MANAGEMENT

Vermicomposting Horse Manure no. 1.224

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Quick Facts...

Vermicomposting uses a specific type of earthworm that works with other compost organisms to decompose manure and bedding.

Earthworms breathe through their skin and must be in an environment that has at least 40 percent moisture (at least as damp as a wrung out sponge).

Worm excrement is commonly called castings.

Worms can double their population every four months under ideal conditions.

What is Vermicomposting?

The prefix "vermi" is Latin for worm. Vermicomposting refers to the utilization of the digestive process of earthworms to make compost. Vermicomposting uses specific types of earthworms (e.g., red worms, tiger worms, red wigglers) that work with other compost organisms to decompose manure and bedding.

Is Windrow Vermicomposting Right for My Operation?

Advantages

- Minimal aeration of the windrow is necessary; therefore, labor and equipment costs are reduced.
- Supplemental nitrogen is not needed so there are no nitrogen costs.
- Worm castings (worm feces) improve plant growth over windrow compost.
- Under ideal conditions red worms double their population every four months.

Disadvantages

- Initial cost of red worms (up to $12 per pound for bulk orders plus shipping) may be cost prohibitive.
- Monitoring and caring for red worm population year round.
- Decomposition depends upon the number of red worms in the windrow.
- The market is less developed for worm castings than it is for regular compost.
- This technique may not kill weed seeds or parasites.

What Types of Earthworms are Used?

There are three types of earthworms:

1. ***Anecic*** (Greek for "up from" or "out of the earth")
   - Builds permanent burrows into the deep mineral layers of the soil.
   - Drags organic matter from the soil surface into their burrows for food.
   - Includes the familiar bait worm–the nightcrawler (*Lumbricus terrestris).*
2. ***Endogeic*** (Greek for "within the earth")
   - Builds extensive permanent burrows in the upper mineral layer of soil.
   - Feeds on the organic matter in the soil.
   - Lives exclusively in soil and usually are not noticed, except after a heavy rain when they come to the surface.
3. ***Epigeic*** (Greek for "upon the earth")
   - Lives on the soil surface.
   - Forms no permanent burrows.
   - Feeds on decaying organic matter.

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• Used for composting and commonly called: red worm, manure worm, brandling worm, red wiggler, and compost worm (all *Eisenia fetida);* tiger worm and red tiger worm (both *Eisenia andrei*).

In Colorado, both *E. fetida* and *E. andrei* have been proven to withstand near freezing conditions. This makes them the best choice for outdoor vermicomposting. Often laboratory tests are required to distinguish the two *Eisenia* species and because their performance is the same, the generic name, *Eisenia* (eye-**sen**-ee-uh), will be used to refer to both species throughout this fact sheet.

The Biology of *Eisenia*

Respiration, Digestion, Excretion, and Reproduction

Earthworms breathe through their skin and must be in an environment that has at least 40 percent moisture (at least as damp as a wrung out sponge). If their skin dries out they cannot breathe and will eventually die.

Instead of teeth, *Eisenia* have a gizzard like a chicken. They eat bacteria, fungi, other compost organisms and decaying organic matter small enough to fit into their mouth. In doing so, they can consume close to their body weight in compost material every 24 hours. However, on average, they consume half their body weight every 24 hours. To get this rate of decomposition you must maintain ideal compost conditions, as described below.

Worm excrement is commonly called castings. While they may look and feel like tiny flecks of sticky soil, they are full of beneficial soil microbes. Scientists have yet to conclude exactly why *Eisenia* castings are good for plants, but they seem to contain nutrients that plants can easily use and disease-suppressing microbes. The mucous covering on the castings also appears to slow down nutrient release. In addition, enzymes in the gut of *Eisenia* may kill many pathogens harmful to plants, horses, or humans that pass through its gut. In any case, castings will not burn your plants, even seedlings, and they have a neutral pH.

Under ideal conditions, *Eisenia* can double their population every three months. They are hermaphroditic (having both male and female reproductive parts) and become sexually mature when the familiar band (the clitellum) appears around their body, closer to their mouth. Each worm with a clitellum is capable of producing four cocoons per week containing, on average, two baby worms each.

Will horse dewormers kill red worms?

The most common wormer used is known by the brand name Ivermectin® made by the Merial Company. Merial's research shows that the active chemicals in Ivermectin® are deactivated when manure is exposed to sunlight. Equine studies show that 95 percent of the active chemicals in Ivermectin® are deactivated in the horse before being passed in the feces. Leading experts in vermicomposting believe that the concentration of Ivermectin® in the horse manure is not high enough to seriously injure Eisenia.

Environmental Requirements

Eisenia tolerate temperatures from 39 to 90 F. Their ideal range is 65 to 75 F. They tolerate moisture levels from 40 to 100 percent but prefer 60 to 80 percent. *Eisenia* tolerate a pH range of 2 to 9, preferring a range of 5.5 to 7. *Eisenia* are sensitive to sunlight or electric light. Their breathing becomes depressed after as little as five minutes of light exposure. At this point *Eisenia* become confused and disoriented, making it difficult to find shelter. More than 30 minutes exposure to sunlight can kill *Eisenia*. They normally do not live in densities greater than 1,000 worms per cubic foot of material. *Eisenia* search out these desirable conditions in a windrow provided there is a food source.

How Do I Get Started?

This sheet bases much of its information on fact sheet 1.225, *Composting Horse Manure in Dynamic Windrows*. It's necessary to refer to that fact sheet in order to understand and implement the information and methods described herein.

How many *Eisenia* are needed?

One pound of *Eisenia* (approximately 1000 worms) will eat approximately 3.5 pounds of material per week. A single horse produces about 350 pounds of manure per week. So, you will need 100 pounds of *Eisenia* per horse to digest each week's amount of manure. If this manure is mixed half and half with bedding, you'll need 200 pounds of *Eisenia* per horse. For many, the initial cost of $12 per pound plus shipping makes this suggested population prohibitive.

The best option for many operations is to start with as many worms as you can afford, maintain ideal conditions for them, and record doubling times to calculate when you have a population that can decompose your amount of manure and bedding. Monitoring your vermicomposting windrow is the best method for determining how quickly the manure and bedding are composting. Dig into the windrow and see if the material has been transformed into castings. With a little practice you will be able to distinguish bedding and manure from castings. Castings are usually darker than manure. See Table 1 for ideal pounds of *Eisenia* required to digest fresh manure and bedding produced in a week within seven days.

Example: *50 pounds of* Eisenia *will reproduce to 1,000 pounds of worms shortly after four doubling periods (in just over 16 months). In two years, that initial 50 pounds of* Eisenia *will be more than enough (3200 pounds) to vermicompost the manure from 30 horses.*

Regardless of the option you choose, request *Eisenia* that are "bed run." These contain worms, castings, bedding, and cocoons. They will speed the colonization of your windrow and adjust to specific conditions of your vermicomposting windrow faster.

How to Set Up the Vermicomposting Windrow

Option 1: Establish the area for the vermicomposting windrow following the guidelines in fact sheet 1.225, *Composting Horse Manure in Dynamic Windrows*, but **do not** add additional nitrogen to the manure and bedding. Monitor temperature in the windrow and turn it **before** temperatures reach 145 F to prevent carbonizing the material and reducing its palatability for *Eisenia. Eisenia* digest material faster if it has composted for seven to 10 days first.

Create an initial base of material 6 feet wide, 18 inches tall, and 6 feet long. The base should be oriented east/west so it receives sun- light on its south side all day.

Table 1: Ideal pounds of *Eisenia* required to digest all manure and bedding as it is produced.

Number of Horses	Pounds of Eisenia Required with Manure Only	Pounds of Eisenia Required with Manure and Bedding[a]
1	100 pounds	200 pounds
2	200 pounds	400 pounds
5	500 pounds	1,000 pounds
10	1,000 pounds	2,000 pounds
20	2,000 pounds	4,000 pounds
30	3,000 pounds	6,000 pounds
40	4,000 pounds	8,000 pounds

[a]50 percent manure and 50 percent bedding.
+ Assumes one pound of worms eats ½ pound of material every 24 hours.
++ Assumes three doublings per year (every four months is one doubling).
+++ Requires that normal weekly volumes are supplied and not excess from stockpiles.

Water this base of material until it feels wetter than a wrung out sponge. Divide your quantity of worms and distribute them evenly over the top of the moistened base material. *Eisenia* should immediately migrate into the material.

Once the worms have colonized this material, add a 3-inch layer of material weekly to the start-up pile and moisten appropriately. Add to the pile gradually to prevent it from heating up and killing the worms.

Since this process should not generate heat, it is advisable to set up the initial windrow in the summer. A large windrow will be formed during the season to help retain heat during the winter months.

After the pile reaches a height of 3 feet, add new material to the end of the pile in the direction that the windrow will be built. It should match the width of the start-up pile and have a height of 3 feet to allow for volume reduction. Facilitate the heating of this new material (by turning and watering) to a maximum temperature of 145 F. *Eisenia* will migrate into this new material once it has digested all of the start-up pile and the new material has cooled below 90 F and has ideal moisture levels.

Continue lengthening the windrow until you run out of space. At this point you can make a "U-turn" and advance back in the opposite direction, parallel to the first windrow.

Warning: Manure and bedding are difficult to wet once they completely dry out!

Option 2: Create a base layer as you would in Option 1 that is 18-inches tall, 6 feet wide and as long as six weekly volumes of material will allow. Water the material and distribute *Eisenia* evenly across this 18 inch tall windrow as you would in Option 1. Allow *Eisenia* to colonize this windrow and digest most of

the material in the base. The time required for this will be dependent on the number of *Eisenia*. Monitor weekly for moisture and digestion.

Once *Eisenia* have digested most of the base layer, add a 3-inch layer of material on top of the base layer down the length of the windrow. Continue weekly monitoring for moisture and digestion. Create additional 3-inch layers at a frequency determined by how quickly *Eisenia* digests the material.

After this first windrow reaches 3 feet in height, begin building the second base layer parallel to and touching the first windrow as you did initially. As *Eisenia* begin colonizing this new base layer, add your first 3-inch layer to this second windrow. Add more layers as you notice *Eisenia* digesting the material.

Which Option Do I Choose?

Option 1:

Advantages

- Involves less hand labor.
- *Eisenia* population grows more rapidly.
- Pathogen and weed seed reduction.

Disadvantages

- Digestion is not as thorough.
- There is a greater chance of the windrow becoming dangerously hot.

Option 2:

Advantages

- There is a lesser chance of the windrow becoming too hot.
- Digestion is more complete – more castings.

Disadvantages

- More hand labor involved.
- *Eisenia* population does not grow as rapidly.

Maintaining the Vermicomposting Windrow

Adding more material to a windrow will be based on how quickly *Eisenia* are digesting their current vermicomposting section. Moisture and temperature management in the windrow dictates where they migrate to or from.

Monitor temperature along the length of the windrow with a compost thermometer (2 feet long). If temperatures exceed 90 F, open holes along the top of the windrow to release the heat. Maintaining high moisture levels suppresses heat-producing microbes, but be careful – too much water will force air (and worms) out of the windrow.

It may be necessary to cover the windrow with a compost cover to retain heat during colder periods. Use clear or black plastic films to retain the windrow's heat and gain solar heat. Be sure to leave openings at the ground level to allow for air exchange and to prevent anaerobic conditions. Higher windrows retain more heat as well, but do not exceed 5 feet in height.

Harvesting the Vermicompost

Allow time for the majority of worms to migrate into the new material before harvesting castings (keep your worms!). You will need to check older sections of the windrow to see if the worms have migrated out of it prior to harvesting. Castings can be tilled into the soil directly from the windrow or screened for adding to greenhouse soil mixes, potted plants, lawns, and gardens.

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