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Research Article

Sustainable Organic Waste Management by Vermicomposting

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ABSTRACT

Nowadays researchers are searching for a technology for organic waste management which should be cost effective, ecological sustainable with no adverse effect on environment and beneficial to the society too. Vermiculture appears to be a novel sustainable technology for waste treatment which has a great future in the field of organic waste management. This work focuses on the vermiculture technology or vermicomposting in which nontoxic organic residues of plant and animal wastes are used as substrates to produce vermicast. Organic wastes are converted into usable form of nutrients by organic process. Vermicompost increases the strength of plant growth and it also conditioned soil (Nyamunokara, 2014 & Manyuchi et al., 2014). Vermicomposting helps in degradation of solid wastes, and also it is a cost effective technique. It is a bio-oxidative process which mainly involves Eisenia foetida species of earthworms to carry out the process. In the current study recycling of organic waste like cowdung, dry leaves, domestic wastes etc., has been carried out where moisture content and temperature was maintained. The work focused on the factors that affect the earthworm growth rate in terms of change in length and mass during vermicomposting. Increasing the vermicomposting period, the substrate quantity and the cow dung composition increased the earthworm's length (Manyuchi & phiri, 2013).

Keywords: *Vermicomposting, Vermiwash, Vermicast, Sustainable, Leachate, Vermin compost extract, Cow manure.*

INTRODUCTION

Management of solid waste has become one of the biggest problems we are facing today. Solid waste is defined as the organic and inorganic waste materials produced by different sources and have lost value in the eye of their owner. It has been estimated that India, as a whole, generate as so much tones of solid waste of diverse composition per year. Earthworm farming (vermiculture) is another bio-technique for converting the solid organic waste into compost.

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Soil is one of the most important natural resource on earth, but the excess use of chemical fertilizers has contributed to environmental degradation especially on soil fertility by reducing the natural nutrients on the soil surface. Earthworms, an important fauna group in most ecosystems contributes to distribution of litter surface, enhance soil nutrient cycling though the rapid incorporation of detritus in to mineral soils. Earthworms also accelerate the mineralization as well as the turnover of soil organic matter. So they are known as "Farmer's Friend" or "Nature's Best Friend". There are about 3,627 species of terrestrial earthworms in the world (Samaranayake, 2010). One of the most important earthworm families is Lumbricidae, and one of its member Eisenia fetida, can be used to stabilize organic waste by the process called "Vermicomposting" (Pirsaheb et al., 2013).

It is a simple biotechnological or organic process of composting, in which earthworms are used to enhance the process of waste conversion and produce a better product is known is manure (Adhikary, 2012). Vermi composting process promotes plant growth, improves soil quality and helpful in managing different kinds of agricultural, industrial and domestic wastes. It provides major nutrients to the soil for plant growth and also consists of important vitamins and growth hormones. Eisenia fetida is most commonly used earthworms for the management of organic wastes. It lives in the upper layer of soil surface and is non-burrowing species of earthworms. The non-burrowing types are red or purple and 10 to 15 cms long, but their life span is only 28 months. The burrowing types are pale and live deep soil in the. The non-burrowing earthworms eat 10% soil and 90% organic waste material; those convert the organic waste into vermicompost faster than the burrowing earthworms (Kamineni, 2014). Earthworms live and breed at temperature between 55 and 85 degree Fahrenheit (Sherman, 2003). For commercial production, earthworm bed should be kept at 6.8 to 7.2 pH range, but normally they grow in soil having pH range of 4.2 to 8.0. (2).

Vermicompost is highly nutritive organic fertilizer. It retains soil nutrients for long time. It is a good replacement of chemical fertilizers and procuring better prices for the organic produce using such composting material locally available at much lower cost (Ansari & jaikishan 2011; & Chauhan & singh 2013). Vermicomposting is the process of producing compost by utilizing earthworms to turn the organic waste into high-quality compost that consists mainly of worms cast in addition to decayed organic matter (ismail 2005; & devi & prakash 2015). Vermicomposting helps to convert the organic wastes (agro-wastes, animal manure and domestic refuse) into highly nutrient fertilizers for plant and soil (gajalakshmi & abassi 2004).

Vermicompost is a finely divided peat-like material with excellent structure, porosity, aeration, drainage and moisture-holding capacity (ismail 2005; & Edwords et al., 2011). Vermicompost and organic fertilizer rich in NPK, micronutrient and beneficial soil microbes (nitrogen fixing and phosphate solublizing bacteria and actinomycetes), is a sustainable alternative to chemical fertilizers, which is an excellent growth promoter and protector for crop plants. (sinha et al., 2011; & chauhan & singh 2015).

MATERIALS AND METHODS

The experiments were carried out at Sukhdhamkothi. The heritage hotel, kota (Rajasthan). Eisenia Fetida earthworms were used and these were obtained from KVS jhalawar Institute. The earthworm breeding was done in 80.59m x 0.13m worm bins and earthworms were loaded at 100-200 worms/m^2, at standard conditions. The earthworms had an average weight of 1g and length of 50mm. Cow dung was obtained from a nearby farm and the substrate waste was comprised of kitchen waste of the hotel.

This study, carried out at a heritage hotel- Sukhdham kothi**,** kota, consisted of different stages, viz. building of a vermicompost bed; import of a composting epigenic earthworm-Eisenia fetida and production of vermicompost using dry grass

and dry leaves and cow manure. The whole field experiment consists several phases given below-

Phase 1: Construction & Stabilization of Vermin Bed

First of all construction of H.D.P.E. vermicompost station or vermin bed was carried out as shown in the given figure-1. A H.D.P.E Laminated vermibed 10x8x3m^3 (lxwxh) was stabilized in a shade area at sukhdhamkothi, heritage hotel, kota. (Rajasthan). The vermicomposting units were set up at the vermicompost station using the vermitech pattern. H.D.P.E vermin beds were build as containers for culturing the earthworms. The unit had the drainage holes (2x2cm^2) to facilitate the effective water drainage.

Fig. 1: Construction and Stabilization of H.D.P.E vermin bed

H.D.P.E. vermin beds are much better than cemented vermin beds in many aspects as given in the following table-

Table 1: Comparison between H.D.P.E & CEMENTED VERMI BEDS

S.N.	Particulars	H.D.P.E Laminated Vermi Bed	Cemented Vermi Bed
1	Selection of place	Can be installed easily at any place	Framework made of brick and cement makes it immovable
2	Relocation	Easily possible	Not possible
3	Constitution	Made of strong 7 layers H.D.P.E. laminated fabric	Made with cement and bricks
4	Life cycle	Long term	Life time
5	Investment	Less investment required	More investment
6	Fear of escape of worms	No such fear	Such fear away exists
7	Vermi wash	75-100 Ltr. Can be used for plant and agricultural fields.	No facility to store as it gets absorbed in the ground
8	Aeration	Facility available on both sides	No facility available
9	Fertilizer production and type	5.5-6 ton/year, controlled humidity, high quality (free from insects and ants)	4-5 ton/year, uncontrolled humidity, low quality (carrying insects and ants)

Phase 2: Preparation of culture bed

The Vermin culture bed was prepared by implementing following procedural steps-

1-The vermicomposting experiment was conducted in HDPE bags. For the verminbed of each combination of the manure, kitchen waste, gardens left over material, dry leaves, and cow manure were used. Earthworm were added in each combination unit of the manure. First of all loamy soil was set up in HDPE Vermin bed, to the height of 15 cm, which was moistened.

2-The earthworms 'Eisenia fetida' were inoculated into this layer.

3-Lumps of fresh/dry cattle dung were scattered over the soil.

4-The soil was then covered with dry grass, dry leaves up to 10cm thickness.

5-Then a layer of domestic kitchen waste was spread over the layer of dry leaves.

6-The entire unit was covered with cotton jute bags to protect the earthworms from sunlight and birds.

The above procedural steps of vermin culture bed preparation can be well explained by demonstration with the help of given figures-

Fig. 2: Moistening of Vermin bed with water

Fig. 3: Alternate layering of dry leaves, cow dung & earthworms

Fig. 4: Layering of cow dung and dry leaves

Fig. 5: spreading and layering of dry leaves

Fig. 6: Vermi bed covered by dry leaves

Fig. 7: Vermi bed covered by cotton gunny bags

The Vermin bed was kept moistened by sprinkling water twice a week and turned once a week, up to the seventh week of the harvest of the vermicompost. During the process of

vermicomposting, the analysis of the process and its contents was monitored on weekly basis. The temperature of the vermicompost unit was measured weekly and recorded.

In the second phase of composting, two hundred earthworms species 'Eisenia fetida' (epigamic species), were imported from KVS Jhalawar. The earthworms were cultured for 120 days in one bag and were used for the production of vermicompost from dry grass, leaves and cow manure. The dry leaves and grass were collected. The cow manure was procured from farms.

Fig. 8: Inoculation of Eisenia fetida into the culture

RESULT AND DISCUSSION

Vermin compost is a biological organic fertilizer enriched with all the major 16 nutrients required for the crop and plants. The vermin compost produced by the above process, had a dark color, a mull-like soil odour and was homogeneous.

Fig. 9: Prepared organic manure-Vermin compost

Fig. 10: More finely divided form of Vermin compost

Approx 5kg cow manure and 2kg dry leaves were weekly added with the organic wastes during composting. After three and four months, the following parameters were analyzed:

1. The total population of earthworms gets multiplied approx four times during composting.
2. The total amount of the vermin compost produced (weight in kg);
3. Chemical analysis of vermin compost was done in the soil laboratory where temperature and ph of vermin compost were analyzed time to time. The total percentage content of Nitrogen, Phosphorous, Potassium and other minerals were also analyzed in the compost by basic analytical method.

Vermiwash: Vermiwash is a brown colored liquid that is produced during the vermin composting by the action of earthworms

(Ismail, 1997). It is a rich source of macronutrients and micronutrients important in maintaining soil health and increasing crop production. This liquid also contains many plant microbes which are beneficial for the growth and development of plants (Brown et al., 2000). In the current study a brown coloured left over liquid known as Vermiwash, was obtained, which was collected in buckets. This Vermiwash, being nutritive for plants growth, can be better utilize in the form of spray on the plants.

Fig. 11: collection of Vermiwash in buckets

Various analytical data, obtained during the process of vermicomposting can be summarized in the given tables-

Table 2: GENERAL DATA ABOUT VERMI CULTURE BY VERMIN BED:

S.N.	Observations	Quantity
1	Earthworms required for culture & compost unit,	2.5 Kg/cubic meter
2	Vermi wash obtained ideally per unit	29.5 lt
3	Vermi compost production ideally per unit	367.86 Kg/(cubic meter)
4	Vermi culture production ideally per unit	29.50 Kg/(cubic meter)

Table 3: General data about vermicompost unit

S.N.	GENERAL DATA ABOUT VERMICOMPOST UNIT	UNIT DETAIL
1	Cemented structure (7ftx3ftx1ft) @ 50% Subsidy	Rs. -5000.00
2	ISI Vermiculture Bed (12x 4ftx 2ft)	Rs -3750.00
3	Cemented structure, capacity	0.59(cumtr)
4	ISI Vermi culture Bed, capacity	2.72(cumtr)
5	Earth worms price	Rs125.00/Kg
6	Vermi compost price	Rs5.00/kg

Table 4: Nutrient composition of vermicompost and vermiwash

S. No.	NUTRIENTS	VERMICOMPOST	VERMIWASH
1	**PH**	6.9	6.8
2	**organic carbon**	14.5	-
3	**N (%)**	1.5	0.005
4	**P (%)**	0.99	0.0025
5	**K (%)**	1.6	0.064
6	**Ca (mg/kg)**	2762	786
7	**Mg (mg/kg)**	4100	328
8	**S (mg/kg)**	600	-
9	**Fe (mg/kg)**	11210	0.151
10	**Mn (kg/mg)**	1290	214
11	**Zn (mg/kg)**	180	0.132
12	**Cu (mg/kg)**	38	0.117

Source –sample of vermiwash and vermicompost obtained from sukhdhamkothi, Haritage hotel.

Precautions taken during the process of vermicomposting

The following precautions were taken during vermin composting:

1. Most Indian species are not suitable for the purpose of composting. Eisenia foetida is found to be better for vermin compost production.
2. Only plant based materials such as grass, dry leaves or vegetable peeling should be utilized in preparing vermin compost.
3. Material of animal origin such as eggshells, meat, bone, chicken dropping, etc are not suitable for preparing vermin compost.
4. Tobacco leaves, onion, garlic, chilli etc. of kitchen wastes are not suitable for rearing earthworms.
5. The earthworms should be protected against birds, termites, ants and rats.
6. Moisture should be maintained during the process. Either stagnant water or lack of moisture could kill the earthworms.
7. After completion of the process, the vermin compost should be removed from the bed at regular intervals and replaced by fresh waste materials.

CONCLUSION

Waste is generally organic and inorganic in nature. Organic waste mainly consists of food, vegetable, fruit, paper and agricultural waste etc. These types of organic wastes are biodegradable in nature and vermicomposting is the best option which helps in degradation of solid wastes, Incorporation of vermicomposting application had a good effect on the soil physical, chemical and biological properties, increasing plant cover and decreasing the soil losses. The vermin compost produced can be of significant value to the end users like farmers for replacement of chemical fertilizers and procuring better prices for the organic produce using such composting material locally available at much lower cost (Ansari & jaikishan 2011; & Chauhan & Singh 2013). Increasing the vermin composting period, the substrate quantity and the cow dung composition increased the earthworm's length and mass by a factor of more than 3. At the same time, increasing the cow dung composition and the interaction between increase in vermicomposting period and increase in substrate quantity also resulted in vermicomposting is promoted by in vermicomposting period, substrate quantity and substrate composition (Manyuchi & phiri, 2013).

The main advantages of the current process experiment of sustainable organic waste management by vermicomposting comprises the following facts-

- Easy decomposition of biodegradable waste by vermicomposting (with better N P K values) is quite a natural process where no external energy is required.
- Earthworms are important creatures that are capable of transforming waste into gold.

Eisenia foetida, most common species of earthworms are used and comparatively a very good quality of organic compost was obtained.

Thus the Earthworms are nature's helping friends in improving soil quality.

- The study area was very economical in maintenance & experimental process is totally natural.
- The N P K parameters (Nitrogen, Phosphorus & Potassium contents) in the prepared compost showed increase at the end of the day.

Future scope of the study

1. Other physico-chemical parameters of vermin compost like Thermal &Electrical conductivity etc. can be studied.
2. The use of Vermin compost as a fertilizer for different types of plants (like medicinal, herbal & ornamental etc.) can also be studied.

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