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Vermicompost 101

The first in a two-part article series discusses how vermicompost is made and how to use it.

With growing interest in organic and sustainable production methods, we're seeing interest and increased questions about the use of vermicompost in greenhouse container production. In the first of a two-part series, we'll cover the basics of vermicompost, including how it's made and tips for using it in container production. In the second article, we'll discuss our experiences trialing different vermicompost products for bedding plant and vegetable transplant production in greenhouses.

How does vermicompost differ from compost?

Compost is the end product of organic matter that has decomposed in a controlled manner. Composts can be made from almost any feedstock that's decomposable in nature. Yard waste, food scraps, animal waste and animal bedding are common sources for compost. When completely decomposed and cured, composts can make an excellent amendment to greenhouse container substrates.

However, composts can cause problems in container substrates if they're not properly prepared. Immature or "hot" composts can release high levels of ammonia and volatile organic compounds, which can damage seedlings and sensitive plants. Immature composts can also compete with the plant in the container for nitrogen, leading to nutrient deficiencies. While a great substrate amendment, a mature/finished compost cannot typically act as the sole source of nutrients for container production due to its low overall fertility and slow nutrient release rate. This is especially true in greenhouse production of bedding plant and vegetable transplants where higher levels of nutrients are required during the narrow window that the crops are produced.

Vermicompost is the end product of the process whereby worms feed on slowly decomposing materials in a controlled environment to produce a nutrient-rich soil amendment. Most operations use red wigglers (*Eisenia fetida*). The worms facilitate an enhanced decomposition process by physically degrading the feedstock and stimulating microbial activity. Worms secrete mucus, which enriches the moisture and carbon content of the feedstock, enriching the associated microbe community. As worms digest the feedstock, physical degradation of particles from their gut muscles, as well as their associated microbes, facilitate decomposition. This improves the structure and the nutrient availability of the final product. Since vermicompost introduces an additional finishing process, it doesn't suffer from some of the same problems as traditional compost in short-term greenhouse production. The "hot" compost problem isn't observed in vermicompost and, in fact, the bulk of the nitrogen is in the nitrate form instead of ammonium. Due to the fact that vermicompost is a further processed form of the feedstock than traditional compost, nutrient levels are higher and the plant availability is greater. Additionally, vermicomposts may contain microbial communities that have been found, in some cases, to suppress plant diseases.

All vermicomposts are not created equal

Similar to traditional composts, several factors affect the quality of a finished vermicompost, including the feedstocks and processes used. It's important to understand how a particular vermicompost is made and work with the supplier to periodically test batches to ensure they're suitable for production.

The feedstock or initial organic matter in the compost has a large impact on the finished product. The initial nutrient levels will

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Table 1. Nutrient analysis during the different phases of composting at Worm Power, LLC. Analysis is on a fresh weight (as received) basis.

	Raw dairy manure and bedding feedstock	Thermophillic compost	Vermicompost
	% Dry weight		
N	0.4	1.0	1.7
P_2O_5	0.1	0.4	0.7
K_2O	0.2	0.9	1.5
	ppm		
Ammonium-N	757	10	64
Nitrate-N	9	9	2,222

change the finished product. If you start with a feedstock that has low levels of nitrogen and higher levels of carbon, then you will end up with a product that has lower levels of plant-available nitrogen in the end. Some of the commonly used feedstocks for vermicompost are food scraps, yard waste, sawdust, and animal manures and bedding material. Manure-based vermicomposts tend to have higher levels of nitrogen and other nutrients than the previously mentioned feedstocks. Therefore, a lower application rate can be used to provide plant fertility. Figure 1 on page 68 shows an example of the effect of the different sources of vermicompost on plant growth. Vermicompost produced from dairy manure and bedding was suitable as the sole fertilizer source for producing tomato transplants at an incorporation rate of 10% by volume, whereas this same rate did not result in proper plant growth when using a sawdust-based feedstock.

The process followed for vermicomposting will also affect the end product. Commonly used processes include outdoor windrows, in-vessel rotating systems, static piles with aeration tubes and continuous flow reactors (in which thin layers of feedstock are frequently added to the top of a relatively deep bed containing worms, while finished material is periodically harvested from the bottom of the bed).

Chemical properties

As we've discussed, vermicomposting enriches the amount and availability of nutrients within a feedstock. Table 1 on page 66 gives one example of the nutrient transformation that takes place when a dairy solid feedstock is thermophillically composted and then subsequently vermicomposted.

The recommended pH range of bedding plants and vegetable transplants grown in peat-based substrates is 5.5 to 6.5 and container-grown plants often exhibit nutrient deficiencies out of this range. Iron and manganese deficiency is commonly observed in container-grown plants with a high root-zone pH and this deficiency is easily mitigated by lowering the substrate pH. The pH of vermicompost is often above the acceptable range and between 7 to 8 (Figure 1a). Organic producers have fewer tools than conventional growers >>>

Figure 1a: pH

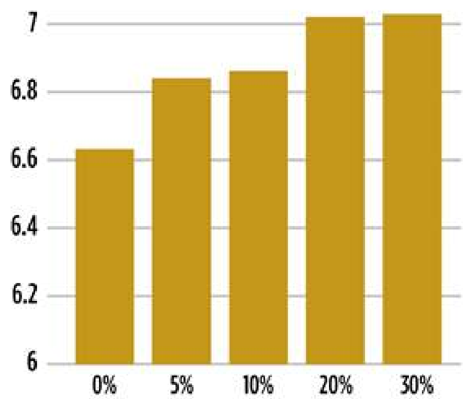
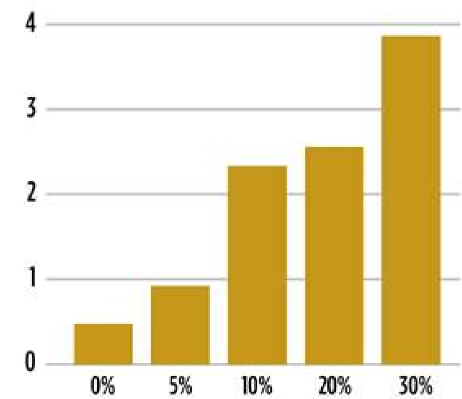


Figure 1b: Electrical Conductivity (mS/cm)



Figures 1a and 1b: Substrate pH (A) and electrical conductivity (B) of a peat/perlite substrate substrate with dairy solids vermicompost added at 0% to 30% by volume.

to lower substrate pH. Approved citric or acetic acids may be used, but they're weaker acids than sulfuric, nitric or phosphoric acid. Another solution is to test substrate pH before adding lime and modify your lime rate to account for the high pH of vermicompost.

EC is also an indicator of the fertility level of the substrate or nutrient solution. Vermicompost often has a high EC due to its nutrient content and other non-essential salts. Therefore, vermicompost EC should be tested and the incorporation rate should be adjusted so as to not damage sensitive plants and seedlings. In dairy manure-based vermicompost, we've observed EC readings of 10 to 20 mS/cm.

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To put this in perspective, North Carolina State University recommended EC level for a conventional grower of tomatoes and peppers is 2 to 3.5 mS/cm using the "pour-thru" method. Vermicompost should, therefore, be added to substrates in low amounts to increase the fertility without harming sensitive plants (Figure 1b). One confounding aspect of the EC level is that no guidelines have been established for organic production. As compared with conventional fertilizers, organic components tend to have higher levels of other non-essential salts that add to the EC, but don't necessarily contribute to fertility. Therefore, with organic fertilization, it's difficult to draw a direct link between EC and fertility. Therefore, a laboratory analysis is also essential to determine the constituent nutrients/salts in a particular vermicompost source.

Vermicompost in certified organic production

The National Organic Program (NOP) allows the use of vermicompost in certified organic production, so long as their guidelines are met. The vermicompost must be made from allowed materials, including plant/animal materials not contaminated with prohibited substances, non-synthetic substances that aren't prohibited by NOP and synthetic substances approved by NOP for use as plant or soil amendments. The vermicomposting process should ensure that aerobic conditions are maintained, such as by adding thin layers of organic matter at 1- to 3-day intervals, regular turning or using forced air pipes. Moisture should be maintained at 70% to 90% and temperatures should be kept below 95F (35C) so that earthworms aren't harmed. The time period followed will depend on the type of process used. Typically, this is six to 12 months for outdoor windrows, two to four months for indoor container systems, and 30 to 60 days for continuous flow reactors. If compost/vermicompost is prepared following NOP criteria, then there's no restriction in organic production systems on the time interval between application and harvest of edible crops.

An excellent fact sheet on this topic is available at www.extension.org/pages/18567/making-and-using-compost-for-organic-farming. Organic producers should always consult their certification agents before purchasing and using products.

Photos 1a and 1b. Tomato transplants grown in dairy solids vermicompost (A) and sawdust-based vermicompost (B) added to a peat/perlite substrate at rates of (L to R) 0%, 5%, 10%, 20% and 30% by volume.

In summary, if you're intending to add vermicompost to your container substrates, we recommend testing early and often. Work with your vermicompost supplier to understand their material and recommendations for using it in container production, then be sure to monitor the pH and EC of your substrate before planting and during production. We recommend that growers make small batches of vermicompost containing substrates and that they test them under their own growing conditions. **GT**

Disclaimer: Mention of trademarks or brand names is for informational purposes only and doesn't imply its approval to the exclusion of other products that may be suitable.

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