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Production Technology of Vermicompost and Its Characteristics

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Abstract

Farmers and agricultural scientists face a wide range of challenges as crop yields stagnate, organic matter declines, multi-nutrient deficiencies occur, climate change affects agriculture, primary agricultural resources are shrinking, genetically modified organisms are resisting them and labour is scarce. It has been determined that uneven fertilization and diminishing soil organic matter content have caused crop yield and productivity of the majority of crops to stagnate. Vermicomposting contributes significantly to the maintenance and enhancement of soil fertility. As organic wastes are returned to the soil, they can improve soil properties and contribute to the improvement of soil quality, fertility and productivity. Vermicomposting organic waste creates high-quality compost in terms of nutrients and is effective at speeding up the decomposition process. It is a crucial part of an integrated plant nutrient supply system that ensures healthy soils, balanced fertilization and long-term productivity.

Keywords: Earthworm, Natural enemies, Soil health, Vermiculture

Introduction

Many faunas are found in the soil, some of which are helpful in increasing the fertility of the soil. It has been observed that earthworms are more closely associated with agriculture than any other soil fauna. Real humic acids, as opposed to polysaccharide-gum humic acids, are produced in the intestine of earthworms. Approximately 50% of the gums produced by earthworms are in the type of mucoproteins that support and stabilize pore space distribution. Earthworm soil casts provide a higher level of plant nutrients (nitrogen, Ca, Mg, K, P and exchangeable calcium) and organic carbon than regular soil. The earthworms contribute 60-90 kg of nitrogen to the soil through their castings and decaying tissues. Using earthworms, you can produce high-quality compost from organic waste and farm waste. For this, *Eisenia foetida*, *Perionyx exacavatus*, *Eudrillus euginiae* and *Lumbrius rubellus* are important. These species could be raised on dung and organic squander. A technique for cultivating them is vermiculture and another is vermicomposting, which involves using them to break down residues into compost. About 1,000 adult earthworms can create 1 kg of compost every day from 5 kg of garbage (Chanda *et al.*, 2013). Only 5 to 10% of the substrate is assimilated by the earthworm; the remainder goes through the digestive tract and is thrown up as cast. Earthworm cast contains nutrients, vitamins, hormones and antibiotics. Vermicompost is a solid, fine-grained organic material that can be used in soil to loosen it and allow air to enter. Vermicompost of good grade has an organic content of more than 20%, a high bulk density, 10.04% air space, particles larger than 0.2 mm in diameter and a moisture content of between 75% and 90%. As well as nutrients, a few of the worm's secretions and their associated microbes play a role in vermicompost's growth promotion. With continuous use, it enhances the basic characteristics of the soil. By slowing nutrient release, vermicompost allows plants to absorb nutrients more readily. Vermicompost-enriched soil adds additional nutrients that aren't available in chemicals. In addition to its multi-faceted benefits, vermicompost also contributes to crop growth and yield.

Article History

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Vermicomposting

It is a process for creating compost using earthworms, which typically reside in soil, consume biomass and expel it undigested and the compost obtained from this process is called vermicompost.

Vermiculture

The science of vermiculture involves breeding and reraising earthworms in controlled environments.

Vermi Technology

"Vermi-technology" refers to a broad range of methods and innovations involving the utilization of earthworms (vermiculture) for different purposes, including waste management, soil improvement and sustainable agriculture. Vermi-technology works to improve the socioeconomic status of rural people by creating opportunities and reducing pollution through recycling solid waste, among other things.

Types of Earthworms in Vermicomposting

Earthworms belong to the phylum Annelidae group of the animal kingdom, which are long, cylindrical and divided into several grooves. There are over 3000 species of earthworms worldwide, with 384 species being found in India (Sharma *et al.*, 2005). Mostly 3 types of worms are used in vermicomposting.

1. Epizoic

This type of worm is also referred to as manure worms or compost worms, because of its short lifespan and quick reproduction and high decomposition rate. Epizoic worms travel downhill after grabbing food from the top of partially decomposed organic materials. *Eisenia foetida* (Red earthworm), *Eudrilus eugeniae* (night crawler), *Perionyx excavatus*, *etc*. are under this group (Yangchan *et al.*, 2019). *Eisenia foetida* is selected for its fast reproduction and its ability to transform substantial quantities of organic waste into vermicompost. Red earthworm has body length 3-10 cm, body weight 0.4-0.6 g, maturity 50-55 days, conversion rate of 2.0 q per 1500 worms in 2 months, cocoon production occurs every 3 days and incubation period are 20-23 days (Yangchan *et al.*, 2019).

2. Endozoic

This worm is also referred to as a field worm because it consumes food from the lower part of the soil rather than organic matter. Endozoic worms aid in soil churning, air movement and the blending of organic debris.

3. Anesic

Anesic lives in a hole created by himself lives an incredibly complex lifestyle and likes to eat leaves.

Materials Used in Vermicompost Preparation

All biodegradable wastes, including crop residue, weed biomass, vegetable waste, leaf litter, hotel trash, agro-industry waste and the biodegradable elements of both urban and rural waste.

Favorable Conditions of Earthworms in the Composting Material

- pH: 6.5-7.5.
- Moisture: 60-70%.
- Aeration: 50%.
- Temperature: 18 °C to 35 °C.

Procedure for Vermicomposting

When consumed of materials through the worms, they are physically broken down into particles in the gizzard, which expands the surface area that microorganisms can colonize. In the gut, several enzymes carry out various functions such as protease, lipase, amylase, cellulase and chitinase. These enzymes convert intricate biomolecules into straightforward substances. Only 5-10% of the material consumed by worms is incorporated into their tissues for development; the remainder is expelled as cast. The gut wall's mucus secretions increase the vermicompost's structural integrity. Vermicomposting can be done by various methods but the most popular ones are the bed and pit processes.

Bed Method

An organic mixture of 6×2×2 feet size is laid down on the pucca/ kachcha floor as a bed for composting. This method is simple to follow and put into use (Figure 1).

Figure 1: Bed method of vermicomposting

Pit Method

Composting is carried out in cemented pits of size 6×2×2 feet. This cover can be made of pallet grass, jute bag or any other material that is locally used to cover the pit. Due to inadequate aeration, water logging at the bottom and higher production costs, this approach is not chosen (Figure 2).

The vermicomposting unit (size: 6×2×2 feet) is installed in a cool, moist and shaded place. The number of units can change depending on the quantity that is available and the requirements of raw materials. In a 3:1 ratio, cow dung is mixed with chopped dried leafy material and kept for 15-20 days to partially decompose. During this time, the pile should be kept moist with light water to maintain a favorable temperature for the worms. We release 1500-2000 red earthworms on top of the pit or bed and cover them with gunny bags or paddy straw to protect them from predators. After putting the worms, water should be sprayed properly so that it can always be kept moist. To promote aeration and optimum decomposition, the bed needs to

Figure 2: Pit method of vermicomposting

be changed over once every 20 to 30 days. In the confined space joined by drainage pipes installed at the tank's base, a reddish-colored liquid that reacts with alkaline and dissolved nutrients, known as vermiwash, accumulated. In this way, vermicompost is ready for 45-50 days. Rock phosphate, Azolla, *etc*. can be added accordingly for the value addition of vermicompost.

Precautions

• Avoid covering vermicompost beds or piles with plastic wrap because doing so could trap heat and gases.

• Keep the heels of vermicompost from preventing excessive temperatures as it can harm their population.

• The worms are killed by dry circumstances and they are driven away by water-logging. In the summer, watering should be done every day and in the wet and winter months, every third day.

• A higher quantity of acidic materials such as tomato wastes and avoids citrus wastes.

• To develop a drainage pathway around the pile to avoid stagnation of water, especially in locations with extreme rainfall during the wet season.

• Non-biodegradable objects including glass shards, plastics, ceramic tubes or bulbs, stones, *etc*. should not be present in the organic materials used for composting.

Characteristics of Vermicompost

An application of vermicompost, which is made from organic material biodegraded non-thermophilically by earthworms and microorganisms, has a great ability for water-holding, aeration, drainage and porosity. It has a larger surface area that provides a variety of microsites for microbial activity and good nutrient retention. Additionally, the majority of the nutrients such as nitrates, phosphates, exchangeable calcium, soluble potassium, *etc*. are present in forms that plants can use. In table 1, we showed the nutrient composition of vermicompost. Vermicompost has been observed to include auxins, cytokinins, humic compounds and other chemicals that are created by microbes and enhance plant growth. Based on reports, vermicasts have an increased Base Exchange Capacity and high organic matter content, as well as phosphorus, potassium and calcium, with reduced electrical conductivity, a significant increase or reduction in oxidation potential and water-soluble chemicals, which are potentially hazardous to the environment. Vermicompost contains many enzymes such as proteases, amylases, lipases, cellulases and chitinases that continue to break down organic matter long after they ejected from the system. The diverse population and activity of microbes present in vermicompost makes it an ideal soil amendment. Vermicompost is recognized as a superior product because it is consistent and has a minimum contamination level thereby having a tendency to retain more nutrients for a longer period of time without endangering the ecosystem.

Table 1: Nutrient composition of vermicompost

Nutrient Element	Content
Organic carbon (%)	10-14
Nitrogen (%)	0.5-1.6
Phosphorus (%)	0.2-1.1
Potassium (%)	0.2-1.7
Calcium (%)	1.2-7.6
Magnesium (%)	0.1-0.6
Sodium(ppm)	600-1600
Zinc (ppm)	40-1100
Copper (ppm)	26-48
Iron (%)	0.21-1.33
Manganese (%)	0.011-0.20

(Source: Ray, 2016)

Natural Enemies and Their Control

The most common natural enemies of vermiculture are ants, termites, centipedes, rats, pigs, birds, *etc*. Before mixing the material into the pile, treat the area with 4% neem-based insecticide or chlorpyriphos 20 EC at 2 ml l^{-1}.

Harvesting

When the raw material is completely broken down, it appears brittle, grainy and black. Watering needs to stop when the compost is ready. The completely decomposed manure should be placed on a pile of partially decomposed cow dung so that earthworms can come out of the manure and migrate to cow dung. After two days, the compost should be separated from the partially decomposed cow dung and sieved as per its utility.

Storing and Packing of Vermicompost

To protect from the sun, chopped vermicompost should be stored in a shady and cool place. Loss of moisture and nutrient content will take place in the presence of sunlight. One must note that the harvested material should be

stored openly rather than packed in a pouch. When selling, packaging should be done. If it has been stored in an open space, water should be sprayed periodically to maintain moisture levels. Vermicompost can be stored for up to 1 year without any loss of its quality if the moisture content is maintained at 40% level.

Application of Vermicompost to Crops

Vermicompost can be used in all types of crops (agriculture, horticulture, ornamental and vegetable crops) but is mainly used for vegetables and fruit crops. Vermicompost should be used around the root area in the open ring and mixed with soil. The quantity of vermicompost used in some crops is shown in table 2.

Table 2: Quantity of vermicompost use of different crops

Sl. No.	Crops	Quantity of Vermicompost
1.	Agricultural crops	30-40 q ha^{-1}
2.	Fruit trees	5-10 kg $tree^{-1}$
3.	Vegetables	30-40 q ha^{-1}
4.	Ornamental plants	5-7 q ha^{-1}

(Source: Srinivasarao *et al*., 2013)

Conclusion

The Vermicomposting technology utilizes earthworms as versatile bioreactors that encourage the breakdown of organic materials, maintain soil fertility and promote effective nutrient recycling and plant growth. Vermicompost's value is increased because it also has simultaneously other advantages: if extra worms aren't being grown on polluted waste and aren't being used as a soil pollutant, they can be utilized as a protein-rich animal feed and in pharmaceuticals. In India, many farmers have expertise with this technology in a variety of climate zones, which will lead to a high need for vermicompost in the future to create cultivable land. Since organic waste is found in high quantities in developing countries like India, there is a need to expand in the form of growing on a large scale and maintaining worm cultures as well as using organic waste for their maintenance as cottage industries.

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