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Vermiculture Technology in India: It's Scope, Challenges and Opportunities

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Abstract: Vermicompost is the end-product of the breakdown of organic matter by some species of earthworm. Vermicompost is a nutrient-rich, organic fertilizer and soil conditioner. The process of producing vermicompost is called vermicomposting. The current review article deals with the descriptive cum experimental study on innovative approach on Vermiculture and Vermicomposting processes used to follow in India. The current paper describe the methodology as well as finding of the experiment on the basis of different review of literature . The result of current paper revealed that the vermiculture and vermicomposting has great economic importance. Apart from the economic importance, it is also a great process by which we reduce wastes and producing fertilizers and maintaining the equilibrium of ecological environment .

Keywords: Vermiculture, Vermicompost, Vermiwash, Fertilizer, Earthworm

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Introduction

It was 1991-92 when Maharashtra Bioteks and the Department of Science and Technology, India encouraged the implementation of vermicompost technology in thirteen (13) states of India. The above said organizations have also established a vermicompost unit with Chitrakoot Gramodaya University, Madhya Pradesh which produces five tons of vermicompost per month (Bogdanov, 1996; Edwards, 1988). Vermicomposting and composting of solid organic waste are an economically viable and sustainable waste management technologies (Alshehrei and Ameen, 2021). Wastes often contain heavy metals which are toxic to decomposer micro-organisms. The application of vermicompost and use of *Eisenia*

fetida in wheat field soil remediate the toxic heavy metal from wheat grains and beneficial for human, animal and environment (Singh and Bhartiya, 2020).

Advantages of vermicompost:

1. Vermicompost is rich in all essential plant nutrients.
2. It has a great effect on overall plant growth.
3. It encourage the growth of new shoots/leaves and it also enhance the quality and shelf life of the produce.
4. It is easy to handle.
5. It is easy to store.

6. It does not have bad odor.
7. It enhances soil texture, structure and aeration.
8. It has more water holding capacity and prevents soil erosion.

Tool of Vermicomposting (Earthworm):

The most important tools required for vermicomposting are earthworms (Annelida; Oligochaeta), which consists of over 7000 species. The bodies of earthworm are long and tube like, tapering on both ends and commonly ranging length from one to six inches (Edwards, 1988).

Vermicast:

Vermicast is formed by the feeding action of earthworms. When earthworms eat organic matter, it changes same into small fragments and later on after grinding, they change it into a fine granule (peat) like material with high porosity, aeration, drainage and water holding capacity. Mucus type substance is coated on each particle that increases aeration in the soil, provides excellent water retention properties and improves the drainage in heavy soils. This process improves microbial activity and increases the rate of decomposition. This leads to a humification effect where unstable organic matter or decomposing plant and animal matter is oxidized and stabilized. Microbiologically, vermicast contains an undeniably more assorted microbial populace (like Azotobacter, PGPR, PSB, Actinomycetes) than other fertilizers. Miniature organic entities have a significant impact in soil richness, they not just mineralize complex substances into plant accessible supplements, but microorganisms in the night crawlers' stomach related framework, additionally

combine an entire series of organically dynamic substances including plant development controllers. Night crawlers advance the creation of plant chemicals, auxins, gibberellins and cytokinins from natural waste drastically. These hormones are dose significant and play a fundamental role in plant metabolism as well as plant growth, development and crop quality significantly. Vermicast is humus rich. The break-down of organic material by earthworms enhance the rate of humification of organic matter. The humic and fulvic acids delivered in this interaction have been demonstrated to invigorate plant development. Humic acids are large complex molecules. Fractional oxidation of humic acids permits holding locales for plant supplements including calcium and magnesium. Humic acids are created by the breakdown of natural matter by microorganisms. They are for the most part contrarily charged so drawing in certain particles, for instance calcium. Humic substances advance the transformation of various components into structures accessible to plants. Phosphate responds with different minerals in the dirt, especially iron and aluminum and becomes locked or inaccessible to plants. Humic acids assist substitute iron and aluminum with different components for example calcium making phosphate plant accessible (Chaoui *et al.*, 2003).

As a manure, vermicast contains supplements in a structure that are promptly taken up by plants, like nitrates, replaceable phosphorous, solvent potassium, calcium and magnesium. A common place breakdown of vermicast is as per the following: pH 6.6; N 2.3, P 0.6, S 0.1, Mg 0.65, Ca 8.6, CEC 52.75 (Me/100g), Organic Matter (humus) 20%.

Vermicast vs Chemical Fertilizers in Soil

Criteria for Comparison	Chemical Fertilizers	Vermicast
Macro-nutrient contents	Mostly contains only one (N in urea) or at the most two (N and P in DAP) nutrients	Contains all i.e. nitrogen (N), phosphorus (P) and potassium (K) in sufficient quantities
Secondary nutrient contents	Not available	Calcium, magnesium and sulphur is available in required quantities
Micro-nutrient contents	Not available	Zinc, boron, manganese, iron , copper, molybdenum and chlorine present
pH balancing	Disturb soil pH to create salinity and alkalinity conditions	Helps in the control of soil pH and checks the salinity and alkalinity in soil
Organic carbon	Not available	Very high organic carbon and humus contents improves soil characteristics
Moisture retention capacity	Reduces moisture retention capacity,	Increases moistures retention capacity of the soil
Soil Texture	Damages soil texture to reduce aeration	Improves soil texture for better aeration
Beneficial bacteria and fungi	Reduces biological activities and thus the fertility is impaired	Very high biological life improves the soil fertility and productivity on sustainable basis
Plant growth hormones	Not available	Sufficient quantity helps in better growth and production

Vermicompost Technology (Preparation in Flow Chart)

- a. Keep 100 kg crude materials (natural matter) in raised solidified chamber
- ↓
- b. Take 16 kg of cattle dung and mix it with 25 L of water.
- ↓
- c. Blend this combination with 100 kg of crude material.
- ↓
- d. Keep this blend sodden and mix once consistently for five weeks for decaying
- ↓
- e. Make four raised chambers measuring 3 x 3 x 3 ft with cemented floor
- ↓
- f. Fix an asbestos sheet six ft above for protection from rains
- ↓
- g. Cover it with a perforated cover (Metallic) having two mm holes
- ↓
- h. Keep the partially decomposed matter in these chambers at least 1inch below the top
- ↓
- i. Put the combination of 4000 numbers of three worms (*Eudrilus eugeniae*: *Eisenia feotida*: *Perionyx exhumes* = 1:1:1) over the outside of disintegrated natural matter
- ↓

j. Shower little water once in three days

k. These worms will eat the partially decomposed organic matter and put out the excreta as vermicompost

l. After every ten days remove the vermicompost (excreta) by hand

m. The vermicompost is sieved by use of one mm sieve and spread in thin layer for air drying

n. Matter which could not be sieved is placed back on partially decomposed organic matter for breakdown by earthworms

o. In about one month all the partially decomposed organic matter gets converted into vermicompost

p. Well air dried vermicompost is packed in 1 to 5 kg in polythene sacks, and sealed

Description of Vat:

Different types of vat are used.

1. Container method

Suitable for household purpose. Container of 1 m x 1 m x 0.75 m should contain about 1000 worms. Container can be used provided it has good drainage.

Apart from this there are other types of bin that are used as commercial farm units. These are (a) Can-O-Worms™ (b) Worm-A-Way® (c) Worm-A-Roo™.

(a) Can-O-Worms™

Most popular, Enclosed tier system, Bottom catch tray and spigot, Stackable mesh trays, Worms migrate vertically

2. Heap (Bed) method

Suitable for both commercial and small farm units. Size of the shed varies depending upon the availability of raw material and production requirement. Small unit - 8m x 4m x 4m (10 tons production), Big unit - 30m x 8m x 4m (100 tones production).

(b) Worm-A-Way®

Plastic, Ventilated, Several sizes, Lightweight

(c) Worm-A-Roo™

Double bin system, Plastic, Migration device, Lightweight

Substrate (Raw Materials):

Materials that is required for vermicomposting-

(A) 100 kg of organic matter such as-

1. Crop residues
2. Weed biomass
3. Vegetable waste
4. Leaf litter
5. Hotel refuse
6. Waste from agro-industries
7. Biodegradable piece of metropolitan and country squanders.
8. House organic waste

(B) Cattle dung about 16 kg

(C) Earthworms species: (i) *Eudrilus eugeniae* (ii) *Eisenia fetida* (iii) *Perionyx excavatus*. About 4000 in number.

Procedure:

1. *Partial decomposing of raw material:*

- a. Keep 100 kg crude materials (natural matter) in raised established chamber.
- b. Take 16 kg of cattle dung and mix it with 25 L of water.
- c. Blend this combination with 100 kg of crude material.
- d. Keep this combination clammy and mix once consistently for five weeks. It will be somewhat deteriorated.

(2) *Making of vermicompost from partially decomposed raw material:*

- a. Make four raised chambers measuring 3 x 3x 3 ft with cemented floor.
- b. For protection from rain, fix the asbestos sheet 6 ft above ground.
- c. Keep the partially decomposed matter in these chambers at least one inch below the top.
- d. Cover it with a metallic perforated (2 mm) cover.
- e. Put the mixture of 4000 number of three earthworms (1:1:1) over the surface of partially decomposed organic matter.
- f. Keep it moist by little water spray. These worms eat partially decomposed organic matter and excrete faeces in the form of vermicompost. Spray with a little water **every** three days.

(3) *Processing of the vermicompost:*

- (a) Remove the vermicompost (excreta) by hand after every ten days.
- (b) Store this vermicompost in a pile to separate very small worms.

After 24 h, these worms will reach the bottom of the vermicompost, after which they are removed

and placed on top of the partially decomposed organic matter.

(c) Vermicompost was sieved through 1 mm sieve and finely distributed before air drying.

(d) Matter which could not be sieved is placed back on partially decomposed organic matter for breakdown by earthworms.

(e) In about one month all the partially decomposed organic matter gets converted into vermicompost.

(f) After 10 days of drying, vermicompost is collected and put in a heap. The idea is to remove any remaining earthworm. Inside this heap, put about ½ kg of cattle dung. In about two days all remaining earthworms collect in the cattle dung. This cattle dung is removed and placed on the recharged matter.

Vermicompost is ready in 2-2.5 months. When it is ready, it's black, lightweight and has no bad smell.

Packing:

Prior to pressing, the vermicompost is well dried in air but not in daylight as the moisture content become very low in sunlight and thus market price would decrease. It is packed in 25-50 kg polythene bags and airtight, just like that of other inorganic chemical fertilizers packed in polythene bags.

Necessary Precautions:

(a) For protection from birds and rodents etc. as well as for proper aeration, it is advisable that vermicompost chamber should have perforated cover.

(b) Maintain the moisture at 50-60 % level in the pit.

(c) Temperature between 25-28 C.

(d) Base material (FYM) ought to be to some extent deteriorated.

(e) Proper aeration should be provided without disturbing the worms.

(f) Vermicompost is dried in air well before packing.

Application:

Vermicompost can be utilized for all harvests (farming, plant, elaborate and vegetable) at any phase of yield advancement.

For agricultural crops:

Vermicompost can be applied in agrarian fields when the seedlings are 12 to 15 cm in tallness and water the field.

Flower, Vegetables and fruit trees:

Apply vermicompost around the foundation of the plant, at any phase of advancement and cover with soil. Water routinely. Generally agricultural use: 3-4 tonnes/ha.

Fruit trees: 5-10 kg/tree; Vegetables: 3-4 tonnes/ha; Flowers: 500-750 kg/ha.

Nutrient status of vermicompost:

Organic carbon %	20.43 – 30.31
Total nitrogen %	1.80 – 2.05
Phosphorus %	1.32 – 1.93
Potassium %	1.28 – 1.50
Calcium %	3.0 – 4.5
Copper %	0.0027 – 0.0123
Iron %	0.3 – 0.7
Zinc %	0.028 – 0.036
Sulphur %	Traces to 0.40
Magnesium %	0.4 – 0.7
Sodium %	0.02 – 0.30
Boron %	0.0034 – 0.0075
Manganese %	0.40
Aluminium %	Traces to 0.071
Cobalt, Molybdenum	Present in available form
Carbon : Nitrogen	14-15 : 1
pH	6.5-7.5

Vermiwash:

Vermin wash is a liquid, which contains high amount of enzymes, vitamins and hormones like auxins, gibberellins etc. along with macro- and micro-nutrients. It is plant growth regulator and used as foliar spray.

Apparatus:

For making vermiwash, mechanical assembly device involves:-

1. A bucket for holding the particulate matter.
2. One stop cork.
3. Two hanging pot

The stop plug added to the lower most piece of the container. One hanging pot looms over the can which contain an opening in such a manner so that water falls drop by drop in can and another hanging pot hangs at some lower portion of the stopper so that vermiwash formed in the can gathered in the pot. Upper hanging pot contain water $\frac{1}{50}$ th of the size of the fundamental compartment. Water is filled in this holder and allowed to step by step sprinkle on the container for short-term. This water permeates through the fertilizer, the tunnels of the night crawlers and gets gathered at the base. The stop plug is opened the following day morning and the vermiwash is gathered. The tap is then closed and the suspended pot is refilled with water that evening so that vermiwash can be collected again the following morning. Dung pats and hay may be replaced periodically based on need. The entire set up may be emptied and reset between 10 and 12 months of use.

Substrate (Raw Materials):

- 1 broken bricks
2. Pieces of stones

3. Sand.
4. Partially decomposed cow dung.
5. Soil.
6. 100-200 nos. of earthworms
7. A layer of paddy straw.

Preparation:

1. Take one major pail and one mug.
2. Set up one stop stopper on the lower most piece of the can.
3. Put a layer of broken blocks, bits of stones having thickness of 10-15 cm in the Pail.
4. Over this layer put another layer of sand having thickness of 10-15 cm.
5. Then, at that point put a layer of disintegrated cow excrement having 30-45 cm thickness over it.
6. Then, at that point put another layer of soil having 2-3 thicknesses.
7. Presently open the stopcock of the pail and then the material is taken in the can.
8. Then put 100-200 nos. of earthworms in the bucket.
9. From that point forward, a layer of paddy straw having 6 cm thickness is given.
10. Presently open the stopcock of the pail and splash water routinely for a time of 7-8 days.
11. Following 10 days the fluid vermin wash will be delivered in the can.
12. Balance one pot with a base opening over the container in such a manner so that water falls drop by drop.
13. Consistently 4-5 liters of water is to be poured in the hanging pot.
14. Hold another pot under stop stopper to gather the vermin wash. Consistently 3-4 liters Vermin wash can be gathered.

Vermiwash Analysis Report:

Organic Carbon %	0.008 ± 0.001
Total Kjeldhal Nitrogen %	0.01±0.005
Available Phosphate %	1.69 ± 0.05
Potassium (ppm)	25 ± 2
Sodium (ppm)	8 ± 1
Calcium (ppm)	3 ± 1
Copper (ppm)	0.01 ± 0.001
Ferrous (ppm)	0.06 ± 0.001
Magnesium (ppm)	158.44 ± 23.42
Manganese (ppm)	0.58 ± 0.040
Zinc (ppm)	0.02 ± 0.001
Total Heterotrophs (CFU/ml)	1.79 x 10 ³
Electro conductivity dS/m	0.25 ± 0.03
pH	7.48 ± 0.03

Application:

1. Blend 1 L of vermin wash with 7-10 liters of water and splash the arrangement in the leaf (upper and lower side) in the evening at the developing harvest.

2. Blend 1 L of vermin wash with 1 L of cow pee and afterward add 10 L of water to the vermin pee arrangement and blended completely and keep it over night prior to showering 50-60 L of such arrangement and to be splashed in one bigha of land to control different yield sicknesses.

Vermiculture:

Vermiculture alludes to the biomass creation of night crawlers in semi-normal conditions, giving reasonable substrate and feed to them to stay dynamic all the year. Worms that can get by imprisonment under semi-normal conditions like pH, temperature, dampness and actual unsettling influences must be kept. They should show great populace development for culture engendering. These characters are not found in many worms and thus, effective refined is conceivable just with these night crawlers regardless of the spot of their

starting point. In USA and Canada refined of worms began as business venture where as in India they were kept up with as societies for various examination exercises. Since over 10 years, ranchers, agro based ventures and metropolitan families refined worms as the natural material for natural waste administration in India. However, many exploration labs are engaged with completing examination on this viewpoint (Bogdanov, 1996).

Vermicomposting and Sustainable Environment:

Apart from this Vermicomposts have great potential in horticulture and agriculture crop production due to production of plant growth regulators by the greatly increased microbial populations (Bogdanov, 1996).

Level of Plant Available Nutrients:

Fertilizers are higher in ammonium, while vermicompost would in general be higher in nitrates, which is the more plant-accessible type of nitrogen. Vermicomposted excrement has higher N accessibility than the soil compost on a weight basis. The stock pace of a few supplements, including P, K, S and Mg were expanded by vermicomposting as contrasted and traditional treating the soil. Apparently the course of vermicomposting will in general bring about more significant levels of plant-accessibility of most supplements than does the ordinary treating the soil (Decaens *et al.*, 1999).

Level of Beneficial Microorganisms:

It is generally accepted that vermicompost significantly surpasses regular manure concerning levels of helpful microbial movement. Besides, these are microorganisms which are greatly improved at changing supplements into structures promptly taken up by plants than present in fertilizer (Neuhauser *et al.*, 1984; Roberts and Dorrough, 1984).

Effects on Plant Parasitic Nematodes:

Presence of vermicompost changes the creation and action of microorganism populaces in the root

framework, initiating them to emit chemicals, free mineral nitrogen or to harm the nematodes' compound receptors. These progressions upset the nematode hatchlings' root-area sensor instruments, diminishing their capacity to attack roots. Such cycles would consequently hose the harmfulness of the nematode pathogenic impact. The overall safeguard prompt a decrease and postponement in the nematodes attack of the root framework. Vermicompost subsequently seem to apply some sort of activity on plant, straightforwardly or by implication, and limit or even take out the nematodes pathogenic impact (Devliegher and Verstraete, 1997)

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