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FACULTY OF AGRICULTURE SCIENCE AND ALLIED INDUSTRIES

Earthworms and vermi-compost

Soil fauna including protozoa to mammals though not considered major is the important source of nutrients. Among the soil fauna earthworms have attracted more attention than others because of their importance in agriculture.

Earthworm gut is the site of production of genuine humic acids which are distinct from the polysaccharide-gum humic acids. About half of the gums secreted by earthworm are in form of mucoproteins that help stabilizing pore space distribution. The earthworm soil casts are richer in available plant nutrients (nitrate nitrogen, exchangeable Ca, Mg, K and P) and organic matter. The earthworms through their casts and dead tissues supply about 60-90 kg N to the soil. Earthworm eats on fungal mycelia. Earthworms convert farm waste and organic residues into high quality compost. For this, *Eisenia foetida*, *Perionyx excavatus*, *Eudrillus euginiae* and *Lumbrius rubellus* are important.

Vermi-compost is a stable fine granular organic matter, when added to clay soil loosens the soil and provides the passage for the entry of air. The mucus associated with the cast being hygroscopic absorbs water and prevents water logging and improves water holding capacity. In the sandy soils where there is the problem of water retention, the young strong mucus coated aggregates of vermi-compost hold water for longer life.

In the vermi-compost, some of the secretions of worms and the associated microbes act as growth promoters along with other nutrients. It improves physical, chemical and biological properties of soil in the long run on repeated application. The organic carbon in vermi-compost releases the nutrients slowly and steadily into the system and enables the plant to absorb these nutrients.

Definition of vermi-composting:-

Vermi-composting is a method of making compost, with the use of earthworms, which generally live in soil, eat biomass and excrete it in digested form. This compost is generally called vermi-compost or Worm compost.

Definition of Vermiculture:-

Vermi-culture means scientific method of breeding and raising earthworms in controlled conditions.

Vermitechnology:-

Vermitechnology is the combination of vermi-culture and vermi-composting. Thus, earthworms can be used in the following areas.

1. For development of arable soils, turnover of soil, break down of plant organic matter aeration and drainage
2. for production of useful products like vermi-fertilizer and worm tissue for animal feed.
3. For maintenance of environmental quality and monitor of the environment for soil fertility, organic and Heavy metal non-biodegradable toxic material pollution.

Types of earthworms in vermicomposting:-

Earthworms belong to phylum Annelida of Animal Kingdom. They are long and cylindrical in shape and size having a large number of grooves. There are about 3000 species of earthworms in the world which are adapted to a range of environment. More than 300 species have been identified in India. Although, hermaphrodite, two mature earthworms are required to propagate. At the time of egg laying, the clitellum is transformed into hard, girdle like capsule called cocoon. Shedding of cocoon ranges from 1 to 5, only a few of them survive and hatch. The juveniles and again formation of cocoons takes a period of 50-60 days. Normally, the average life span of earthworms varies with species ranging from 1 to 10 years.

Epigeics (surface feeders) are important in vermicomposting. The epigeics such as *Eisenia foetida* and *Eudrilus eugeniae* are exotic worms and *Perionyx excavatus* is a native one being used for vermi-composting in India.

Epianecic are feeders on leaf litter and soil at upper layers of soil. This group such as *Lampito mauritii* is indigenous and is active in in-situ decomposition of organic wastes and residues in soil.

Both epigeics and epianecics groups of earthworms are slender, shorter in length and red to dark brown in colour.

They have high reproduction activity and efficient in recycling of organic materials. Increased attention has been paid to *Eisenia foetida* and *Eudrilus eugeniae* which have been found to be potential agent in vermicomposting of wide range of agricultural wastes and can grow at a wide range of temperature varying from 0-40 °C. However, the optimum temperature ranges from 20-30 °C.

Mechanism of vermi-composting:-

Materials consumed by worms undergo physical breakdown in the gizzard resulting in particles < 2 μ, giving thereby an enhanced surface area for microbial processing. This finally ground material is exposed to various enzymes such as protease, lipase, amylase, cellulase and chitinase secreted into lumen by the gut wall and associated microbes. These enzymes breakdown complex biomolecules into simple compounds.

Vermi-culture industry or vermi-compost preparation:-

1. Basic raw material: Any organic material generated in the farm like bhusa, leaf fall etc., Horse dung, due to the risk of Tetanus virus, lethal to human beings is not advisable to be used as feeding material for earthworms. Paddy husk, merigold and pine needles have also not advised to be used as feeding materials for earthworms.
2. Starter: Cow dung, Biogas slurry, or urine of cattle
3. Soil animal: Earth worms (Species: *Eisenia foetida*)
4. Thatched roof/vermished.

Favourable conditions of earth worms in the composting material:

- A. pH: Range between 6.5 and 7.5
- B. Moisture: 60-70% of the moisture below and above range mortality of worms taking place
- C. Aeration: 50% aeration from the total pore space
- D. Temperature: Range between 18 °C to 35 °C

Procedure:-

It is mostly prepared in either pit or heap method. The dimensions either heap or pit are 10 x 4 x 2 feet. The length and width can be increased or decreased depending on the availability of material but not the depth because the earthworms' activity is confined to 2 feet depth only. First of all select a site which is not under any economic use and is shady and there is no water stagnation. The site should also be nearby to water source.

1st layer: bedding material of 1" thick with soft leaves

2nd layer: 9" thick organic residue layer finely chaffed material

3rd layer: Dung + water equal mixture of 2" layer.

Continue the layer up to pile to ground level in the case of pit method and upto 2'in heap or surface bed method.

Protect the worms against natural enemies like ants, lizards, snakes, frogs, toads etc., Maintain proper moisture and temperature by turnings and subsequent staking. At the day of 24th, 4000 worms are introduced in to the pit [1m²=2000 worms] without disturbing the pit by regular watering the entire raw material will be turned into the Vermi-compost in the form of worm excreta. The turnover of the compost is 75% [the total material accommodated in the pit is 1000 kg; the out turn will be 750 kg]

Harvesting of the vermicompost from the pit:-

Stop watering before one week of harvest. Sometimes the worms spread across the pit come in close and penetrate each other in the form of ball in 2 or 3 locations. Heap the compost by removing the balls and place them in a bucket. However, under most instances, top layer has to be disturbed manually. Earthworms move downward and compost is separated. After collection of compost from top layers, feed material is again replenished and composting process is rescheduled. The material is sieved in 2 mm sieve, the material passed through the sieve is called as vermi-compost which is stored in a polythene bags [Note: Vermi-composting is done under thatched roof to protect worms against rain and sun].

Recomposting is done in the same pit or bed. Similar to the above described pit/heap method, vermicompost can be prepared in wooden box or brick column in similar way.

In-situ vermi-composting can be done by direct field application of vermicompost at 5 t/ha followed by application of cow dung (2.5 cm thick layer) and then a layer of available farm waster about 15 cm thick. Irrigation should be done at an interval of 15 days.

Precautions:-

1. Do not cover vermi-compost beds/heaps with plastic sheets because it may trap heat and gases.
2. Do not overload the vermi-compost heap to avoid high temperature that adversely affects their population.
3. Dry conditions kill the worms and water logging drives them away. Watering should be done daily in summer and every third day in rainy and winter season.
4. Addition of higher quantities of acid rich substances such as tomatoes and citrus wastes should be avoided.
5. Make a drainage channel around the heap to avoid stagnation of water particularly in high rainfall areas in rainy season.
6. Organic materials used for composting should be free from non-degradable materials such as stones, glass pieces, plastics, ceramic tubes/bulbs etc.

Natural enemies and their control:-

The important natural enemies of vermi-culture are ants, termites, centipedes, rats, pigs, birds etc.

Preventive Measures include treating of the site with chlorpyrifos 20 EC at 2 ml/l or 4% neem based insecticide before filling the heap.

Transportation of live worms:-

Live earthworms can be packed with moist feed substrate in a container (card board/plastic) with provision of aeration. Feed substrate quantity should be roughly 0.5-1.5 g/individual for 24 hours of transportation journey.

Culture should contain cocoon, juveniles and adults because sometimes adults do not acclimatize to new Environment and may even die. Under such circumstances cocoons are helpful for population build up of Earthworms.

Nutrient composition of vermi-compost

S.No.	Nutrient	Content
1	Organic carbon	9.15 to 17.98 %
2	Total nitrogen	1.5 to 2.10 %
3	Total phosphorous	1.0 to 1.50 %
4	Total potassium	0.60 %
5	Ca and Mg	22.00 to 70.00 m.e/100 g
6	Available S	128 to 548 ppm
7	Copper	100 ppm
8	Iron	1800 ppm
9	Zinc	50 ppm

Besides the above nutrients the vermi-compost also contains Protease, Lipase, Amylase, Cellulase enzymes

Conversion rates:

1000 earth worms may convert 5 kg waste material per day

1000 worms weighs about a kilogram

Advantages of composting over direct application:

1. There will be no immobilization in compost because of narrow C:N ratio
2. Application is easy, because the compost is humified and have a structure of crumb and granular.
3. It is hygienic; pathogens and weeds seeds are destroyed.

Advantages of direct application:

1. No loss of nutrients
2. It improves physical properties better than compost on soil application.

Application rate:-

It can be applied in any crop at any stage, but it would be more beneficial if mixed in soil after broadcasting. Threat of application is as Field crops 5-6 t/ha; vegetables 10-12 t/ha; flower plants 100-200 g/sq ft; fruit trees 5-10 kg/tree.

Advantage of vermicompost:-

1. Vermi-compost is a rich source of nutrients, vitamins, enzymes, antibiotics and growth hormones. So it gives disease resistance to plants. Nutrient content of vermi-compost is higher than traditional composts. It is a valuable soil amendment.
2. Vermi-compost harbours certain microbial populations that help in N fixation and P solubilization. Its application enhances nodulation in legumes and symbiotic mycorrhizal associations with the roots.
3. Superiority of vermi-compost over other synthetic growth media is more pronounced in plant nurseries. It can be used as rooting medium and for establishment of saplings in nurseries.
4. It improves taste, lusture and keeping quality of the produce.

