 1,000 square feet. Products that are high in ammonium nitrogen (some biosolid composts) should be used with care since the ammonium can be injurious to young seedlings under certain conditions. If a compost high in ammonium is used, waiting several days after incorporation and prior to planting can reduce the potential for plant injury.

When utilizing any organic amendment it is important to thoroughly incorporate the amendment in order to avoid pockets or layers of organic material. The need for additional amendments like lime, soil sulfur, gypsum, or starter fertilizers should be based on soil tests and knowledge of the chemical composition of the compost

Additional information regarding compost and compost use is available from the University of California Extension Service, agricultural laboratories, and various professional organizations, including the Association of Compost Producers and the National Compost Council.

TABLE 1 - YARD WASTE COMPOST FOR USE AS AN INCORPORATED SOIL AMENDMENT -SPECIFICATION GUIDELINES-

1) **Gradation:** A minimum of 90% of the material by weight shall pass a ½" screen. Material passing the ½" screen shall meet the following criteria.

Percent Passing	Sieve Designation
85 – 100	9.51 mm (3/8")
50 – 80	2.38 mm (No. 8)
0 – 40	500 micron (No. 35)

2) **Organic content:** Minimum 50% based on dry weight and determined by ash method. Minimum 250 lbs. organic matter per cubic yard of compost.

3) **Carbon to nitrogen ratio:** Maximum 35:1 if material is claimed to be nitrogen stabilized.

4) **pH:** 5.5 – 8.0 as determined in saturated paste.

5) **Soluble salts:** Soluble nutrients typically account for most of the salinity levels but sodium should account for less than 25% of the total. To avoid a leaching requirement, the addition of the compost shall result in a final ECe of the amended soil of less than 4.0 dS/m @ 25 degrees C. as determined in a saturation extract. Use the following table to determine the maximum allowable ECe (dS/m of saturation extract) of compost at the desired use rate.

Desired Use Rate		Salinity (ECe) of On-Site Soil		
Cu. Yds. Amendment per 1000 sq. ft. for incorporation to 6" depth	Volume Percentage of Amendment	3 dS/m	2 dS/m	1 dS/m
		Maximum ECe of Compost		
1	5	**14**	**28**	**42**
2	11	**7**	**14**	**21**
3	16	**5**	**9.5**	**14**
4	22	**3.5**	**7**	**10.5**
5	27	**3**	**5.5**	**8.5**
6	32	**2.5**	**4.5**	**7**

Example: Specification calls for 6 cu. yds. compost per 1000 sq. ft. for incorporation to a 6" depth, and site soil has an ECe of 2.0. In order to avoid exceeding an ECe of 4 in the final blend, compost ECe should be less than 4.5 dS/m.

6) **Moisture content:** 35-60%

7) **Contaminants:** The compost shall be free of contaminants such as glass, metal and visible plastic. Heavy metals, fecal coliform, and *Salmonella sp* shall not exceed levels outlined in California Integrated Waste Management regulations.

8) **Maturity:** Physical characteristics suggestive of maturity include:
color: dark brown to black
odor: Acceptable = none, soil-like, musty or moldy Unacceptable = sour, ammonia or putrid
particle characterization: identifiable wood pieces are acceptable but the balance of material should be soil-like without recognizable grass or leaves.