Compost: Matching Performance Needs With Product Characteristics

Compost is becoming an increasingly popular soil amendment with growers, landscapers and other end users. Compost consists of organic matter (such as leaves, landscape trimmings, food scraps, or woody debris) that has undergone varying degrees of decomposition. In California, commercial composters are required to meet specific regulatory requirements on the compost process itself that protect health and safety. However, because no state or national standards exist for rating the quality of compost products, you must perform your own quality assessment. In addition to a visual inspection, you may want to assess other compost characteristics to ensure that you're getting a product that meets your specific needs within the price range that you're willing to pay. Before shopping for compost, determine your reasons for using compost. Once you've determined the performance requirements (e.g., for seed germination), look for a compost with appropriate characteristics. The table below is designed to help you assess compost products. The table is organized down the left column by performance requirement and across the top row by characteristic.

Performance Requirement	Compost Characteristics					
	Feedstock Type (Compost Ingredients)	**Salinity**	**Effect of Composting Method**	**Stability/ Maturity**	**Nutrients**	**pH**
Source of available nutrients	The nutrients in the feedstock will determine the available nutrients in the final product. Compost made from manures and biosolids is frequently higher in nitrogen (N) than that made primarily from yard trimmings or wood.	Not a significant factor	The anaerobic compost process (exposed to little or no oxygen) generates significant amounts of ammonia (NH_3) that are released into the atmosphere, leaving less nitrogen in the compost product. Compost that is produced through an aerobic process (exposed to adequate amounts of oxygen) generates less volatile ammonia.	Stable and mature compost contains a variety of available macronutrients, such as carbon (C), nitrogen (N), phosphorus (P) and potassium (K). Compost also contains micronutrients, such as copper (Cu), iron (Fe) and zinc (Zn). Unstable compost can immobilize nitrogen (N) and make it unavailable for plant use. See comments on the last page for information on assessing stability/maturity.	Most compost suppliers will give an analysis of major nutrient content in compost. However, not all of the nutrients are available for plant use. Typical mineralization (plant availability) rates are 10% to 15% for N and 30% for P for the first year. Approximately 85% of K is available during the first year. To calculate available nutrients, multiply the mineralization rate by the total amount of nutrient in the compost. Mineralization rates may vary by feedstock. Although significant N may not be readily available for fast-growing crops, its slow release contributes to soil nutrient levels over time.	The pH of the growing medium plays a large role in the availability of plant nutrients. In general, the pH of the compost should be greater than 5. However, pH of the soil should be taken into account.
Source of beneficial microorganisms	Some research suggests that carbon-rich feedstocks produce a compost with a higher fungal content and that nitrogen-rich feedstocks produce a compost with a higher bacterial content. More diverse feedstock may result in a more diverse population of microorganisms. Carbon-rich feedstocks include leaves and yard trimmings. Nitrogen-rich feedstocks include manures.	Not a significant factor.	Aerobically composted material is more likely to contain beneficial microorganisms than anaerobically digested or processed materials. Large compost piles may be more difficult to keep aerobic. However, large piles may be kept aerobic through frequent turning. Refer to the "Compost Quality Standards" publication listed on the last page for information on desirable microbiological test results.	In general, beneficial microorganisms are found in mature compost. See comments on the last page for information on assessing maturity.	Not a significant factor.	Alkaline (pH greater than 7) soils tend to be dominated by bacteria. Acidic (pH less than 7) soils tend to be dominated by fungi.
Appropriate for seed germination and/or transplants	Compost made from animal manure may not be appropriate for seed germination and transplants since it is frequently higher in salinity than compost made from yard trimmings and woody debris. Salinity should be assessed through lab analysis.	.75–3 dS/m (deci-Siemens/meter or millimhos/centimeter) is best for seedlings and young, tender plants. This should be the salinity of the final growing medium after compost has been applied and blended.	Aerobically composted material is most appropriate for seed germination and/or transplants. Compost that is intentionally, or unintentionally, anaerobically composted may contain ammonia and volatile organic acids that are considered toxic to plants. A smell of ammonia can indicate an immature and/or anaerobically composted material.	Stable and mature compost in combination with fertile soil or potting mix can be safely used for seed germination and/or transplants. Immature composts usually contain more growth-inhibiting substances that can be toxic to plants. A germination test is recommended prior to compost use. See comments on the last page for information on assessing compost stability/maturity.	Too much N can sometimes kill seedlings. In most cases, compost should be blended with soil prior to use for new growth. A standard blend for nursery use is 15% to 25% compost mixed with a standard wood residual.	pH less than 5 is likely to be immature and contain growth-inhibiting substances that can be toxic to plants. Best results are likely with compost that is neutral to alkaline (pH greater than or equal to 7).

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	Feedstock Type (Compost Ingredients)	**Salinity**	**Effect of Composting Method**	**Stability/ Maturity**	**Nutrients**	**pH**
Will not introduce viable weed seeds or pathogens	The type of feedstock composted will determine the likelihood and the type of noxious weed seeds and pathogens that may be present prior to composting. E. coli and salmonella are most prevalent in manure and biosolid feedstock. Seeds would be most likely in yard trimming feedstock.	Not a significant factor	Most weed seeds and pathogens are killed by high temperatures during the thermophilic stage of the composting process. However, some weed seeds are resistant to high temperature. Pursuant to State regulations (Title 14, California Code of Regulations, Section 17868.3), compost must be exposed to high temperatures for specified periods of time to kill weeds seeds and pathogens: ♦ Windrow method (elongated piles of compostable material that is turned on a periodic basis): 131^{o}F (55^{o}C) for 15 days with a minimum of 5 turnings. ♦ In-vessel method (compostable material that is enclosed in a container): 131^{o}F (55^{o}C) for 3 days ♦ Aerated static pile method (compostable material exposed to an air distribution system that either blows or draws air through the material): 131^{o}F (55^{o}C) for 3 days	Stable compost is unlikely to contain viable weed seed or plant pathogens.	Not a significant factor	Not a significant factor
Will not introduce contaminants	Contaminants in the compost product are dependent upon the type and cleanliness of the feedstock used and the level of grinding and screening. Visual inspection may identify some contaminants, such as plastic bags. Trace Elements: Biosolids may be significantly higher in trace elements, including heavy metals, than yard trimmings. However, heavy metals in compost produced by a permitted facility cannot exceed U.S. EPA Part 503 maximum levels. Glass, Plastic, and Metal Objects: Yard trimmings vary in the degree of inert contamination. Plastic sheeting from trash bags is common. However, most of these contaminants can be removed by the processor through adequate screening.	Not a significant factor	Not a significant factor	Not a significant factor	Not a significant factor	Not a significant factor
Enhances water holding capacity, soil structure, organic matter, drainage, and nutrient holding capacity of soil	Most compost is high in organic matter. Higher organic matter content in the compost will increase water-holding capacity. It also improves soil structure in both clay and sandy soils. Because it can break up clay soils, organic matter can help improve drainage. Organic matter also increases cation exchange capacity (CEC). Soils with a high CEC hold onto nutrients and reduce leaching to groundwater. Soil added to the compost may decrease total organic matter.	Not a significant factor	Compost that is ground and/or screened to a smaller particle size (less than ½ inch) may improve cation exchange capacity (CEC).	Not a significant factor	Not a significant factor	An acidic compost (pH less than 7) can have a higher cation exchange capacity (CEC) than an alkaline compost. At high rates of application, the CEC from compost may be a significant proportion of the total CEC in the soil, especially on sandy substrates.
Does not significantly increase soil salinity	The composition of the feedstock will determine the salinity of the final compost. The composting process actually concentrates salts so the finished product is higher in salinity than that the starting material. Compost made from animal manure may not be appropriate in specific situations since it is frequently higher in salinity than compost made primarily from yard trimmings or woody debris.	Certain crops may not tolerate high-salinity compost. For most established crops, electrical conductivity (used to measure salinity) of the growing medium (after compost has been applied and blended) should not exceed 5 dS/m.	Not a significant factor	Not a significant factor	Not a significant factor	Not a significant factor

Assessing Compost Stability and Maturity

It is difficult to determine the stability and maturity of a compost by visual analysis. Opinions regarding the parameters of stability and maturity vary widely within the compost, agricultural, and horticultural industries. The term "stable" is often used to describe compost that is not undergoing rapid decomposition and whose nutrients are relatively available for release into the soil; unstable compost, in contrast, can tie up nitrogen from the soil. It is important to note that compost that is not fully stable can be useful in certain situations.

For example, conventional growers may apply moderately unstable compost to increase soil organic matter; if they normally apply fertilizer, they may not be concerned about a small amount of nitrogen immobilization from compost. The term "mature" refers to the degree of phytotoxicity of a compost. An immature compost will contain more growth-inhibiting compounds than a mature compost. Compost that is immature may, for example, produce short-chain organic acids that are phytotoxic (toxic to plants), especially to seedlings. The following are sometimes used as indicators of compost stability and maturity.

Indicators of compost stability

1. **Temperature of the Compost.** In general, in moderate climates, if the temperature of the compost is more than 15°F (8°C) higher than the ambient air, the compost is still fairly unstable.
2. **Respiration Rate.** The rate of oxygen utilization represents the extent of biological activity. For horticultural applications, < 20 mg O_2 / Kg compost dry solids/hour is considered stable. For field applications, < 100 mg O_2 / Kg compost dry solids/hour is considered stable. The Solvita test, available from Wood's End Laboratories, is a quick test for respiration rate and also measures ammonia content. CO_2 production may also be used to assess respiration rate. Less than 5 mg CO_2 carbon/g compost carbon/day is considered stable and is usually suitable for seeds. Greater than 20 mg CO_2 carbon/g compost carbon/day may be fairly unstable. Composts that are cold, dry, or very salty may not respire even though they are not stable.
3. **Length of Compost Processing.** In general, compost made by the aerobic windrow method should be processed for a minimum of 60 to 90 days to produce a "finished" compost. "Finished" means usable, but not fully stable. However, compost should be processed a minimum of 90 to 120 days to be considered "stable." This is sometimes referred to as being "cured." Some experts believe that compost should cure for six months before use.
4. **Carbon:Nitrogen (C:N) ratio.** The C:N ratio decreases as compost becomes more mature or stable. Consequently, the C:N is sometimes used as an indicator of compost stability. However, for this ratio to be meaningful, you need to know the C:N ratio at the beginning and the end of the compost process. Ideally, the C:N should be approximately 30:1 at the beginning of the compost process. If the C:N ratio is low at the beginning of the compost process, a low C:N at the end of the process may not be a meaningful indicator of compost stability. Assuming the beginning C:N is approximately 30:1, the C:N of a moderately stable finished compost will be between 15:1 and 20:1. A very stable compost will have a C:N between 10:1 and 14:1 at the end of the composting process. A final C:N ratio above 20:1 may not readily release nitrogen. A final C:N of greater than or equal to 30:1 is thought to inhibit mineralization of nitrogen and may actually tie up nitrogen from the soil.
5. **Visual/Olfactory Inspection.** Although not a reliable method, one can do a cursory assessment of a compost by look and smell. In general, a mature compost will not contain recognizable feedstock material and should smell like rich soil. It should not smell foul or of ammonia.

Indicators of compost maturity

1. **Seed Germination.** Growers may want to perform a germination test using the seeds they will be planting. The following Web site includes guidelines for conducting your own seed germination tests: www.compostinfo.com/tutorial/MaturityTests.htm. Many labs will also perform seed germination tests.
2. **Maturity Index.** Some labs will assign a maturity index to compost based upon both the germination rate and the root tissue growth compared to a control.

Additional Resources

Additional information on compost quality may be obtained from the following Internet sites and publications:

Internet Sites

- **California Integrated Waste Management Board:** www.ciwmb.ca.gov/Organics/, (916) 341-6620.
- **California Compost Quality Council:** Web site is currently being developed, (530) 265-4560.
- **U.S. Composting Council:** www.compostingcouncil.org, (440) 989-2748.
- **Wood's End Laboratories:*** http://www.woodsend.org/, (800) 451-0337.
- **BBC Laboratories, Inc.:*** www.bbc-labs.com, (602) 967-5931.
- **Soil Foodweb, Inc.:*** www.soilfoodweb.com, (541) 752-5066.

**Reference does not imply endorsement by the California Integrated Waste Management Board*

Publications

- ***How Agricultural End Users Can Assess Compost Quality***
  Jean VanderGheynst, UC Davis. Available from the IWMB at (916) 341-6300.
- ***Field Guide to Compost Use***
  U.S. Composting Council, (440) 989-2748. Limited number available from IWMB at no cost at (916) 341-6300.
- ***Interpretation Guides to Compost Stability and Compost Maturity***
  BBC Laboratories, Inc., (602) 967-5931.
- ***Compost Quality Standards***
  Organic Ag Advisors and BBC Laboratories, Inc. Available from the IWMB at (916) 341-6300.
- ***Recommended Test Methods for the Examination of Compost and Composting***
  U.S. Composting Council, (440) 989-2748.
- ***Compost Production and Utilization: A Growers' Guide***
  Mark Van Horn, UC Division of Agriculture and Natural Resources, (510) 642-2431.
- ***A Farmer's Field Guide to Compost Production and Use***
  U.S. Composting Council, (440) 989-2748.
- ***Compost—A Guide for Evaluating and Using Compost Materials as Soil Amendments,***
  William Darlington, Soil and Plant Laboratories, Inc. Available from the IWMB at (916) 341-6300.

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