MUSHROOM COMPOST: What is it and How is it Used?

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The descriptive generic definition of compost by the US Composting Council is:

"Compost is the product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and 'processed to further reduce pathogens' (PFRP), and stabilized to the point that it is beneficial to plant growth. Compost bears little physical resemblance to the raw material[s] from which it originated. Compost is an organic matter source 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."

According to the definition, compost is a decomposed organic material. Therefore, it is not soil, nor is it dirt, which contains some organic material along with inorganic minerals.

Mushroom compost is a particular kind of compost that has applications in reclamation and water treatment. It is produced in four phases. Phase I mushroom compost is a mixture of hay, horse bedding straw, cottonseed hulls, cocoa shells, corncobs, poultry litter, gypsum, and water. It is pasteurized and turned several times to reach temperatures of 155-185°F over a two-week period. Phase II compost is the product after final pasteurization process prior to harvesting for another one to two weeks and then inoculated with mushroom spawn and placed in a mushroom house. Phase III compost has sphagnum peat moss added to initiate mushroom growth and harvesting. Phase IV compost is the product after post-production in which steam at 145F is injected into the compost for 24 hours to kill the mycelium, weed seed and bug larvae, prior to removal from the mushroom compost house. There is generally a 40- to 60-day period between Phase I and Phase IV mushroom compost. Because mushrooms are grown all year, mushroom compost is made all year.

Phase IV mushroom compost is considered an agricultural by-product. Its primary use is as a soil amendment to add organic matter, improve soil microflora, increase soil tilth, and improve water retention. Other uses include using it as a mulching material, as an inhibitor of artillery fungus when mixed with hardwood mulch, and as an organic material for anaerobic acid mine drainage wetlands, vertical-flow wetlands, and selenium bioreactors.

There are two "grades" of Phase IV mushroom compost:

1. Phase IV Fresh is pasteurized compost recently removed from the growing house and is less than three months old.

2. Phase IV Aged or Fully Composted is actively windrowed and turned to obtain complete biological decomposition for more than three months.

In general, Phase IV Fresh will have the highest micronutrient levels and soluble salts concentration, but the lowest C:N ratio. It will also be the least expensive. It should only be sold in bulk quantities because of its potential for additional decomposition and mass reduction. Phase IV Aged or Fully Composted material can be bought as bagged or bulk quantities.

Testing methods for compost vary by State and Agency. Agricultural agencies use Test Method for the Examination of Composting and Compost (TMECC). The US Department of Agriculture (USDA) and the Composting Council Research and Education Foundation (CCREF) jointly publish TMECC. Government funded projects may use compost tested by TMECC or by the American Association of State Highway & Transportation Officials (AASHTO). AASHTO is an international leader in setting technical standards for all phases of highway system development.

Standards are issued for design, construction of highways and bridges, materials, and many other technical areas.

Table 1 compares compost parameters for vegetated and non-vegetated areas for AASHTO projects. It is important for users (including farmers, design engineers, contractors, landscapers, or reclamationists) to understand the footnotes in the tables as well as units for each parameter. This is especially important if fresh pasteurized mushroom compost is to be considered for use in both vegetated and non-vegetated use. Table 2 lists the average and standard deviation of fresh pasteurized mushroom compost from a series of mushroom compost samples since 2008, all of which are considered "wet" or "as is."

In comparing the AASTHO standards in Table 1 with the average values of fresh mushroom compost in Table 2, average particle size of the compost is within the AASHTO limits, but soluble salts in compost (with an average of 12.9 dS/m in Table 2) can be two to three times higher than the "Max 5" dS/m standard in Table 1. The apparent elevated values of soluble salts for mushroom compost raise concerns for many people who want to use mushroom compost as a mulch or potting substrate for vegetables and ornamental plants or soil amendment. Soluble salts refer to plant nutrients such as potassium, calcium, magnesium and sodium which are often complexed with anions such as carbonates, sulfates, chlorides, and phosphates. While soluble salts are needed for soil fertility and plant growth, an excessive amount of these salts can have a negative influence on plant growth. As noted in footnote c of Table 1, each plant has a salinity tolerance rating and therefore it is crucial to know current soil characteristics prior to amending with mushroom compost so that excess concentrations are not added which may cause high soluble salt concentrations in the soil or material being used for plant growth.

Examples of salinity sensitive plants that have been grown in soil amended with fresh mushroom compost include the following four examples.

Figure 1

Parameters[A,B]	Reported as (Units of Measure)	Surface Mulch to be Vegetated	Surface Multch to Be Left Unvegetated
pH[C]	pH units	5.0-8.5	N/A
Solubule Salt Concentration (Electrical Conductivity)	dS/m (mm/hos/cm)	Max 5	Max 5
Moisture Content	% wet weight basis	30-60	30-60
Organic Matter Content	% dry weight basis	25-65	25-100
Particale Size	% passing a selected mesh size, dry weight basis	3 in. (75 mm), 100% passing 1 in. (25 mm), 90% to 100% passing	3 in. (75 mm), 100% passing 1 in. (25 mm), 90% to 100% passing
		¾ in. (19 mm), 65% to 100% passing	¾ in. (19 mm), 65% to 100% passing
		¼ in. (6.4 mm) 0% to 75% passing	¼ in. (6.4 mm) 0% to 75% passing
		Max particle length of 6 in. (152 mm)	Max particle length of 6 in. (152 mm)
Stability/ Maturity[D]			
Carbon Dioxide Evolution Rate	mg CO_2-C per g OM per day	<8	N/A
Physical Contaminants (Man-made Inserts)	%, dry weight basis	<1	<1

A Recommended test methodologies are provided in Test Methods for the Examination of Composting and Compost (TMECC, The U.S. Composting Council)

B Landscape architects and project (field) engineers may modify the allowable compost specifications ranges based on specific conditions and plant requirements.

C Each specific plant species requires a specific pH range. Each plant also has a salinity tolerance rating, and maximum tolerable quantities are known. When specifying the establishment of any plant or turf species, it is important to understand their pH and soluble salt requirements and how they relate to the compost in use.

D Stability/ Maturity rating is an area of compost science that is still evolving, and as such, other various test methods could be considered. Also, never base compost quality conclusions on the result of a single stability/ maturity test.

Figure 2

Material as is	Value	Unit	SD of value
pH	6.8		0.6
Organic Matter	24.7	%	2.6
Moisture	61.9	%	4.2
Nitrogen, Total	1.0	%	0.1
Nitrogen Ammonium	0.1	%	0.2
Nitrogen, Organic	0.9	%	0.2
Phosphorus [P2O5], Total	0.5	%	0.1
Potassium, [K20]	1.0	%	0.2
Carbon	13.2	%	2.4
C:N Ratio	13.9		2.9
Soluble Salts	12.9	dS/m	1.9
Calcium	2.2	%	0.4
Magnesium	0.3	%	0.0
Sulfur	0.8	%	0.1
Copper	39.9	ppm	12.1
Iron	998.6	ppm	329.9
Manganese	132.2	ppm	26.6
Zinc	78.7	ppm	15.3
Aluminum	617.6	ppm	124.4
Sodium	1159.2	ppm	370.8
Sodium Adsorption Ratio (SAR)	2.6		0.8
Particle Size % <9.5mm	83.7	%	6.5
Stability/Maturity, mg CO2-C/g organic matter/day	7.4		1.8

Example 1. Strawberries are growing in a high tunnel where a 6-inch layer of compost was applied around the plants and irrigated. Salinity tolerance of strawberries is <4 dS/m.

Example 2. Mushroom compost was applied two inches deep over heavy clay soil without tilling and seeded with fescue grass directly into the compost. The fescue seed has a salinity tolerance of 3.9 dS/m.

Example 3. In Baltimore, a community garden group tilled compost into the soil at a 1:1 ratio and directly seeded lettuce and spinach. Salinity tolerance of these plants are 8 dS/m.

Example 4. A grower used a two-inch mushroom mulch cover for this Norfolk Island Pine houseplant. Typical potting soil has a soluble salt concentration of <4 dS/m.

These examples show that mushroom compost can be used as an amendment or as a potting substrate in a wide variety of plants. When using mushroom compost as a mulching material or as a material for growing plants on reclamation sites, it is important to understand the properties of the material being amended and to understand the nutrient requirements of plants being grown to correctly apply appropriate rates. This evaluation process will enhance growth conditions for plants using fresh mushroom compost.

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