Compost Use Guidelines for Gardens, Landscapes, & Small Farms

Compost is the product resulting from managed, controlled decomposition of organic materials. In general, stable, mature compost results from materials reaching a certain minimum temperature for a specific amount of time with sufficient aeration and moisture. This process promotes growth of certain microorganisms, converts organic carbon to carbon dioxide, reduces the viability of pathogens and weed seeds, and incorporates nutrients into a rich organic matrix.

As an amendment to soil or soilless substrates, compost can beneficially alter chemical, physical and biological properties. Chemical changes include addition of essential plant nutrients, increased cation exchange capacity (CEC), and possible liming effects. Physical changes may include improvements in soil structure, porosity, infiltration, permeability and water-holding capacity. Additionally, compost can increase microbial diversity.

Although compost is beneficial, it is possible to use too much compost! Therefore, it is important to determine "safe" compost application rates to prevent harm to plants and to maintain healthy, productive soil. "Safe" compost application rates depend on the physical and chemical properties of the compost, frequency of application (i.e., one time only or several times per year) as well as soil texture, soil pH and soil fertility. All recommended application rates herein are guidelines based the chemical properties of the compost and based on the assumption that soil pH is optimal and there are no concerns with soil copper (Cu) or zinc (Zn) levels.

Compost Applications Rates

Physical properties: Apply no more than a 3-inch thick layer of compost at any given time when tilled to 6 inches or 50 percent by volume (or equivalent), regardless of chemical properties or application frequency. Higher application rates may negatively affect physical properties of the amended substrate (e.g., too much water-holding capacity, not enough air porosity).

Application frequency: For maintenance (i.e., application on a given bed or garden at least yearly), limit application to a maximum thickness of 1 inch total per year, or lower rates as indicated by chemical properties. For garden or bed establishment (one time application), apply compost at rates according to chemical properties discussed below.

Chemical properties: NCDA&CS standard waste analysis provides measurements of the following parameters: soluble salts (SS), pH, sodium (Na), carbon-to-nitrogen (C:N) ratio, and the essential plant nutrients nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sulfur (S), iron (Fe), manganese (Mn), Zn, Cu, and

boron (B). Upon request and for an additional charge, the agricultural lime equivalent (ALE) is also provided on the report. The maximum compost application rate should be based on the rate-limiting chemical property or parameter.

Determine the rate-limiting chemical property or parameter

The primary rate-limiting chemical properties of compost to consider are soluble salts, zinc, copper and ALE. Refer to Table 1 to determine recommended levels for soluble salts, zinc, and copper and Equation [1] to determine an appropriate level for ALE.

Soluble salts or electrical conductivity (EC) is a general measure of water-soluble plant nutrients. High levels can cause "salt burn" to plants. Symptoms of salt burn include scorched leaf tips and margins, slowed growth, wilting, and brown roots.

Zinc and copper are essential plant nutrients, however, they are also heavy metals that can be toxic to plants. Interveinal yellowing of new growth and stunting are symptoms of zinc and copper toxicity. The potential for zinc and copper toxicity increases as soil pH decreases. Some animal-based manure composts have elevated levels of these nutrients.

Agricultural lime equivalency (ALE) indicates the potential for the compost to increase pH of the amended growing substrate. Specifically, the ALE is defined as the quantity of compost (in tons) that will provide a liming effect equivalent to one ton of agricultural grade limestone (90% $CaCO_3$). There is potential to 'over-lime' when using a compost with significant ALE. Over-liming may reduce availability of nutrients, particularly micronutrients leading to subsequent nutrient deficiencies.

Table 1. Compost application rates based on its limiting chemical properties.[1]

Application rate (maximum compost thickness and percent by volume)[2]	Waste Analysis Parameter				
	Soluble salts (SS) 10^{-5}S/cm[3]		Zinc (Zn) lb/ton		Copper (Cu) lb/ton
3-inch (50%)	0 – 300	*and*	0.00 – 0.15	*and*	0.00 – 0.10
2-inch (33%)	301 – 400	*and*	0.16 – 0.25	*and*	0.11 – 0.15
1-inch (17%)	401 – 800	*and*	0.26 – 0.50	*and*	0.16 – 0.25
< 0.5-inch (8%)	>800	*and*	>0.50	*and*	>0.25

[1] Determine the highest level of these three parameters from the waste report to identify the recommended maximum compost application rate. Consider the possibility that ALE may be a rate-limiting factor if Ca levels are above 45 lb per ton.
[2] Percent volume calculation assumes tillage to a depth of 6 inches.
[3] SS conversion factor: 100 10^{-5}S/cm x 0.01 = mS/cm

To identify the rate-limiting parameter, refer to your NCDA&CS waste analysis report and Table 1 to determine the maximum levels for soluble salts, zinc and copper. The parameter with the lowest application rate based on the maximum level from the waste report is the rate-limiting chemical property. By this practice, the suggested application rate based on levels of parameters identified to cause harm minimizes potential for risk of over application.

As an example, suppose a waste analysis report indicates the following: under "Laboratory Results," SS = 300 10^{-5} S/cm, and under "Nutrients Available for First Crop," Zn = 0.5 lb/ton and Cu = 0.10 lb/ton. Based on Table 1, the maximum application is 3 inches based on SS and Cu levels and 1 inch based on the Zn levels, thus out of these three parameters, Zn is the rate-limiting chemical property and the compost should not be applied at rates greater than 1 inch.

After determining the maximum application thickness from Table 1, consider the potential of the compost to increase soil pH by evaluating the ALE. The ALE is not included with standard analysis of compost samples. However, you can indirectly estimate it by referring to the calcium levels. If the amount of calcium under "Nutrients Available for First Crop" is above 45 lb per ton, assume that the compost has a significant ALE. At this point, you can (1) contact the lab and request that the ALE be determined for an additional charge (using the CCE test) or (2) limit application to less than a 0.5-inch thick layer (tilled to 6 inches).

When the ALE value is known, the maximum application rate depends not only on this value but also on the soil pH and on the soil test report lime rate recommended. If the compost has an ALE, its application rate should not exceed the amount needed to meet the lime requirement of the target crop, otherwise micronutrient deficiencies may occur. To calculate the compost application rate based on ALE, use Equation [1] where lime rate is obtained from a soil test report, ALE is obtained from a waste analysis report, and a fresh (wet) compost bulk density of 1000 lb/yd^3 is assumed.

Equation [1]: Compost thickness (in.) = Lime rate (lb per 1000 ft^2) × ALE × 0.000324

Compare the thickness calculated in Equation [1] to the maximum rate determined in Table 1, and use the lowest amount.

Other Chemical Properties of Compost

Other measurements on the waste analysis report include pH and carbon-to-nitrogen ratio (C:N). The measure of pH indicates hydrogen-ion concentration and helps compost producers monitor the quality and progress of the composting process. Remember that pH cannot be used to predict the impact the compost will have on the final substrate pH. As discussed above, the ALE is needed to predict changes to substrate pH.

The C:N ratio can be an indicator of the stability of a compost. In general, carbon provides energy/food for microbial activity in the compost process. Carbon levels and C:N ratios decrease as the compost matures or stabilizes. A general rule is that a compost with a C:N ratio below 15:1 is "stabilized" — meaning that microorganisms will not excessively deplete available nutrients needed for plants .

Table 2 is a reference that helps determine the volume of compost needed for specific application thicknesses. Use it to determine how much compost should be obtained for a specific gardening or landscaping project.

In summary, to determine the recommended compost application rates:

(1) Never apply more than 3 inches of compost (tilled to 6 inches) or 50 percent by volume (or equivalent).

(2) For maintenance applications (once per year or more), never apply more than a total of 1 inch to any given bed or garden within a year.

(3) For first-time or one-time garden or bed preparation, refer to soluble salts, zinc and copper results on the waste analysis report and refer to Table 1 to determine the maximum rate of compost to apply.

(4) Refer to the calcium results on the waste analysis report to determine if the material has a liming potential If there is more than 45 lb calcium per ton, test the sample for ALE or limit application to less than 0.5 inch (tilled to 6 inches).

(5) If available, use the waste-report ALE value, the soil-test lime recommendation rate and Equation [1] to calculate the appropriate application thickness. If this value is less than the thickness determined from Table 1, then it is the rate-limiting factor.

Table 2. Volume of compost needed to cover a specific area.

Compost thickness (inches)	Cubic feet (ft^3) to cover			Cubic yard (yd^3) to cover			% volume (tilled to 6 inches)
	100 ft^2	1000 ft^2	acre	100 ft^2	1000 ft^2	acre	
0.125	1	10	453	0.04	0.4	17	2.1
0.25	2	21	906	0.08	0.8	34	4.2
0.50	4	42	1,813	0.15	1.5	67	8.3
0.75	6	63	2,719	0.23	2.3	101	12.5
1.0	8	83	3,625	0.31	3.1	134	16.7
1.5	13	125	5,438	0.46	4.6	201	25.0
2.0	17	167	7,250	0.62	6.2	269	33.3
2.5	21	208	9,063	0.77	7.7	336	41.7
3.0	25	250	10,875	0.93	9.3	403	50.0
4.5	38	375	16,313	1.39	13.9	604	75.0
6.0	50	500	21,750	1.85	18.5	806	100.0

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