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A REVIEW

Role of vermicompost and vermiwash as a biotic indicators for enhancement of soil health in sustainable agriculture

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Abstract : Vermicomposting is a promising method of transforming organic wastes into usable substrates. In this process, the digestive tracts of certain earthworm species (e.g. *Eisenia foetida*) are used to stabilize organic wastes. The final product is an odorless, clean, peat-like substance, which has good structure, moisture holding capacity, organic material containing relatively adequate quantities of N, P, K and several micronutrients essential for plant growth. The end product of vermicompost is rich in essential macro and micronutrients along with microorganisms in a very simple form. Adding vermicompost not only improves the soil structure and fertility but also leads to improvement in overall plant growth and thus increases their yield. Vermiwash is liquid plant growth regulator, which contains high amount of enzymes, vitamins and hormones like auxins, gibberellins etc. along with macro and micronutrients used as foliar spray. These inputs maintain soil fertility by improving physical, chemical and biological soil properties as well as sustain soil organic carbon and humic substances and can be used to promote the development of beneficial organisms in the soil. It improve soil structure, water holding capacity, seed germination, drainage, base exchange capacity, checks soil erosion and also helps in the uptake of humic substances or its decomposition products influencing the overall growth and metabolism of plants, also improves the hormonal and biochemical activities of humus substances. Hence, these can used very beneficially as a biotic indicators for enhancement of soil health in sustainable agriculture.

Key Words : Vermicompost, Vermiwash soil health, Sustainable agriculture

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INTRODUCTION

In view of the high cost of inorganic fertilizers and wide gap between addition and removal of plant nutrients by the crop, the recycling of organic wastes has become the necessity in agricultural systems. Intensification of agriculture has adversely impacted on the biodiversity, whereas, the increased use of agrochemicals and declined use of organic manures under intensive cultivation has not only contaminated the ground and surface water but has also disturbed the harmony existing among the soil, plant and microbial population. There has been a growing public concern about adverse impacts of chemical fertilizers and pesticides on the environment and on the safety and quality of food is not properly used. Organic manures are bulky material added in large quantities mainly to improve soil fertility, to maintain humus status and to provide favourable conditions for soil microorganisms. This helps in replenishment of nutrients eliminated by crops or otherwise protect the plant nutrients to be lost through leaching and soil erosion. Thus, organic manures supply practically all the elements required by the crop. It provide all macro and micronutrients, improve the soil structure and provide food for soil microorganisms and soil nutrients are released slowly over time (Worthington, 2001) and can enhance the restoration and productivity of soil (Hornick and Parr, 1987; Parr and Hornick, 1992) .

Vermicompost :

Vermicompost (also called worm compost, vermicast, worm castings, worm humus or worm manure) is the end-product of the breakdown of organic matter by some species of earthworm, feeding on biological degradable waste material and plant residues. Vermicompost is literally the best nutrient-rich, organic fertilizer and soil conditioner. The process of producing vermicompost is called vermicomposting. It is rich in microbial life which helps in breaking down of organic form of substances already present in the soil into plant available forms and eco-friendly, non-toxic, consumes zero fossil energy and is a recycled biological product unlike other compost, worm castings also contain worm mucus which protect plant nutrients from washing away and holds moisture efficiently. These inputs maintain soil fertility by improving physical, chemical and biological soil properties as well as sustain soil organic carbon and humic substances and can be used to promote the development of beneficial organisms in the soil. It improve soil structure, water holding capacity, seed germination, drainage, base exchange capacity, checks soil erosion and also helps in the uptake of humic substances or its decomposition products influencing the overall growth and metabolism of plants, also improves the hormonal and biochemical activities of humus substances (Mathur and Gaur, 1977; Nardi *et al.*, 2004 ; Prasad *et al*., 1972). These inputs sustain soil organic carbon and humic substances. Humic matter affects membrane permeability, protein carriers of ion, activation of respiration and Kreb's cycle in plant. They also influence the photosynthesis, formation of ATP, amino acids, carbohydrates, protein and nucleic acid synthesis and selective effects on enzyme activities (Vaughan and Malcolm, 1985).

Vermicomposting is a promising method of transforming organic wastes into usable substrates. In this process, the digestive tracts of certain earthworm species (e.g. *Eisenia foetida*) are used to stabilize organic wastes. The final product is an odourless, clean, peat-like substance, which has good structure, moisture holding capacity, organic material containing relatively adequate quantities of N, P, K and several micronutrients essential for plant growth. The end product of vermicompost is rich in essential macro and micronutrients along with microorganisms in a very simple form. Adding vermicompost not only improves the soil structure and fertility but also leads to improvement in overall plant growth and thus, increases their yield.

Nutrient rich in vermicompost :

The production of vermicompost from any biodegradable organic waste *i.e.* agricultural waste, city garbage, industrial waste and sewage waste by using earthworms and its utilization in agriculture is one of the most economic ways in keeping the soils alive and healthy for sustainable production/ productivity. It is rich in plant nutrients and provides vital macro-elements such as N, P_2O_5, K_2O, Ca, Mg and micro-elements such as Zn, Fe, Mn and Cu. Apart from this, it contains vitamins, enzymes and plant growth promoting substances such as auxins, cytokinins, gibberellins, etc. It also harbours beneficial microflora. It contains organic carbon (9.15-17.99 %), nitrogen (1.5-2.5 %), phosphorus (0.9-1.7 %), potassium (1.5-2.4 %), calcium (0.5-1.0 %), magnesium (0.2-0.3 %), sulphur (0.4-0.5 %), copper (2.30-2.95 ppm), iron (2-9.3 ppm) and zinc (5.7-11.5 ppm) depending on the nature of substrates used for vermicomposting. Mahendra Pal (2002) reported that the vermicompost contains 0.74 0.14, 0.97 0.11 and 0.45 0.15 % nitrogen, phosphorus and potassium, respectively. (Hornick and Parr, 1987; Parr and Hornick, 1992).

Benefits of vermicompost :

- Enhances soil productivity
- Produces crops with a better taste, luster and lasting quality, without toxic residues: crops can therefore fetch a higher price in the market
- Promotes faster growth of plants, increases crop yield
- Reduces soil erosion
- Increases water-holding capacity of soil
- Induces resistance to pest and disease attack
- Easy to produce and low in cost
- Reduces salinization and acidification

Bedding :

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

- 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.
- 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.
- 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.

Techniques for preparation of vermicompost :

Pit method :

A bed of size of 10 x 1 x 0.3 m is most suitable. The beds should be treated with chloropyriphos @ 2 ml/litre of water to prevent ant and termite problem. After 15 days, fill the beds in layers with organic residues as explained:

- First layer : Decomposable plant material (bottom of bed).

– Second layer : Cow dung/ farm manure/ biogas sludge.
– Third layer : Spread earthworms (1000-2000 in number).
– Fourth layer : Cow dung/ farm manure/ biogas sludge.
– Fifth layer : Dry crop residue/ green succulent leafy material, plus cow dung.
– Sixth layer : Thick layer of mulch with cereal straw (top of bed).

Each layer, except the third, should be 3-4 inch thick, so that the bed material is raised above the ground level. Sufficient dry and green wastes should be used. The mulch at the top prevents loss of moisture and acts as a barrier to predators like birds. The beds should be in shade.

Heap method:

In this method, composting is done on the ground without the pits. Organic material is piled up on the ground, as in the pit method, the only difference is that the heap gets a dome shape. The suitable size for a heap is 10 x 1 x 0.6 m.

Wooden box or brick column :

Rectangular wooden or brick structures (3x1x1 m) are erected above the ground level and the organic material is dumped inside serially as in earlier methods.

These beds have to be watered regularly to maintain a moisture level of 60-80 per cent till the harvest of vermicompost.

Vermicomposting requirements :

Compost worms need five basic things :

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

Multiplication of earthworms :

Earthworms are bisexual, but cross-fertilisation is the mode of reproduction. Adult worms after 15-21 days of copulation lay cocoons which look like coriander seeds. The eggs present inside the cocoon hatch into neonates in about 15-21 days. Neonates take 35-60 days to attain adulthood, which is characterised by a swollen band near the enterior part of the body. *Eudrilus eugeniae*, *Eisenia foetida* and other species used for vermicomposting, completes its lifecycle in about 65-80 days. It lays 400 plus cocoons in about 60 days.

Vermicomposting can be tested from a small collection of pellets on the top of the beds around 45-60 days after start. This is indicative of good multiplication of worms in the beds. In about 60 days, the material is degraded completely and vermicompost is ready for harvesting. The rate of degradation depends on the loading of worms. More the worms, faster the degradation. The heap method, however, has proved to be more effective than the pit system.

Rainy and winter season favours faster multiplication of worms than summer. With manipulation of soil temperature during summer by providing shade and regular watering, the rate can be enhanced. (Hornick and Parr, 1987; Parr and Hornick, 1992).

Harvesting of vermicompost :

After 60-70 days, the beds are ready for harvest. Seven days prior to harvesting, watering of the beds has to be stopped so that the earthworms in the top layers move down for want of moisture.

The beds should be disturbed and the material collected in pyramidal heaps for about 24 hours. The semidried compost from the top of the bed can be collected and sieved to remove any inert material. The concentrated vermiculture (earthworms) that remains at the bottom can be used again for vermicomposting. The compost can be dried in shade (12 hours), bagged and stored. About 3 tonn of vermicompost can be harvested in two months from 10 beds of 10 x 1 x 0.6 m each (Nardi *et al.*, 2004).

Natural enemies :

The important natural enemies of vermiculture are ants, termites, flatworm, centipedes, rats, pigs, birds, etc. Preventive measures include treating of the site with insecticide chloropyriphos 20 E C @ 2 ml/ litre or mixing of neem cakes @ 30 g/ kg food while filling the beds (Nardi *et al.*, 2004) .

Precautions :

– Use only plant materials (Such as vegetable peelings, leaves or grass).
– Remove glass, metal and plastic materials from the organic materials.
– Protect against birds by covering the rings with wire or plastic mesh.
– Sprinkle water regularly and maintain moisture level.
– Prepare compost in the shade to protect it from sun and rain.

Uses of vermicompost :

– Vermicompost is ready in 2 to 2.5 months. When it's ready, it's black, light weight and has no bad smell.
– It can be used for all crops (agricultural, horticultural, ornamental and vegetable) at any stage of the crop development.

Application method and time of vermicompost :

– Agricultural crops: apply vermicompost by broadcasting when the seedlings are 12-15 cm in height.
– Flowers, vegetables and fruit trees: apply vermicompost around the base of the plant, at any stage of development, and cover with soil.

Recommended quantity of vermicompost:(may varies as per soil type and region) :

- General Agricultural use: 3-4 tonnes ha^{-1}
- Fruit tree: 5-10 kg per tree
- Vegetables: 3-4 tonnes ha^{-1}
- Flowers : 500-750 kg ha^{-1}

Vermiwash :

Vermiwash is liquid plant growth regulator, which contains high amount of enzymes, vitamins and hormones like auxins, gibberellins etc. along with macro and micronutrients used as foliar spray (Nardi *et al.*, 2004)

Methods of preparation :

- Take one big bucket and one mug.
- Set up one stop cork on the lower most part of the bucket.
- Put a layer of broken bricks, pieces of stones having thickness of 10-15 cm in the bucket.
- Over this layer put another layer of sand having thickness of 10-15 cm.
- Then put a layer of partially decomposed cow dung having 30-45 cm thickness over it.
- Then put another layer of soil having 2-3 cm thicknesses.
- Now open the stop cork of the bucket and when the materials taken in the bucket.
- Then put 100-200 nos. of earthworms in the bucket.
- After that, a layer of paddy straw having 6 cm thickness is given.
- Now open the stop cork of the bucket and spray water regularly for a period of 7-8 days.
- After 10 days the liquid vermiwash will be produced in the bucket.
- Hang one pot with a bottom hole over the bucket in such a way so that water falls drop by drop.
- Every day 4-5 litres of water is to be poured in the hanging pot.
- Keep another pot under stop cork to collect the vermin wash. Every day 3-4 litres vermin wash can be collected.

Application of vermiwash :

- Mix 1 litres of vermiwash with 7-10 litres of water and spray the solution in the leaf (upper and lower side) in the evening.
- Mix 1 litre of vermiwash with 1 litre of cow urine and then add 10 litres of water to the vermin urine solution and mixed thoroughly and keep it over night before spraying 50-60 litre of such solution and to be sprayed in ¼ hectare of land to control various crop diseases.

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