Production of Enriched Vermicompost for Sustainable Agriculture

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The indiscriminate use of chemical fertilizers and pesticides has had a negative impact on the natural environment and left a residue in food grains. Enriched vermicompost is organic manure (Vermicast). This is combined with helpful microbial inoculants like Azotobacter, Phosphobacter, Azospirillum, Trichoderma, Pseudomonas and Beauveria. Enriched Vermicompost Technology (EVT) is an advanced concept for sustainable agriculture that is gaining traction in the current era, with a focus on conservative agriculture. Enriched vermicompost contains nitrogen (1.8-2.1%), phosphorus (1.1-1.12%), potassium (1.15-1.40%), and a CN ratio (14-20%). It is recommended for vegetable crops at 500-1000 kg/acre, fruit crops at 8-10 kg/tree, and flower crops at 500 g/plant. Enriched vermicompost has several advantages over traditional chemical fertilizers and pesticides, including eco-friendliness, disease-free crops, better yields, improved quality, and enhanced income.

Vermicompost

Vermicompost is organic manure bioprocessed by earthworms. It includes humus, worm castings, live earthworms, cocoons, and other microorganisms (Nagavallemma et al. 2004). Enriched vermicompost is organic manure (vermicast) that contains beneficial microbial inoculants such Azotobacter, Phosphobacter, Azospirillum, Trichoderma, Pseudomonas, and Beauveria. Enriched vermicompost uses locally available waste materials, including agricultural crop residues (maize, sorghum, cumbu/bajra), industrial waste, coirpith, animal waste, cow dung, and water hyacinth (Eichhornia crassipes), as substrate for vermicomposting. Water hyacinth is a low-cost, readily available trash that contains high levels of minerals, particularly potassium (Jafari, 2010). Water hyacinth is a serious threat to aquatic ecosystem and management of water hyacinth remains global need (Raghupathi, 2010). Jafari (2010) emphasizes the importance of reusing this plant in its care. The abundance of water hyacinths has led to a search for a simple solution to manage them. Water hyacinth can serve as a soil mulch, substrate for organic manure production (vermicompost and compost), mushroom cultivation, biogas production, paper production, animal feed and wastewater treatment, and industrial effluent treatment (Lindsey and Hirt, 1999). Vermicomposting is a viable option for reusing water hyacinth biomass or stubbles (Table-1) Raghupathi (2010).

Improved technology for producing vermicompost

An improved method of recycling or reusing water hyacinth waste is called enriched vermicompost technology. According to Gajalakshmi et al. (2011), the collected biomass or stumps are regarded as a valuable feedstock for enriched vermicompost. Vermicompost made using a deep tank system and enhanced with liquid beneficial microbial inoculants can also benefit from this method's ability to improve its chemical and biological characteristics. The process of creating enriched vermicompost from water hyacinth waste involves eleven phases; all of these steps are identical to those of vermicompost, with the exception of enrichment prior to packaging (Figure 1) (Nagavallemma et al., 2004). The raw materials for making enriched compost are locally accessible waste materials such crop residues, water hyacinth, coirpith, animal waste, and industrial waste (Lindsey and Hirt, 1999). Water hyacinth is the most affordable and widely accessible waste among these. The following fundamental demands must be met by the chosen composting locations: an abundance of garbage, energy, a road, transportation, labor availability, water, and shade (Gajalakshmi et al., 2011).

The biomass (water hyacinth) that has been harvested or gathered from lakes, ponds, and rivers can be utilized as a raw material to produce enhanced vermicompost. Depending on the trash's condition, water hyacinth waste is put through a process called pre-composting; the resultant (sun-dried) waste materials are dark or brown in color and have a volume that is half that of the original. Pre-composting is a straightforward procedure that is primarily used to cut waste volume in half. In addition to this, pre-composting promotes partial breakdown of waste materials, which improves microbial colonization, boosts composting efficiency, and shortens composting time (Nair et al., 2006). After pre-composting is finished, waste is utilized as feedstock and filled to 75% of the deep tank's height, which

Table 1. Possible applications for water hyacinth in a particular area

Sl. No	Area	Uses/ reuses
1	India	Vermicompost, Compost, Mulching
2	China	Biogas production, Animal feed, Fertilizer, Water purification
3	Bangladesh	Animal feed, Yarn and rope Bio energy
4	East Africa	Animal feed–pigs, Fertilizer, Crafts and furniture, Charcoal, briquetting, Hydroponics

Source: Gajalakshmi *et al*. (2011), Jafari (2010) and Raghupathi (2010)

Table 2. Nutritional comparison of compost, vermicompost and enriched vermicompost (in %)

Sl. No	Nutrient	Compost	Vermicompost	Enriched Vermicompost
1	Nitrogen	0.8	0.51-1.61	1.18-2.10
2	Phosphorus	0.35	0.19-1.02	1.10-1.25
3	Potassium	0.48	0.15-0.73	1.15-1.40

Source: Nagavallamma *et al*. (2004)

Table 3. Recommended dose of enriched vermicompost

Sl. No	Crop / Soil type	Recommended dose
1	Nursery beds	1.5-3 kg / sq.m
2	Main field	500-750 kg/acre
3	Potted plants / Indoor plants	100gms/plant
4	Kitchen gardens	5-10 kg/sq.ft
5	Lawn	0.5-1kg /10 sq.ft
6	Ornamental trees	5 kg/ tree
7	Land reclamation	2.5 mt /acre
8	Vegetable crops-Brinjal, cabbage, potato	500-100Kg/acre
9	Fruit crops - Mango, coconut, citrus, orange	8-10 kg/tree
10	Flower crops -Roja, Jasmine	500g/plant
11	Plantation crops-Coffee, banana, papaya	2-3kg/plant

Source: Paul, C (2012)

is typically 5 m × 1 m × 1 m. The tank's size varies based on the waste material's availability.

Crop stubbles and farm yard manure will be spread over the preconditioned waste materials. Following the inoculation of earthworms (Eisenia foetida), the waste should be covered with farm yard manure and crop stubbles in the following stage. Finally, fresh cow dung slurry should be sprinkled immediately after, and the top layer should be covered with mulch material to prevent excessive moisture loss. Watering twice a day is essential during the maturation stage. By ceasing the water injection at maturity (after 120 days), the moisture content can be reduced (Kumar and Singh, 2012). This guarantees worm migration to the vermibed area and compost drying. When compost reaches maturity, it is a fine, loose mass of granules. Following harvesting, the obtained material needs to be sieved. Young worms are eliminated from vermicast using this technique.

Enrichment is the process of adding advantageous microbial inoculants to vermicast. The harvested vermicompost is enhanced with advantageous microbial inoculants like Phosphobacter (which increases the use of phosphotic fertilizers added to the soil) and Azotobacter (which supplies a nitrogen source and enhances soil physical properties). Beauveria (controls soil grubs), Trichoderma, Pseudomonas (controls nematodes and diseases that cause wilt), and Azospirillum (improves plant development and fixes nitrogen). Vermicompost's physio-chemical and bio-chemical qualities are primarily improved by the enrichment process. The

nutritional comparison of compost, vermicompost, and enriched vermicompost is shown in Table 2.

Flow chart of Enriched vermicompost production

Site selection

⇩

Collection of waste

⇩

Pre composting

⇩

Selection of earthworm species

⇩

Vermibed preparation

⇩

Shade provision

⇩

Watering

⇩

Harvesting

⇩

Sieving

⇩

Enrichment

⇩

Bagging /Packaging

Nitrogen (1.8–2.1%), phosphorus (1.1–1.125%), potassium (1.15–1.40%), and a CN ratio of 14–20% are present in enriched vermicompost. Plant growth hormones, phosphatase enzyme activity, humic acid, and vitamin precursors from earthworm feces all contribute to the growth and development of plants. Vermicompost is produced from 750–850 kg of waste materials per tonne. From crop to crop, the recommended rate of treatment varies significantly (Table 3).

Conclusion

Chemical pesticides and fertilizers play a major role in today's food production. This careless use of chemicals causes pollution, global warming, and higher production costs, among other environmental problems. The potential advantages of enriched vermicompost over chemical fertilizer include improved soil texture and nutrient enrichment, which lead to higher productivity, resource conservation, and improved crop yields (both quantitatively and qualitatively). Additionally, this enhanced vermicompost can preserve an ecosystem's beneficial biota by acting as a biopesticide. Therefore, the most hospitable and sustainable substitute for chemical fertilizers and a farmer-friendly method of safeguarding our natural resources for future generations is enriched vermicompost.

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