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REVIEW ARTICLE OPEN ACCESS

A Review: Vermicompost

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Abstract

The process of "bio-oxidation and stabilization of organic material involving the joint action of earthworms and mesophilic micro-organisms" is known as vermicomposting. Worms can reduce the volume of agricultural waste by 40 to 60% when given the right circumstances Earthworm activity produces vermicompost, which is rich in macro and micronutrients, vitamins, growth hormones, enzymes such as proteases, amylases, lipases, cellulose, and chitinase, as well as immobilized microflora. Even after leaving the worms, the enzymes continue to degrade organic molecules. Reduced irrigation water use, fewer pest and termite attacks, reduced weed growth, quicker seed germination and seedling growth and development, more fruits per plant (in vegetable crops), and more seeds produced annually (in cereal crops) are some of the advantages of using vermicomposting in agricultural production. Utilizing earthworms and vermicomposting can boost horticultural productivity without the need of agrochemicals. Vermicomposting has advantages, although its application is still relatively new. This review aims to raise awareness about this particular local soil amendment.

Keywords: Vermicomposting, Agriculture, Nutrient content, Growth, Yield *etc.*

Introduction

Numerous systems have been developed to address the growing environmental and economic issues generated by the disposal of organic wastes from industrial, agricultural, and residential sources. Vermiculture is the word for growing earthworms in organic wastes, and vermicomposting is the process by which earthworms break down organic wastes (Edwards, 2022). There is a noticeable trend toward the effective recycling and use of organic leftovers through the deployment of innovative technologies, mostly based on biological processes. Thus, it is feasible to protect the natural goods and conserve the existing resources. In certain situations, it is also conceivable to fight disposal issues and reduce the consequences of pollution. (ICAR, 2022). Growing in popularity as a cutting-edge biotechnology, vermicomposting turns agricultural and industrial wastes into high-quality products that may be used to enhance soil fertility and structure in organic farming (Garg, Gupta, 2021). Some of the advantages of using vermicompost in agriculture include less water used for irrigation, decreased pest and termite attacks, decreased weed growth, faster seed germination and rapid seedling growth and development, more fruits per plant (in vegetable crops), and more seeds produced annually (in cereal crops).

Because it includes too many nutrients, pure vermicompost is not very beneficial for agricultural output (Olle 2022a, Olle, 2021).Vermicomposting-based substrates have the following positive effects on agriculture (Olle, 2022b): they promote faster growth, higher crop yields, the growth of beneficial microorganisms, permanent improvements to soil structure, and increased secretion from plants; for plants with longer growing seasons, additional fertilization with bio humus or its leotion is sufficient; mineral fertilizers are not needed in this situation; they are 100% natural and perfect for use in organic farming and artificial environments. As a result, the author made the decision to provide an overview of the literature on vermicompost and its uses and benefits in agriculture.

History

Philosophers such as Thoreau and Pascal have been captivated by earthworms (Adhikary, 2021). Earthworms were important to several ancient civilizations, such as Greece and Egypt. The beneficial properties of earthworms were originally recognized by the ancient Egyptians. According to Cleopatra, the 69–30 B.C. Egyptian pharaoh, "earthworms are sacred." She understood how crucial the worms were to the yearly flood-induced fertilization of the croplands in the Nile Valley. Extermination of earthworms from Egypt carried a death sentence. For fear of upsetting the God of Fertility, Egyptian farmers were forbidden from coming into contact with earthworms. The earthworm was thought to play a significant part in enhancing soil quality by the Ancient Greeks. Worms are the earth's intestines, according to the Greek philosopher Aristotle (384–322 B.C.) (Medany, 2018). The ancient Indian scholar Sir Surpala (10 Cent. A.D.) Suggested adding earthworms to the soil in order to have an adequate output of crops, such as pomegranates (Sinha, 2019b).

As unheralded soldiers of humanity and friends of farmers, earthworms are genuinely living up to the beliefs and dreams of Sir Charles Darwin, who claimed that no other creature in the world has likely played as significant a role in the history of life on Earth (Sinha *et al.*, 2019a). Additionally, they are supporting the views of eminent Russian scientist Dr. Anatoly Igonin (Sinha *et al.*, 2019a), who stated: "Nothing and no one can be compared with earthworms and their positive influence on the whole living Nature; they create soil and improve soil fertility and provide critical biosphere functions: disinfecting, neutralizing, protective, and productive" (Sinha *et al.*, 2019a).

An effective method for converting agro-industrial processing wastes into a rich source of plant nutrients is vermicomposting technology. These garbage items contain an abundance of energy, protein, and nutrients that would be wasted if they were dumped in open landfills and dumps. Furthermore, recycling of nutrients back into the soil occurs when vermicompost is used as an organic amendment in agriculture, which in turn preserves the ecosystem's sustainability (Garg, Gupta, 2021).

What is vermicomposting?

Vermicomposting, in its broadest sense, is the solid phase aerobic environment breakdown of organic wastes by the utilization of earthworms and microorganisms at their peak biological activity (Garg, Gupta, 2021).

"Bio-oxidation and stabilization of organic material involved by the joint action of earthworms and mesophilic micro-organisms" is the definition of vermicomposting. Earthworm activity produces vermicompost, which is rich in vitamins, growth hormones, proteases, amylases, lipases, cellulose, and chitinase, as well as immobilized microflora and macro and micronutrients. Even after they are expelled from the worms, the enzymes keep breaking down organic materials (Barik *et al.*, 2020).

Vermicomposting is the process of using earthworm activity to decompose organic waste. Sludge and solids from sewage systems, materials from breweries, paper trash, urban leftovers, food and animal wastes, and horticulture residues from processed potatoes, dead plants, and the mushroom business have all been successfully treated by it (Dominguez, Edwars, 2023).

Vermicomposting is a decomposition process where microorganisms and earthworms work together. Earthworms are important catalysts for the biochemical breakdown of organic materials because they fracture, condition, and drastically change the biological activity of the substrate process that is ultimately carried out by micro-organisms. As mechanical blenders, earthworms change the physical and chemical condition of organic matter by progressively decreasing its carbon to nitrogen ratio, increasing the surface area exposed to microorganisms, and creating an environment that is much more conducive to microbial activity and more breakdown. They move pieces of feces rich in bacteria mostly during transit through the earthworm's gut, homogenizing the organic material. Vermicompost, the final product, is a finely split substance that resembles peat and has a high porosity and water-holding capacity. It retains most of the nutrients in a form that the plants can easily absorb. The high rates of mineralization and abundance of organic matter in these earthworm castings suggest that the availability of nutrients, especially ammonium and nitrate, to plants has been significantly increased (Dominguez, Edwars, 2023).

The following are the several stages of the vermicomposting process (Garg, Gupta, 2021).

(1) The first stage of pre-composting: Earthworms are fed the organic waste after it has been pre-composted for about 15 days. All potentially volatile chemicals that might be harmful to earthworms are removed

during this step, along with easily decomposable compounds.

(2) Mesophilic phase: In this stage, earthworms mix organic matter with soil particles, promoting microbial activity and preparing organic waste materials for the creation of organic manures through their natural ability to break down organic matter.

(3) Phase of maturation and stability.

Roles of Vermicompost

Adhikary (2021) lists the following benefits of vermicompost

(1) A significant portion of humus is included in red worm castings. Humus facilitates the formation of soil particle clusters, which improves the soil's ability to retain water and opens up air channels.

(2) It is thought that humus can help to avoid harmful bacteria, nematodes, fungus, and plant infections.

(3) Worm castings, often referred to as vermicasts or worm casts, are biologically active mounds that include millions of bacteria, enzymes, and plant remnants that the worms could not fully consume.

(4) Plants can easily access the nutrients included in castings.

(5) The worm stomach functions similarly to a tiny composting tube, combining the ingredients and inoculating the waste materials.

(6) The greatest potting soil available for greenhouses, houseplants, gardening, and farming is worm castings.

(7) Vermicompost's high amounts of nutrients, humic acids, and humates have been linked to "hormone induced activity" in plants, according to some research that hypothesized about the growth responses of plants in the material.

(8) Possibility of Developing Biological Resistance in Plants: Actinomycetes and antibiotics included in vermicompost aid in boosting the crop plants' "power of biological resistance" against pests and illnesses. When earthworms and vermicompost were utilized in agriculture, the amount of chemical pesticides sprayed was considerably decreased—by more than 75%.

(9) Ability to Reduce Pest Attack: There appears to be substantial proof that worm castings can occasionally ward off hard-bodied bugs.

(10) Ability to Suppress Plant Disease: Studies on tomato (*Lycopersicum esculentum*), pepper (*Capiscum annuum*), and cabbage (*Brassica oleracea*) revealed that the application of vermicompost inhibited 20%–40% of insect pest infections, including aphids (*Myzus persicae*), mealy bugs (*Pseudococcus spp.*), and cabbage white caterpillars (*Peiris brassicae*).

(11) Vermimeal Production: Vermimi production, the most economically feasible use of vermiculture, satisfies the expanding need for animal feed protein, which is fueled by the growth of the human population and food supply.

Vermicompost's advantageous effects on soil (Sinha, 2019b):

1. Boost soil structure, "Soil Organic Matter" (SOM), and stop soil erosion.
2. Boost the amount of nutrients, microbial activity, and helpful soil bacteria.
3. Increase cation conversation capacity.
4. Minimizes soil compaction and erosion, and lowers the bulk density of the soil.
5. Destruction of soil-bearing plant diseases.
6. Proliferation water-holding capa city of soil.
7. Remove soil salinity and sodicity.
8. Sustain optimum pH value of soil.

According to Joshi *et al.*, (2021), vermicompost is the best organic manure for improving the development and production of various plants for the following reasons:

1. The nutritional value of vermicompost is higher than that of conventional composts.
2. This is because earthworm activity has raised the degree of humification and the pace of mineralization.
3. Vermicompost exhibits excellent levels of drainage, aeration, porosity, and water-holding capacity.
4. It is beneficial for plant growth because it contains microbiota, namely fungus, bacteria, and actinomycetes. Vermicompost contains nutrients that are accessible to plants, including phosphates, nitrates, exchangeable calcium, and soluble potassium.
5. Vermicompost also contains additional plant development-influencing substances that are created by microorganisms, such as plant growth regulators.
6. Earthworm-processed organic wastes were shown to produce auxins and cytokinins.
7. Certain metabolites, including vitamin B, vitamin D, and related compounds, are released into the soil by earthworms.
8. There is a rise in N availability along with P, K, Ca, and Mg availability in the castings. Only in the last few decades has the importance of vermicompost in agricultural fields' nutrition come to the attention of researchers worldwide. Since waste management is seen as a crucial component of a sustainable society, it is necessary to divert biodegradable portions of that waste from landfills and into alternative waste management techniques like vermicomposting. Vermicast, or earthworm excrement, is a nutritive

organic fertilizer that is high in humus, NPK, micronutrients, and helpful soil microorganisms, including bacteria that fix nitrogen, phosphate, and dissolve phosphate, actinomycete growth hormones, auxins, gibberlins, and cytokinins. It has been demonstrated that vermicompost and its bodily liquid, vermiwash, protect and stimulate agricultural plant development (Adhikary, 2021). Vermicompost may include plant nutrients such N, P, K, Ca, Mg, S, Fe, Mn, Zn, Cu, and B. According to Theusnissen *et al.*, (2018), vermicompost's high humic acid concentration promotes the synthesis of phenolic compounds like flavonoids and anthocyanins, which may improve plant quality and act as a deterrent to pests and diseases.

Vermicompost's primary ingredients are C, H, and O. It also contains micronutrients and nutrients such as N, P, Ca, K, Mg, and S that are similar to inorganic fertilizers applied to the soil in terms of their effects on plant development and production. Conversely, vermicompost contains a high concentration of humic substances, which provide a range of locations for chemical reactions; microbial components that are known to stimulate plant growth and suppress disease through the actions of bacteria (Bacillus), yeasts (Sporobolomyces and Cryptococcus), fungi (Trichoderma), and chemical antagonists (phenols and amino acids) (Theunissen *et al.*, 2018).

Without using agrochemicals, earthworms and vermicompost can increase horticulture productivity. By producing "chemical-free," safe, "nutritive and health protective" (rich in minerals and antioxidants) foods for people (even against certain forms of cancer), it will benefit society in a number of social, economic, and environmental ways. It will also save human waste and eliminate harmful "agrochemicals" from the planet. Vermicompost is used on farms to improve soil fertility, prevent erosion and compaction, reduce greenhouse gas emissions, and mitigate global warming by burying massive amounts of atmospheric carbon (absorbable by green plants during photosynthesis) back into the soil (Sinha *et al.*, 2019).

Effect of vermicompost on agricultural crop performance

Yield

Research on the production of important vegetable crops, such tomato (*Lycopersicon esculentum*) and eggplant (*Solanum melongena*), has shown excellent results (Adhikary, 2021). Similarly, when vermicompost was treated at a rate of around 6 tons/ha, potato productivity was considerably greater overall than it was in the control group (Adhikary, 2021). Comparing vermicast to chemical fertilizer, garden pea green pod plants, more green grain weight per plant, and greener pod yield were generated (Adhikary, 2021). Analyzing the data showed that applying "Parthenium Vermicompost" at a rate of 5 t/ha improved eggplant (*Solanum melongena*) production (Seethalakshmi, 2020). Farmers around the nation are increasingly using vermicompost as a source of organic manure to supplement chemical fertilizers (Vyvahare, 2020). Crop production increased by vermicompost is most likely due to increased nitrogen absorption (Seethalakshmi, 2020).

Growth

The development of more blossoms and fruits was encouraged by worms and vermicompost in the vegetable crop (Adhikary, 2021). Vermicomposting can significantly impact a crop's germination, growth, blooming, fruiting, and yields (Mistry, 2020). The development of tomato transplants was encouraged by vermicompost; shoot biomass increased by up to 2.2 times. The primary cause of the variations in development was found to be the varying nutrient contents of the potting mixes; however, some alterations in the substrate's physical and biological characteristics may also be to blame (Tringovska, Dintcheva, 2017). Examining the results showed that eggplant (*Solanum melongena*) growth was improved by "Parthenium Vermicompost" treated at a rate of 5 t/ha (Seethalakshmi, 2020). Vermicompost application improved overall production, fruit/plant count, stem height, quantity of leaves, LAI, leaf dry weight, length of root, and numbers of roots (Joshi *et al.*, 2021).

Content of Nutrients

When compared to artificial fertilizer, vermicast increased the proportion of protein and carbs in garden peas (Adhikary, 2021). When "Parthenium Vermicompost" was treated at a rate of 5 t/ha, it enhanced the food quality of Brinjal (*Solanum melongena*), according to the data analysis (Seethalakshmi, 2020). Vermicompost was used to increase the pH, the total soluble solids, micro and macronutrients, protein (%), and carbohydrate (%) contents of the juice, as well as the quality of the fruits and seeds (Namde, 2021). According to studies, using vermicomposts, humic acid treatments, and bacteria that promote plant development might be employed to create a sustainable agricultural system that reduces the need for artificial fertilizers (Joshi *et al.*, 2021).

Protection of Plants

The chief finding was that plants treated with worm and vermicompost saw much lower disease incidence

(Adhikary, 2021). Vermicompost similarly guards plants against a range of pests and illnesses by either squelching or discouraging them or by fostering in the plants a natural resilience to them (Sinha *et al.*, 2019). One benefit of disease resistance is that solid vermicompost and its non-aerated extract have showed promise in Cornell University lab studies as a control for *Pythium aphanidermatum*, a pathogen that affects too many vegetable crops. "Garlic doesn't tend to have Pythium problems," pointed out Fraser (Dunn, 2019). "I thus wanted to see how effectively the compost would encourage plant development. Both leaf growth and weight increase were clearly impacted. "The healthier and more vigorous the plants are with the microbiology in their root zone, the more the plants are able to thwart attacks from destructive crop pathogens and insect pests," he continues. Additionally, vermicompost-fed crops are more resistant to bacterial wilt, powdery mildew, parasitic nematode infections, and blight than crop-fed synthetic fertilizers, according to recent research from Ohio State University (Dunn, 2019).

Human Health

In comparison to their chemically grown counterparts, spontaneously grown fruits and vegetables, particularly those raised on "earthworms and vermicompost," have been shown to be far more nutrient-dense, rich in "proteins, minerals and vitamins," and "antioxidants." This makes them potentially very good for human health. In almost 85% of the patients that were examined, their antioxidant levels were high. It has been discovered that they offer protection against several types of "cancers" as well as "cardiovascular diseases" (Sinha, 2019).

Conclusion

Vermicompost is created by earthworm activity and is high in macro and micronutrients, cellulose, chitinase, proteases, amylases, growth hormones, vitamins, and chitinase. Vermicompost is the greatest organic manure to increase plant growth and yield. It can protect crops from harmful pests and increase agricultural productivity without negatively impacting the ecology. The use of vermicompost increased the nutritional value of the plants, encouraged development, and improved the quality of the fruits and seeds.

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