World Research Journal of Agricultural Biotechnology
Volume 1, Issue 1, 2012, pp.-01-03
Available online at http://www.bioinfo.in/contents.php?id=296

BIOTECHNOLOGICAL SOLID WASTE MANAGEMENT BY VERMICOPOSTING

MEENAKUMARI T.[1]* AND SHEKHAR M.[2]

[1]Department of Zoology, B.V. Bhomaraddy college of UG and PG Bidar-560 056, Karnataka, MS, India.
[2]Department of Biotechnology, Bangalore University Bangalore-560 056, Karnataka, MS, India.
*Corresponding Author: Email- meena862@yahoo.in

Received: May 12, 2012; Accepted: July 03, 2012

Abstract- Vermiculture appears to be an innovative sustainable technology for waste treatment, which holds a promising future in the field of solid waste management. Vermiculture is the process of culturing worms to decompose organic food waste, turning the waste into a nutrient rich material capable of supplying necessary nutrients to help plant growth. This method is simple, effective, convenient and noiseless. It saves water, energy, landfills, and helps to rebuild the soil. The worms have the ability to convert organic waste into nutrient-rich material which reduces the need for synthetic fertilizers.
Vermicompost improves soil structure and aeration as well as increasing its water-holding capacity. Worms help the environment by decomposing organic material (food and yard waste) turning it into a natural rich organic soil amendment. The end result is called vermicompost, wormpoop or worm castings. Vermicompost provides a tremendous source of nutrients for plants that dramatically improve the texture and fertility of soil. This replaces valuable nutrients taken out of the soil when fruit and vegetables are harvested. Vermicomposting adds beneficial organisms to the soil. These microorganisms and soil fauna help to break down organic materials and convert nutrients into a more available food form for plants. Vermiculture composting is nature's way of completing the recycling loop. Being born, living, dying, and being reborn again. Adding compost to soil aids in erosion control, promotes soil fertility, and stimulates healthy root development in plants.
Key words- Vermitechnology, Earthworm, *Eisenia Foetida,* Compost, Vermicast.

Citation: Meenakumari T. and Shekhar M. (2012) Biotechnological Solid Waste Management by Vermicoposting. World Research Journal of Agricultural Biotechnology, Volume 1, Issue 1, pp.-01-03.

Introduction

Management of solid waste has become one of the biggest problems we are facing today. The rapid increase in the volume of waste is one aspect of the environmental crisis, accompanying recent *global development* (Rapid urbanization. encroachment of fertile area and booming population is leading to generation of massive amount of waste). 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, generates as much as 25 million tones of urban solid waste of diverse composition per year. But per capita waste production in India is minisculous compared to the per capita production of wastes in the industrialized countries. It is estimated that the per capita waste generated in India is about 0.4 kg/day with the compostable matter approximately 50-60%. Most common practices of waste processing are uncontrolled dumping which causes mainly water and soil pollution. Besides dumping or sanitary land filling, the final disposal of solid waste can be carried out by other methods like incineration and composting. Earthworm farming (vermiculture) is another bio-technique for converting the solid organic waste into compost. An innovative discipline of vermiculture biotechnology, the breeding and propagation of earthworms and the use of its castings has become an important tool of waste recycling the world over. Essentially, the vermiculture provides for the use of earthworms as natural bioreactors for cost-effective and environmentally sound waste management.

Now there is an all-round recognition that adoption and exploitation of vermiculture biotechnology besides arresting ecological degradation could go a long way towards meeting the nutrient needs of the agricultural sector in a big way. On another front, widespread use of vermicultural biotechnology could result an increased employment opportunity and rapid development of the rural areas. It is high time that the scientific community of the country gave a serious attention to standardizing and popularizing vermiculture technology on a countrywide basis.

Role of earthworms in the breakdown of organic debris on soil surface and soil turn over process was first highlighted by Darwin (1881). Since then it has taken almost a century to appreciate their important contribution in curbing organic pollution and providing topsoil to impoverished lands. Although this realization has awakened the global population to give a serious thought to utilize them for the benefit of mankind, by the turn of this century [16]. Vermicomposting facilities have already entered domestic and industrial marketing in countries like Canada, USA, Italy and Japan. Vermicomposting was started in Ontario (Canada) in 1970 and is now processing about 75 tones of refuse per week. American Earthworm Company (AEC) began a farm in 1978-79 with about 500 tones capacity per month. Aoka Sangyo Co. Ltd., Japan has three 1000 tones per month plants processing wastes from pulp and food industries. Besides these, there are about 3000 other vermicomposting plants in Japan with 5-50 tones capacity per month. It has also started in Italy and in the Philippines. It is now time for India to think about vermitechnology commercially.

Vermitechnology

The use of organic amendment, such as traditional thermophilic composts, has long been recognized as an effective means of improving soil structure, enhancing soil fertility, increasing microbial diversity and populations [5], improving the moisture-holding capacity of soils and increasing crop yields. Effects on microorganisms have also been associated with their capability to suppress soil-borne plant diseases, plant parasitic nematode populations and increased crop yields [14]. Vermicomposts are finely-divided mature peat-like materials with a high porosity, aeration, drainage and water-holding capacity and microbial activity which are stabilized by interactions between earthworms and microorganisms in a non-thermophilic process [7]. Vermicompost contains most nutrients in plant available form such as nitrates, phosphates and exchangeable calcium and soluble potassium [8,21]. Vermicompost have large particulate surface areas that provide many micro sites for microbial activity and for the strong retention of nutrients. Vermicomposts are rich in microbial populations and diversity, particularly fungi, bacteria and actinomycetes [7,23] Vermicomposts consistently promote biological activity which can cause plants to germinate, flower and grow and yield better than in commercial container media, independent of nutrient availability [1,2]. For instance, substitution of small amounts of vermicomposts into soil-less bedding plant potting mixture has resulted in significant increase in the germination and growth of marigolds tomatoes and peppers, in greenhouse trials, when all necessary nutrients are available, even at substitution rates as low as 5-30% into the medium [1-3]. Vermicompost contains plant growth regulators and other plant growth influencing materials produced by microorganisms [9,23] including humates [4]. Krishnamoorthy and Vajrabhiah (1986) reported the production of cytokinins and auxins in organic wastes that were processed by earthworms. Vermicompost also contains large amounts of humic substances [18] and some of the effects of these substances on plant growth regulators or hormones [19]. However, most research on the use of vermicomposts has been in the greenhouse, and few workers have reported on the use and effects of vermicomposts in the field. The technology to use surface and subsurface local varieties of earthworms in composting and soil management is called vermitech. Regular inputs of feed materials for the earthworms can be in the form of agro wastes, kitchen wastes, and nitrogen rich materials like cattle dung, goat manure and pig manure. Poultry manure should however be handled carefully due to the presence of toxic components. By processing these wastes into organic fertilizers we also get rid of organic solid wastes. Vermicomposting therefore is also solid waste management, where organic wastes are considered as resources. Vermitechnology comprises three main processes:

- Vermiculture- Rearing of earthworms.
- Vermicomposting- Biodegradation of waste biomass in earthwormic way.
- Vermiconvertion- Mass maintenance of sustainability of wast lands through earthworms.

Utilizable products and benefits of vermitechnology are waste biomass management, animal protein production, and organic pollution abatement, waste land conservation, land reclamation, production of worm-worked manure, soil fertility and enhancement in plant production.

Worms for Culture (Vermiculture)

Vermiculture is used for conversion of solid wastes in to a nutrient -rich material. 'Vermi' means worms (earthworms) and 'culture' means farming; thus, vermiculture is a farming of earthworms. In this process, earthworms are harnessed as versatile natural bioreactors, which convert the organic solid waste into a valuable by-product (Fig. 1). The Nature has created and differentiated earthworms into epigeic, anecic and endogeic functions in the respective soils. Out of the three ecological varieties, the epigeics in particular and the aneceic in general, have largely been harnessed for use in the vermicomposting process. Epigeics like *Eisenia foetida* [10,11] and *Eudrilus euginiae* [15] have been used in converting organic wastes (agro waste and domestic refuse) into vermicompost. Though these surface dwellers are capable of working hard on the litter layer and can convert all the organic waste into manure they are of no significant value in modifying the structure of the soil. The anecics however are capable of both organic waste consumption as well as in modifying the structure of the soil. Such burrowing species that are widely used in soil management like the earthworms, *Lampito mauritii* [12] also effectively create a drilosphere apart from helping in compost production. Worm-worked soils are conspicuously different from soil devoid of earthworms. Importantly, the tunnel formed by the worms [22] aid in the passage of water, which also washes the nutrients from the drilosphere to the roots that extend quite rapidly along these channels. This principle is also applied in the preparation of vermiwash. Vermiwash functions as a good foliar spray, as it contains the requisite nutrients in it [13].

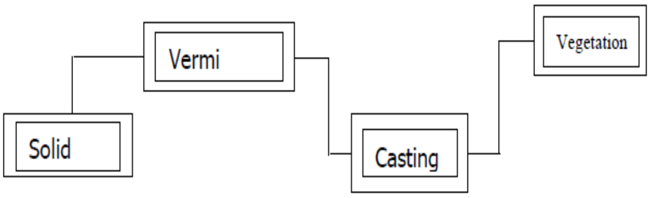

Fig. 1- Schematic representation of Vermicomposting

Vermicomposting

Composting can be done either in pits or concrete tanks or well rings or in wooden or plastic crates appropriate in a given situation. It is preferable to select a composting site under shade, in the upland or an elevated level, to prevent water stagnation in pits during rains. Vermicomposting is set up by first placing a basal layer of vermibed comprising broken bricks or pebbles (3-4 cms.) followed by a layer of coarse sand to a total thickness of 6-7 cms. To ensure proper drainage, a 15 cms moist layer of loamy soil follows. Into this soil 100 earthworms are inoculated. Small lumps of cattledung (fresh or dry) are then scattered over the soil and covered with a 10cm layer of hay. Water is sprayed till the entire set up is moist but not wet. Less water kills the worms and too much water chases them away. Watering the unit is continued and the unit is monitored for 30 days. The appearance of juvenile earthworms by this time is a healthy sign. Organic refuse is added from the 31st day as a spread on the bed. Addition of refuse can be done twice a week, watering to requirement. After a few applications, the refuse is turned over without disturbing the bed. The day enough refuse has been added into the unit, watering is continued and 45 days later the compost is ready for harvest. The organic refuse changes into a soft, spongy, sweet smelling, dark brown compost [13].

Conclusion

Vermicomposting technology is known throughout the world, although in limited areas. It may be considered a widely spread, though not necessarily popular technology. As a process for handling organic residuals, it represents an alternative approach in waste management, in as much as the material is neither landfilled nor burned but is considered a resource that may be recycled. In this sense, vermicomposting is compatible with sound environmental principles that value conservation of resources and sustainable practices.

Vermicomposting in developing countries could prove to be useful in many instances. Some aspects of the process may be labour intensive when mechanized equipment such as front-end loaders, trommel screens, tractors, etc., are not available to handle large volumes of material. In areas where creation of low or semi-skilled jobs is considered advantageous, Vermicomposting may supply an opportunity for employment. Where accumulation of food waste, paper, cardboard, agriculture waste, manures, and biosolids are problematical, composting and vermicomposting offer good potential to turn waste material into a valuable soil amendment.

References

[1] Atiyeh R.M., Arancon N.Q., Edwards C.A. and Metzger J.D. (2000a) *Bioresource Technology,* 75(3), 175-180.

[2] Earthworm-processed organic wastes as components of horticultural potting media for growing marigold and vegetable seedlings. (2000b) *Compost Science and Utilization,* 8(3), 215 -223.

[3] Atiyeh R.M., Arancon N.Q., Edwards C.A. and Metzger J.D. (2002a) *Bioresource Technology,* 81, 103-108.

[4] Atiyeh R.M., Lee S.S., Edwards C.A., Arancon N.Q. and Metzger J.D. (2002b) *Bioresource Technology,* 84, 7-14.

[5] Barakan F.N., Salem S.H., Heggo A.M. and Bin-Sinha M.A. (1995) *Arid Soil Research and Rehabilitation,* 9(4), 467-480.

[6] Chirashree Ghosh (2004) *Bioresource Technology*, 93, 71-75.

[7] Edwards C.A. and Burrows I. (1988) *Earthworms in Environmental and Waste Management,* 211-220.

[8] Edwards C.A. (1988) *Earthworm ecology,* 327-354. CRC press, Boco Roton, FL.

[9] Grapplli A., Galli E. and Tomati U. (1987) *Agrochimica,* 21, 457-462.

[10] Hartenstein R., Neuhauser E.F. and Kaplan D.L. (1979a) *Proceedings of the Eighth National Sludge Conference,* 238-241, Information Transfer Inc., Silver Spring MD.

[11] Hartenstein R., Neuhauser E.F. and Kaplan D.L. (1979b) *Oecologia,* 43, 329-340.

[12] Ismail S.A. (1993) *Congress on traditional Sciences and technologies of India*, IIT Bombay, 10.27-10.30.

[13] Ismail S.A. (1997) *Vermicology,* The biology of Earthworms, Orient Longman, Hyderabad, 92.

[14] Johnston A.M., Janzer H.H. and Smith E.G. (1995) *Canadian Journal of Plant Science,* 75(2), 347-354.

[15] Kale R.D. and Bano K. (1988) *Mysore J. Agri. Sci.,* 22, 339-344.

[16] Kale R.D. (1998) *Earthworm-Cinderella of Organic Farming*. Bangalore, India.

[17] Krishnamoorty R.V. and Vajrabhiah S.N. (1986) *Proceedings of the Indian Academy of Sciences (Animal Science*), 95, 341-351.

[18] Masciandaro G., Ceccanti B. and Garcio C. (1997) *Bioresource Technology,* 59, 199-206.

[19] Muscolo A., Bovalo F., Giorfriddo F. and Nardi S. (1999) *Soil Biology and Biochemistry,* 31, 1303-1311.

[20] Norman Q. Arancon, Clive A. Edwards, Atiyeh R. and Metzger J.D. (2004) *Bioresource Technology,* 93, 139-144.

[21] Orozco F.H., Cegarra J., Trvjillo L.M. and Roig A. (1996) *Biology and Fertility of Soil,* 22, 162-166 (1996).

[22] Rahuman A.A. (1984) *Functional Morphology of the Megascolecid Earthworm Lampito mauritii kinber*g (1984) 117/118, 111-120.

[23] Tomati U., Grappelli A. and Galli E. (1987) *Proceeding of International Symposium on Earthworms, Selected Symposium and Monograph*.

[24] Viveka S., Vijayalakshmi G.S. and Palaniappan R. (2005) *Environment and Ecology,* 23(1), 29-32.