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EARTHWORM: A NATURAL ECOFRIENDLY ORGANISM FOR RECYCLING OF ORGANIC RESIDUES AND IMPROVEMENT OF SOIL HEALTH BY VERMICOMPOST

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Abstract

Vermicompost of agriculture waste is an important method in which organic waste such as leaves or stalks of agricultural field is converted into useful compost by means of worms is useful to the environment. Earthworm and microbes acts together and breaks down the complex organic matter of agricultural field and resulting material is rich in nutrients and oxygen. Composting is becoming an effective way to increase organic matter of soil. In addition to increasing organic matter of soil compost also increases soil microbial population (Pera et al., 1983; Perucci, 1990), which leads to the improvement of soil quality. The entire residues after crop is harvested must go back to the soil to replenish the lost nutrient, so vermicompost is considered as excellent way to recycling nutrient in the ecosystem. Soil organic carbon enhancement through crop residues recycling by means of vermicomposting along with fertilizers and integrated nutrient management (INM) are major option to improves soil health and crop productivity. The major objective to vermicomposting is that more ground water recharge and lesser depletion of water table as well as reduces soil salinity and less pollution by agrochemicals.

Key words: Agrochemicals, Earthworm, Rural economy, soil health, soil organic carbon, soil texture, Vermibed, waterholding capacity, soil texture.

Introduction

Degradation of organic waste using earthworm is one of the excellent achievements in the biological sphere. Earthworm breaks down complex organic matter in to water soluble substance. In the degradation process microbes and earthworm degrades together agricultural waste or any other kind of municipal waste and produces compost calledVermicompost.

Distribution and Groups of earthworm

Earthworm belongs to phyla which have originated about 600 million yearsago during pre-Cambrian era. Earthworm is an invertebrate animal with cylindrical body without legs. There are merely more than 5,500 known species of worm today .There natural life span varies from 3.5 -10 years. They are burrowers and found in soil rich in decaying organic matter usually in gardens, lawns, irrigated farm lands, near bank of ponds, rivers lakes, they do not prefers to live in sandy clay and acidic soil deficient in the organic matter. Thus their presence is indicator of quality of soil status. They generally inhabit in upper layer of earth to a depth of 30-45 cm and even can go down up to 3 meters or more during the summer in search of moisture. They are found in the everywhere except Polar Regions and dry land. There are generally three groups of earthworm are recognized. The group comprised those species that pass much of soil through the intestine and termed as geophagous. Those species are known from soil of pH as low as 4.5-5.5 and soil of little significance (e.g. *Eiseniarosea, Lumbricusterrestris)* while second group of species comprises limiphagous or limicolous (e.g. *A. chlorotica)* and third group species are litter feeders. Litter includes all types of accumulation of organic matter such as leaves, manures, and decaying agricultural waste. Litter feeders become geophagus when they hibernate (e.g. *E. foetida* (Fig 2), *L. rubellus*).

Worms used in vermicompost preparation

Vermicomposting is an industrial process that was originally developed to remove unwanted organic matter from the agricultural and industrial waste. One of the earthworm species most often used composting is the red worms (*E. foetida, E. andrei, L. rubellus*) and Blue worm *Perionyxexcavates* (Fig 1);but, *P. excavatus*is suitable for warm climate. The ideal temperature for red worms in between 55-77° F but temperature above 84°F is harmful, sometimes fatal temp below 50°F slows down the worm activity. It needs the moist environment because most of breath of earthworm is taken by their skin. They show optimum growth at pH 7 but tolerate the pH 4.2 – 8.0 or more. In such vermicomposting system worms needs source of large quantity of food such as cattle manures, earthworm sludge, agricultural waste, grass/weed, wood chips.

Fig 1: Perionyxexcavatus (Asian worm)

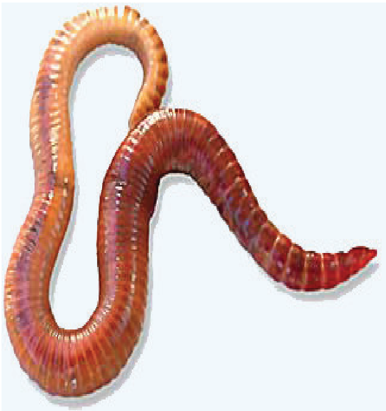

Fig 2: *Eiseniafoetida*

Classification

Kingdom:	Animalia
Phylum:	Annelida
Class:	Cliellata
Sub-class:	Oligochaeta
Order:	Haplotaxida
Family:	Megascolecidae
Genus:	*Perionyx*
Species:	*excavatus*

Food and feeding mechanism

Earthworm are omnivorous they feeds upon the all sorts of organic humus, decaying matter, small protozoan, nematodes and other microorganism found in the soil. They commonly feeds upon large quantity of soil, hence their intestine is always full of soil. Organic matters passes into pharynx through buccal chamber where it receives salivary secretion. Salivary secretion contains the mucin and proteolytic enzymes. The mucin lubricates the foods while proteolytic enzymes hydrolyse the proteins into peptones and proteases. On reaching the food into gizzards food converted into fine state and in the intestine hydrolyzed peptones is converted into amino acid by the action of proteases while by the action of lipase, Amylase, cellulase, chitinase on fat, carbohydrate, cellulose and chitin respectively completes the digestion process and digested food is absorbed in the small intestine and remains are egested as castings by anus.

Role of earthworm in soil fertility

Earthworm plays a key role in soil biology as versatile natural bioreactors. They support the beneficial soil micro-flora; destroy soil pathogens and converts organic waste into useful products which improves the soil fertility such as nutrients, vitamins, enzymes, antibiotics, growth hormones and proteinaceous materials. Hence it is termed as artificial fertilizer factories. Earthworm modifies soil physical, chemical and biological properties and it is believed that they enhance nutrient cycling by ingestion of soil and humus and by production of casts. Various evidences show that casts has higher concentration of exchangeable Ca, Na, Mg, K, P and Mo than the surrounding soil. Soil enrichment is achieved by speeding up mineralization of organic matter from 2-3 times. Earthworm greatly increases the amount of soluble and available NPK. Since earthworm casts are rich in N compared to the surface horizon of soil. Higher nitrogen content in earthworm cast facilitates microbial population as well as enzyme activity. About 96% inorganic nitrogen in earthworm casts present as $NH4^+$. Casts are also enriched in soluble phosphorous in comparison to the underlying soil. Earthworm favors nitrification since they increase population and soil aeration. Microbial activity of casts enhances the transformation of soluble nitrogen into protein, so minimizes the chances of leaching of nitrogen to lower horizon of soil. Cast of earthworm contains 2-3 times more available K than the surrounding soil.

Earthworm for water management / waste management / disease and pest management

Earthworm affects the porosity of soil by burrowing and by deposition of casts due to loosely packed aggregates on the soil surface (Vanrhee, 1977). Most of the burrow of earthworm is air filled spaces in the soil considered as good for water holding capacity. Because of burrowing activities of earthworm it improves air and water penetration into the soil; on the other hand earthworm castings stabilize the soil aggregation. In the modern age disposal of organic waste material from sources like domestic, agricultural, industrial sources causes environmental pollution as well as considered as large reservoir of CO_2 emission which causes greenhouse effect. It has been demonstrated that earthworm causes processing of domestic and industrial waste (Kale et al., 1982; Muyima et al., 1994). In tropical and sub-tropical condition *P. excavatus* is best vermicomposting earthworm for organic solid waste management (Kale, 1998). By such management earthworm produces efficient bio-product that is vermicompost. Almost all insect and pathogens attack the nutritionally weaker plant. Earthworm provides balanced nutrition to the plant, thus giving them the tolerance to pest attack.Doube et al. (1994) evaluated the control of fungal root disease of cereal crop using earthworm and biological control agent.

Materials and method for preparation of vermicompost

Materials required for compostingare any kind of degradable waste (crop residues, weed, kitchen waste, rotten plant biomass, excreta of animal husbandry such as cow dung, biogas slurry), bedding material, housing/shed, fine sand, garden soil. Bedding is material that provides living condition and these are food source, moisture, aeration, protection from temperature. One essential condition for bedding material is that it should have moisture retentivity because earthworm prefers mostly cutaneous respiration that requires moisture environment. Commonly used bedding materials are hay, paper mill sludge, plant stalk, corn stalk, saw dust, legume stalk, corn cob, chopped weed etc. worm start to eat bedding material and breaks down it into finer particles size. It should be always keep in mind that breakdown of bedding material be a slow process because rapid degradation causes rise in the temperature which may be fatal. High Carbon: Nitrogen content of bedding material may causes rapid degradation. To obtain optimum C/N ratio the substances like saw dust, paper, and straw can be mixed with nitrogen rich material such as poultry extra, biogas residues and fish scraps. Vermiculture bed should be treated with Chlorpyriphos @ 2 ml/liter of water to prevent ants, termites. Vermicultutre bed may be prepared by 2-5 cm saw dust/husk/fibrous waste like coir waste or sugarcane trash at the bottom layer then spread 2 cm of fine sand that is followed by garden soil 2-5cm. vermicompost is produced in shade and humid or cool surrounding. It may be produced in the pit of 10×10 ×3 m or structure of cemented break column of 3×1×1m in above the ground. In the absence ofChlorpyriphosneem cake @ 30 gm/1 kg of organic residues during filling of bed. Since the natural enemy of vermiculture is ants, termites, flatworm, centipedes, rats, pigs, birds etc. After 15 days of treatment with anti-termite or other insecticide fill the pit with organic residues. During filling of pit bottom should poured with first decomposable material followed by cow dung /farm manure/biogas sludge and spread 1000-2000 in number. After spreading of worms again pours the cow dung /farm manure/biogas sludge then add dry crop residues /green succulent material and cow dung. Green succulent leafy material maintains the moisture content while on the top layer put cereal straw which acts as mulching agent. Mulching prevents the loss of water or moisture and barrier to predator like birds which eats the worms. Sheltered vermiculture protect the worms from sunlight and rain. Compost worm are good eater, they are able to eat food more than their body weight in the day. Manures are the most commonly worm feed. Cattle manures provide good nutrition. Poultry manures have high nutritional value due to high nitrogen content. All other waste material should be predigested with cow dung for 20 days before placing it over vermibed for composting. Predigested waste material should be mud with 30 percentage of cattle dung by weight or volume. Mixed material is put placed in container and at top earthworm should be placer gently for 1×1×0.5 height .As general for such configuration 1 kg (1000) of worm is required. Traditionally cow dung were used in the making dung cake or used as fertilizer but currently it is used in the production of bio-gas. Vermicompost can be made from slurry of biogas plant which is highly concentrated in the bacteria .biogas slurry left aerobically for 15 days increases the rate of vermicomposting process. Watering is required for vermibed but daily watering is not required however it depends on temperature and humidity. In general 60 % of water should be maintained .It is advised to sprinkle the water rather than the pouring of water and stop the water before the harvesting of compost. During vermicomposting earthworm multiply and it is estimated that earthworm doubles it no in about 30 days. Earthworm gets adulthood in 45-50 days and per worm produce 6-14 young ones. During the fermentation process composting material should be over turned 4-5 times to maintain uniform decomposition and for lowering of temperature. When material becomes quit soft it is placed into another container and worm of earthworm days to earthworm week old are introduced into them. A container of 1.1.05 holds 35 to 40 kg of feeding and bedding material. For such amount of material 1000-1200 worms are required for processing of material. During composting process material should have 60% moisture, pH 6.3 and temperature range of 20-30°C. Worms should allow feed until it is converted into highly granular mass. Vermicompost unit of Rajendra Agriculture University, Pusa is shown in Fig 3.

Fig 3: Vermicompost unit

Harvesting of vermicompost

After the 60-70 days, the beds are ready for harvest. Seven days prior to harvesting, watering of bed should be stopped, so that earthworm moves from bottom to top layer to down for searching of moisture. Bed is disturbed and material is collected in the shape of pyramids for 24 hours. Dried vermicompost from the top is sieved and removed any inert material (Fig. 4). Concentrated earthworm at the bottom can be used again for vermicomposting. Compost is dried in the shade for 12 hours then bagged and stored. About 3 tons ofvermicompost can be harvested in two month from ten beds of 10×1×0.6 m

Fig 4: Harvested vermicompost

Table1: Percentage Nutrient Composition analysis of Vermicompost and Compost

Nutrient element	Vermicompost (%)	Compost (%)
Organic carbon	10-14	12
Nitrogen	0.51-1.6	0.8
Phosphorous	0.19-1. 02	0.4
K	0.15-0.73	0.5
Ca	1.18-7.61	2.2
Mg	0.093-0.568	0.5
Na	0.06-0.16	<0.01
Zn	0.0042-0.011	0.0012
Cu	0.0026-0.0048	0.0012
Fe	0.2050-1.3313	1.1690
Mn	0.0105-0.2038	0.0414

Source: (Srinivasarao et al., 2011)

Environmental Impact of vermicompost towards climate resilience

Compared to other waste related compost vermicompost has high potential impact on environment. Vermicomposting helps in the conservation of environment. The organic content of earthworm dropping encourages the passage of air and water through soil. So soil ends up being a better environment for the critters of the soil food web and for plants. In India and Australia worms studied have shown to remove heavy metals from soil, which they termed vermiremediation. The accelerated humification of organic waste with less cost is the need of vermicomposting technology using earthworm is the solution for the current urban waste. The converted urban waste through vermicompost technology result in good humus, which is highly valued material fulfilling the major nutritional need of plant .The use of vermicompost reduces Nitrogen application rate of fertilizers, in this way the vermicompost technology will reduces the harmful side effect to environment by the application of huge amounts of chemical fertilizers to agricultural field there by reducing N_2O emission, a potential greenhouse gas. Organic matter in soil could effectively increase the activity of metals in soil and improves metals mobility and distribution in soil. The application of natural fertilizer (compost and vermicompost) in soil has helped in increase in metal mobility through the formation of soluble metalorganic complexes (Yang et al., 2005). Leachate from vermicomposting operation is often regarded as beneficial in the sense that when collected it can be used as liquid fertilizer, often called 'Worm tea'. While this is true, the leachate also has the potential to pollute when not collected and used positively. Previous studies using earthworm reactors to help treat dilute sewage found that while such reactors achieved good result, the resulting leachate was still polluting in terms of Biological Oxygen Demand, Chemical Oxygen Demand and nitrate Concentration.

Advantages of vermicompost

Eco-friendly

It reduces the environment pollution by less use of agrochemical .It minimizes the attack of pest and disease.

Reduces the soil- salinity land soil erosion causes recharging of ground water lesser waste land formation

Farmer's friendly

It contains valuable Vitamins, enzymes and phytohormone, so enhances soil productivity, increases yield with less irrigation. It protect crop from intermittent dry spells.

National economy friendly

Lesser use of agro chemicals so saves foreign exchange, boost to rural economy, more export to agriculture product with lower pesticide residues. Less expenditure on water supply and pollution control.

Conclusion

Vermicomposting is known to throughout the world but unfortunately this technology is not recognized as popular technology. Since it recycles organic residues or crop residues so it represents alternative approach in waste management. In comparison to other waste management vermicomposting has potential impact on environment. The vermicompost reduces the nitrogen use in the form of fertilizers. So reduces the emission of nitrous oxide a major greenhouse gases and minimizes the harmful effect of environment. There are many farmers utilizing vermicompost in the different in the different climatic zone and there will lot of demand of vermicompost in future for developing country to fulfill the demand of agriculture yield.

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