Journal of Advanced Zoology

ISSN: 0253-7214
Volume 45 Issue 3 Year 2024 Page 225:231

"Earthworm Can Provide Life To Soil And Eradicating Use Of Chemical Fertiliser"

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Article History Received date: 05/02/2024 Revised date: 20/02/2024 Accepted date: 02/03/2024

Introduction

Earth worms are nature's way of recycling organic nutrients from dead tissues back to living organisms. Many have recognized the value of these worms. Ancient civilizations, valued the role earthworms played in soil. Earthworms are sacred and recognized the important role the worms played in fertilizing. The earthworm is a natural resource of fertility and life. Earthworms live in the soil and feed on decaying organic material. After digestion, the undigested material moves through the alimentary canal of the earthworm, a thin layer of oil is deposited on the castings. This layer erodes over a period of 2 months. So although the plant nutrients are immediately available, they are slowly released to last longer. The process in the alimentary canal of the earthworm transforms organic waste to natural fertilizer. The chemical changes that organic wastes undergo include deodorizing and neutralizing. This means that the pH of the castings is 7 (neutral) and the castings are odorless. The worm castings also contain bacteria, so the process is continued in the soil, and microbiological activity is promoted.
The process of composting crop residues using earthworms comprise spreading the agricultural wastes and cow dung in layers as 1.5 m wide and 0.9 m high beds of required length. Earthworms are introduced in between the layers @ 350 worms per m3 of bed volume. The beds are maintained at about 40 - 50% moisture content and a temperature of 20 - 30o C by sprinkling water over the beds. The earthworms being voracious eaters consume the biodegradable matter and give out a part of the matter as excreta or vermi-castings. The vermi-casting containing nutrients is rich manure for the plants.Vermicomposting is the process of turning organic debris into worm castings. The worm castings are very important to the fertility of the soil. The castings contain high amounts of nitrogen, potassium, phosphorus, calcium, and magnesium. Castings contain: 5 times the available nitrogen, 7 times the available potash, and 1 ½ times more calcium than found in good topsoil. The content of the earthworm castings, along with the natural tillage by the worms burrowing action, enhances the permeability of water in the soil. Worm castings can hold close to nine times their weight in water.Using earthworms to convert waste into soil compost, has been done on small and large scales and found that waste produced by the worms was could be very beneficial to plants and soil. People are commercially producing vermicompost and sell the castings that the worms produce. People who own farms or even small gardens, and they put earthworms into their compost heap, and then use that for fertilizer.

Materials for preparation of Vermicompost

Any types of biodegradable wastes-
1. Crop residues
2. Weed biomass
3. Vegetable waste

4. Leaf litter
5. Hotel refuse
6. Waste from agro-industries
7. Biodegradable portion of urban and rural wastes

Stages of vermicomposting

Stage 1	:	Processing involving collection of wastes, shredding, mechanical separation of the metal, glass and ceramics and storage of organic wastes.
Stage 2	:	Pre digestion of organic waste for twenty days by heaping the material along with cattle dung slurry. This process partially digests the material and fit for earthworm consumption. Cattle dung and biogas slurry may be used after drying. Wet dung should not be used for vermicompost production.
Stage 3	:	Preparation of earthworm bed. A concrete base is required to put the waste for vermicompost preparation. Loose soil will allow the worms to go into soil and also while watering, all the dissolvable nutrients go into the soil along with water.
Stage 4	:	Collection of earthworm after vermicompost collection. Sieving the composted material to separate fully composted material. The partially composted material will be again put into vermicompost bed.
Stage 5	:	Storing the vermicompost in proper place to maintain moisture and allow the beneficial microorganisms to grow.

Compost worms need five basic things:

1. An hospitable living environment, usually called "bedding"
2. A food source
3. Adequate moisture (greater than 50% water content by weight)
4. Adequate aeration
5. Protection from temperature extremes

Bedding

Bedding is any material that provides the worms with a relatively stable habitat. This habitat must have the following characteristics:

High absorbency

Worms breathe through their skins and therefore must have a moist environment in which to live. If a worm's skin dries out, it dies. The bedding must be able to absorb and retain water fairly well if the worms are to thrive.

Good bulking potential

If the material is too dense to begin with, or packs too tightly, then the flow of air is reduced or eliminated. Worms require oxygen to live, just as we do. Different materials affect the overall porosity of the bedding through a variety of factors, including the range of particle size and shape, the texture, and the strength and rigidity of its structure. The overall effect is referred to in this document as the material's bulking potential.

Low protein and/or nitrogen content (high Carbon: Nitrogen ratio)

Although the worms do consume their bedding as it breaks down, it is very important that this be a slow process. High protein/nitrogen levels can result in rapid degradation and its associated heating, creating inhospitable, often fatal, conditions. Heating can occur safely in the food layers of the vermiculture or vermicomposting system, but not in the bedding.

Vermicompost Production Methodology : Selection of suitable earthworm for vermicompost production, the surface dwelling earthworm alone should be used. The earthworm, which lives below the soil, is not suitable for vermicompost production. The African earthworm (*Eudrillus engenial),* Red worms (*Eisenia foetida)* and composting worm (*Peronyx excavatus)* are promising worms used for vermicompost production. All the three worms can be mixed together for vermicompost production. The African worm (*Eudrillus eugenial)* is preferred over other two types, because it produces higher production of vermicompost in short period of time and more young ones in the composting period.

Selection of site for vermicompost production

Vermicompost can be produced in any place with shade, high humidity and cool. Abandoned cattle shed or poultry shed or unused buildings can be used. If it is to be produced in open area, shady place is selected. A thatched roof may be provided to protect the process from direct sunlight and rain. The waste heaped for vermicompost production should be covered with moist gunny bags.

Containers for vermicompost production

A cement tub may be constructed to a height of 2½ feet and a breadth of 3 feet. The length may be fixed to any level depending upon the size of the room. The bottom of the tub is made to slope like structure to drain the excess water from vermicompost unit. A small sump is necessary to collect the drain water.
In another option over the hand floor, hollow blocks / bricks may be arranged in compartment to a height of one feet, breadth of 3 feet and length to a desired level to have quick harvest. In this method, moisture assessment will be very easy. No excess water will be drained. Vermicompost can also be prepared in wooden boxes, plastic buckets or in any containers with a drain hole at the bottom.

Vermiculture bed

Vermiculture bed or worm bed (3 cm) can be prepared by placing after saw dust or husk or coir waste or sugarcane trash in the bottom of tub / container. A layer of fine sand (3 cm) should be spread over the culture bed followed by a layer of garden soil (3 cm). All layers must be moistened with water.

Common Bedding Materials

Bedding Material	**Absorbency**
Horse Manure	Medium-Good
Peat Moss	Good
Corn Silage	Medium-Good
Hay – general	Poor
Straw – general	Poor
Straw – oat	Poor
Straw – wheat	Poor
Paper from municipal waste stream	Medium-Good
Newspaper	Good
Corrugated cardboard	Good
Lumber mill waste -- chipped	Poor
Paper fibre sludge	Medium-Good
Paper mill sludge	Good
Leaves (dry, loose)	Poor-Medium
Corn stalks	Poor
Corn cobs	Poor-Medium
Paper mill sludge	Good
Sawdust	Poor-Medium
Shrub trimmings	Poor
Hardwood chips, shavings	Poor
Softwood chips, shavings	Poor
Leaves (dry, loose)	Poor-Medium
Corn stalks	Poor
Corn cobs	Poor-Medium

The selection of bedding materials is a key to successful vermiculture or vermicomposting. Worms can be enormously productive (and reproductive) if conditions are good; however, their efficiency drops off rapidly when their basic needs are not met (see discussion on moisture below). Good bedding mixtures are an essential element in meeting those needs. They provide protection from extremes in temperature, the necessary levels and consistency of moisture, and an adequate supply of oxygen. Fortunately, given their critical importance to the process, good bedding mixtures are generally not hard to come by on farms. The most difficult criterion to meet adequately is usually absorption, as most straws and even hay are not good at holding moisture. This can be easily addressed by mixing some aged or composted cattle or sheep manure with the straw. The result is somewhat similar in its bedding characteristics to aged horse manure.

Worm Food - Compost worms are big eaters. Under ideal conditions, they are able to consume in excess of their body weight each day, although the general rule-of-thumb is of their body weight per day. They will eat almost anything organic (that is, of plant or animal origin), but they definitely prefer some foods to others. Manures are the most commonly used worm feedstock, with dairy and beef manures generally considered the best natural food for Eisenia, with the possible exception of rabbit manure. The former, being more often available in large quantities, is the feed most often used. Worms can survive in a pH range of 5 to 9 (Edwards, 1998), but some researchers say near to neutral condition (Latifah AbdManaf *et al.*, 2009) and few say 7.5 to 8.0 is optimum (Georg, 2004). In general, the pH of worm beds will come down over time. If the food source is alkaline, the effect is a moderating one, tending to neutral or slightly alkaline pH. If the food source or bedding is acidic (coffee grounds, peat moss), then the pH will go down to below 7.0. This condition may encourage pests such as mites. The pH can be adjusted upwards by adding calcium carbonate and downwards by adding peat moss. Earthworms are very sensitive to salts, hence, prefers salt content of less than 0.5 per cent (Gunadi *et al.*, 2002).

Earthworms prefer mostly organic food of plant or animal origin. Manures are the most commonly used. Dairy and beef manures are generally considered as the best natural food with exception of rabbit manure (Gaddie and Douglas, 1975). Horse manure is suitable for the growth of earthworms and does not need any pretreatment and can be applied directly as a feed. They especially enjoy vegetable and fruit peelings, grains, coffee grounds and filters and newspaper. They should not be overloaded with high citrus diet as orange peels can introduce d-limonene which gives moldy fruit stand. The 'sewage sludge' from the municipal water and wastewater treatment plants and the punch waste materials (gut contents of slaughtered ruminants) from abattoir also make good feedstock for earthworms (Edwards, 1988; Edwards, 1998; Fraser-Quick, 2002; Sinha *et al.*, 2009a). Livestock rearing waste *e.g.* cattle dung, pig and chicken excreta makes excellent feedstock for earthworms.

Solid waste from paper pulp and cardboard industry, food processing industries including brewery and distillery, vegetable oil factory, sugarcane industry, aromatic oil extraction industry, sericulture industry, logging and carpentry industry also make excellent feedstock for vermicomposting (Edwards, 1988; Edwards, 1998; Kale, 1998). Worms can also compost 'fly-ash' from coal power plants. Some trees such as cedar and fir having high levels of tannins, when used a feed, it can harm worms and even drive them from the beds. Pre-composting of wastes can reduce or even eliminate most of these threats (Gunadi *et al.*, 2002). The meat, dairy and oil based products shouldn't be added.

Ants, bacteria, beetle, centipedes, collembola, fruit flies, fungus gnat, mite, millipede, mold, pill bug or roly poly, slug, snail, soldier fly, soldier fly larva, sow bug, spider, springtail, moles and birds and white worm are some of the enemies of earthworm (Mark Leary, 2004). Moles and birds can be prevented by barriers such as wire mesh while, centipedes can be destroyed manually (Sherman, 1997). Avoiding sweet foods in the vermin beds and maintaining pH above 7.0 will control the ants. White and brown mites compete with worms for food only but red mites are parasitic thus suck blood or body fluid from worms as well as cocoons (Sherman, 1997). Maintaining the moisture level below 85 per cent, addition of calcium carbonate to keep pH stays at neutral or above can control mite. Worms may be affected by 'Sour crop or protein poisoning' disease (swollen clitellum'or worm crawl aimlessly around on top of the bedding) which can be solved by avoiding protein rich foods/ overfeeding and keeping pH at neutral or above.

Common Worm Feed Stocks

Food	Advantages
Cattle manure	Good nutrition; natural food, therefore little adaptation required
Poultry manure	High N content results in good nutrition and a high-value product
Sheep/Goat manure	Good nutrition
Hog manure	Good nutrition; produces excellent vermicompost
Fresh food scraps (e.g., peels, other food prep waste, leftovers, commercial food processing wastes)	Excellent nutrition, good moisture content, possibility of revenues from waste tipping fees
Pre-composted food wastes	Good nutrition; partial decomposition makes digestion by worms easier and faster; can include meat and other greasy wastes; less tendency to overheat.
Fish, poultry offal; blood wastes; animal mortalities	High N content provides good nutrition; opportunity to turn problematic wastes into high-quality product

Putting the waste in the container -The predigested waste material should be mud with 30% cattle dung either by weight or volume. The mixed waste is placed into the tub / container upto brim. The moisture level should be maintained at 60%. Over this material, the selected earthworm is placed uniformly. For one-meter length, one-meter breadth and 0.5-meter height, 1 kg of worm (1000 Nos.) is required. There is no necessity that earthworm should be put inside the waste. Earthworm will move inside on its own.
Watering the vermibed -Daily watering is not required for vermibed. But 60% moisture should be maintained throughout the period. If necessity arises, water should be sprinkled over the bed rather than pouring the water. Watering should be stopped before the harvest of vermicompost.
Harvesting vermicompost -In method of composting, the castings formed on the top layer are collected periodically. The collection may be carried out once in a week. With hand the casting will be scooped out and put in a shady place as heap like structure. The harvesting of casting should be limited up to earthworm presence on top layer. This periodical harvesting is necessary for free flow and retain the compost quality. Other wise the finished compost get compacted when watering is done. In small bed type of vermicomposting method, periodical harvesting is not required. Since the height of the waste material heaped is around 1 foot, the produced vermicompost will be harvested after the process is over.After the vermicompost production, the earthworm present in the tub / small bed may be harvested by trapping method. In the vermibed, before harvesting the compost, small, fresh cow dung ball is made and inserted inside the bed in five or six places. After 24 hours, the cow dung ball is removed. All the worms will be adhered into the ball. Putting the cow dung ball in a bucket of water will separate this adhered worm. The collected worms will be used for next batch of composting.Worm harvesting is usually carried out in order to sell the worms, rather than to start new worm beds. Manual Methods -Manual methods are the ones used by hobbyists and smaller-scale growers, particularly those who sell worms to the home-vermicomposting. In essence, manual harvesting involves hand-sorting, or picking the worms directly from the compost by hand. This process can be facilitated by taking advantage of the fact that worms avoid light. If material containing worms is dumped in a pile on a flat surface with a light above, the worms will quickly dive below the surface. The harvester can then remove a layer of compost, stopping when worms become visible again. This process is repeated several times until there is nothing left on the table except a huddled mass of worms under a thin covering of compost. These worms can then be quickly scooped into a container, weighed, and prepared for delivery.

Storing and packing of vermicompost -The harvested vermicompost should be stored in dark, cool place. It should have minimum 40% moisture. Sunlight should not fall over the composted material. It will lead to loss of moisture and nutrient content. It is advocated that the harvested composted material is openly stored rather than packed in over sac. Packing can be done at the time of selling. If it is stored in open place, periodical sprinkling of water may be done to maintain moisture level and also to maintain beneficial microbial population. If the necessity comes to store the material, laminated over sac is used for packing. This will minimize the moisture evaporation loss. Vermicompost can be stored for one year without loss of its quality, if the moisture is maintained at 40% level.

Advantages of vermicompost

- Vermicompost is rich in all essential plant nutrients.
- Provides excellent effect on overall plant growth, encourages the growth of newshoots / leaves and improves the quality and shelf life of the produce.
- Vermicompost is free flowing, easy to apply, handle and store and does not have bad odour.
- It improves soil structure, texture, aeration, and waterholding capacity and prevents soil erosion.
- Vermicompost is rich in beneficial micro flora such as a fixers, P- solubilizers,cellulose decomposing micro-flora etc in addition to improve soil environment.
- Vermicompost contains earthworm cocoons and increases the population and activity of earthworm in the soil.
- It neutralizes the soil protection.
- It prevents nutrient losses and increases the use efficiency of chemical fertilizers.
- Vermicompost is free from pathogens, toxic elements, weed seeds etc.
- Vermicompost minimizes the incidence of pest and diseases.
- It enhances the decomposition of organic matter in soil.
- It contains valuable vitamins, enzymes and hormones like auxins, gibberellins etc.

Conclusions

Keeping in view the increasing interest towards organic farming across the globe, Vermicompost has been recognized as one of the potential organic sources of nourishing the plants in Agriculture, Horticulture and Floriculture. Vermicompost is rich in macronutrients, besides micronutrients, plant growth promoting hormones, beneficial soil microbes and mycorrhizal fungi. In view of ever increasing demand for organic foods across the world and its pivotal role in maintaining the soil health and productivity, vermicompost is definitely going to be a viable component of organic farming. Switching over to sustainable agriculture by 'Vermiculture Revolution' can truly bring in 'economic prosperity' for the farmers and the nations with 'environmental security' for the earth. Further, earthworms do have multifarious uses in Agriculture and pharmaceutical industries.

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