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Journal of Advanced Studies in Agricultural, Biological and Environmental Sciences (JABE) www.jabe.in

A Peer Reviewed & Refereed, International Open Access Journal

Vol.2.Issue.3.2015 (July-Sept.) **ISSN:2394-2606**

VERMICOMPOST, A BEST SUPERLATIVE FOR ORGANIC FARMING: A REVIEW

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ABSTRACT

Agrochemicals which drive the 'green revolution' came as a 'mixed blessing' for mankind. Over the years it has worked like a 'slow poison' for the environment and the society. To resolve the various problems related to 'human food safety, nutritional quality and environmental security' a global movement is going on to scientifically revive the traditional 'Organic Farming' systems. Organic farming is conceived as one of the alternatives to conventional agriculture in order to sustain production without seriously harming the environment and ecology which are more scientific than those of the conventional. Vermiculture or vermicompost may be a best alternative for organic farming. Vermicompost can have dramatic effects upon the germination, growth, flowering, fruiting and yields of crops. Application of vermicompost increases soil health, soil minerals, water holding capacity, soil micro-organisms and nutritional values of yielding crop as well as decreases plant pest populations. Vermicomposting is a self-promoted, self-regulated, self-improved and self-enhanced, low or no-energy requiring zero-waste technology, easy to construct, operate and maintain. It excels all other biological or mechanical technologies for production of 'bio-fertilizer'.

Keywords: Agrochemical, conventional agriculture, green revolution, organic farming, vermiculture, vermicompost.

Cite this article: **Jayanta Mistry,** ***"VERMICOMPOST, A BEST SUPERLATIVE FOR ORGANIC FARMING: A REVIEW ".*** *Journal of Advanced Studies in Agricultural, Biological and Environmental Sciences,* 2(3): 2015, 38-46

1. INTRODUCTION

1.1. Vermiculture and Vermicomposting: Now in developing or growing countries people with awareness of ill effect of chemical fertilizer and pesticide also interested to buying organic agriculture product. In India some of the super market also supplied organic crops, organic fruits and organic vegetables, which are sell in high price rate in compare with conventional or chemically grown crop. Vermiculture for producing a better manure or compost called vermicompost developed by agriculturist is now being a new branch in agriculture, termed as Organic Farming. Vermiculture is the culture of earthworms. The worms are either used to expand a vermicomposting operation or sold to customers who use them for the same or other purposes. By this culture farmers can expand their crop production into organic form. Vermicomposting is the biotechnological process by which earthworms are used to convert organic materials into a humus-like material known as vermicompost. Vermicomposts are stabilized organic soil amendments that are produced by a non-thermophilic process, in which organic matter is broken down through interactions between earthworms and microorganisms, under aerobic conditions. During vermicomposting the nutrients are released and converted

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into soluble and available forms (Ndegwa and Thompson, 2001) that's providing nutrients such as available N, soluble K, exchangeable Ca, Mg, P and microelements such as Fe, Mo, Zn, and Cu (Amir and Fouzia, 2011) which can easily taken up by plants (Edwards and Fletcher, 1988; Edwards, 1998). Vermicompost can have dramatic effects upon the germination, growth, flowering, fruiting and yields of most crops, particularly rice, fruit and vegetables. In short, earthworms, through a type of biological alchemy, are capable of transforming garbage into 'gold' (Tara Crescent, 2003; Vermi Co., 2001). Vermiculture can maintain the global 'human sustainability cycle'-that is, producing food in farms back from food and farm wastes. Vermicomposting is a self-promoted, self-regulated, self-improved and self-enhanced, low or no-energy requiring zero-waste technology, easy to construct, operate and maintain. It excels all other waste conversion technologies by the fact that it can utilize waste organics that otherwise cannot be utilized by others. It excels all other biological or mechanical technologies for production of 'bio-fertilizer' because it achieves 'greater utilization' than the rate of 'destruction' achieved by other technologies and the process becomes faster (Sinha *et al*., 2011).

1.2. EARTHWORMS FOR VERMICULTURE:

In 1881Darwin referred Earthworms as farmer's friends and natures ploughmen. Aristotle called earthworms as the 'intestine of earth' (Martin, 1999), as they could digest a wide variety of organic materials. There are an estimated 1800 species of earthworm worldwide (Edwards & Lofty, 1974). In India 509 species with 67 genera and 10 families have been reported by Kale, 1991. The vermicomposting through different species of earthworm has been studied (Edwards *et al*., 1998; Kale, 1998). Epigeic earthworms as *Eudrilus eugeniae*, *Eisenia foetida* and *Perionyx excavatus* are the almost popularly used species for vermicomposting (Kale *et al.,* 1982). *Eisenia foetida* is preferred because of its high multiplication rate and thereby converts the organic matter into vermicompost within 45-50 days.

Three Types of Earthworm: **Anecic** (Greek for "out of the earth") – these are burrowing worms that come to the surface at night to drag food down into their permanent burrows deep within the mineral layers of the soil. Example: the Canadian Night crawler.

Endogeic (Greek for "within the earth") – these are also burrowing worms but their burrows are typically more shallow and they feed on the organic matter already in the soil, so they come to the surface only rarely.

Epigeic (Greek for "upon the earth") – these worms live in the surface litter and feed on decaying organic matter. They do not have permanent burrows. These "decomposers" are the type of worm used in vermicomposting. (Information sourced from Card *et al*., 2002.)

1.3. Organic farming: Green revolution agriculture has been a stunning technological achievement. It claims that green-revolution methods—involving high-yielding plant and animal varieties, mechanized tillage, synthetic fertilizers and bio-pesticides, and now transgenic crops are essential in order to produce adequate food for the growing human population (Borlaug, 2000; Huang *et al*., 2002; FAOUN, 2004). The environmental price of green-revolution agriculture includes increased soil erosion, surface and groundwater contamination, release of greenhouse gases, increased pest resistance, and loss of biodiversity (National Research Council, 1989; Pimentel, 1996; Tilman, 1999; Relyea, 2005). Advocates on this side argue that more sustainable methods of food production are essential over the long term (Pretty *et al*., 2003; Tilman *et al*., 2002). Agrochemicals which ushered the 'green revolution' in the 1950-60's came as a 'mixed blessing' for mankind. It increases food productivity, but at the cost of environment and society. Over the years it has worked like a 'slow poison' for the farm soil and the society. To resolve the various problems related to 'human food safety, nutritional quality and environmental security' a global movement is going on to scientifically revive the traditional 'Organic Farming' systems (Lampkin, 1990). Sharma (2001) makes a case for organic farming as the most widely recognized alternative farming system to the conventional one. Veeresh (1999) opines that both high technology and sustainable environment cannot go together. Organic farming is conceived as one of the

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Vol.2.Issue.3.2015 (July-Sept.) **ISSN:2394-2606**

alternatives to conventional agriculture in order to sustain production without seriously harming the environment and ecology. According to the Directorate General for Agriculture and Rural Development for the European Commission (2009), Organic farming can broadly be defined as the form of agriculture that relies on techniques such as crop rotation, green manure, compost and biological pest control, and mechanical cultivation to maintain soil productivity and control pests, excluding the use of synthetic fertilizers and synthetic pesticides, plant growth regulators, livestock feed additives and genetically modified organisms. Organic Farming is based on principles of agro-ecology. These include: Improvement and maintenance of agro-ecosystem based on conservation and maintenance of soil fertility, biologically active soil life, increase in biodiversity, preventing exploitation and pollution of natural resources, natural nutrient mobilization, conservation of water, pest management through biological pest control, no use of synthetic and agrochemicals, prohibition of Genetic Engineering and related products, usage of farm manures and crop residues (Shiva *et al*., 2004).Organic farming systems with the aid of 'Vermiculture Biotechnology' promoted by earthworms which was an important viewed by Sir Charles Darwin centuries ago calling them as 'friends of farmers' can resolve the diverse problems related to safety, security and productivity of food, protection of farmlands and the farmers in most economical way.

1.4. The International Scene: International Federation of Organic Agriculture Movements (IFOAM) was founded in France in 1972. It spearheads and coordinates organic farming efforts the world over by promoting organic agriculture as an environment friendly and sustaining method. It focuses on organic farming by highlighting the minimum pollution and low use of non-renewable natural resources through this method. It has about 600 organisational members spread over about 120 countries including India. The Food and Agriculture Organisation (FAO) of the United Nations provides support to organic farming in the member countries. It also attempts the harmonization of national organic standards, which is absolutely essential to increase international trade in organic products. India too has adopted the National Programme for Organic Production (NPOP) with national standards.

2. MATERIALS AND METHODS

2.1. Vermicompost unit: Vermicomposting is done by various methods, among them bed and pit methods are more common (published by ICAR Research Complex for NEH Region, Mizoram).

Bed method: Composting is done on the pucca / kachcha floor by making bed (6x2x2 feet size) of organic mixture. This method is easy to maintain and to practice.

Pit method: Composting is done in the cemented pits of size 5x5x3 feet. The unit is covered with thatch grass or any other locally available materials. This method is not preferred due to poor aeration, water logging at bottom, and

2.2. Process of vermicomposting: Vermicomposting unit should be in a cool, moist and shady site. Cow dung and chopped dried leafy materials are mixed in the proportion of 3: 1 and are kept for partial decomposition for 15 – 20 days. A layer of 15-20cm of chopped dried leaves/grasses about 150 - 200 kg should be kept as bedding material at the bottom of the bed. Beds of partially decomposed material of size 6x2x2 feet should be made. Red earthworm (1500-2000) should be released on the upper layer of bed. Beds should be kept moist by sprinkling of water (daily) and by covering with gunny bags. Bed should be turned once after 30 days for maintaining aeration and for proper decomposition. Compost gets ready in 45-50 days.

2.3. Preventive measures: The floor of the unit should be compact to prevent earthworms' migration into the soil. 15-20 days old cow dung should be used to avoid excess heat. The organic wastes should be free from plastics, chemicals, pesticides and metals etc. Aeration should be maintained for proper growth and multiplication of earthworms. Optimum moisture level (30-40 %) should be maintained 18-25^{0}C temperature should be maintained for proper decomposition.

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Vol.2.Issue.3.2015 (July-Sept.) **ISSN:2394-2606**

3. RESULTS AND DISCUSSION

3.1. Vermicompost improves soil health: Earthworms are great soil managers and conditioners. Earthworms loosen the soil as they move through it. Their activity creates channels in the soil for movement of air and water. Presence of worms improves water penetration in compacted soils and can increase cumulative rainfall intake by up to 50%. Worm activity can increase air-soil volume from 8 - 30% and increases the bioavailability of nutrients and trace elements which are present in the soil (Barley and Jennings, 1959). Vermicompost contains plant growth regulators and other plant growth influencing materials produced by microorganisms (Grappelli *et al*., 1985; Tomati *et al*., 1987) including humates (Atiyeh *et al*., 2000c). The 'humic acids', 'fulvic acids' and 'humins' in humus are essential to soil and plants in several ways. Krishnamoorthy and Vajrabhiah (1986) reported the production of cytokinins and auxins in organic wastes that were processed by earthworms. Adding of vermicompost to soil improves the chemical and biological properties of soil and hence improves its fertility (Purakeyastha and Bhatnagar, 1997). Vermicompost improve the soil structure, increasing the water holding capacity and porosity which facilitate the root respiration and growth (Lee, 1992; Parthasarathi *et al.,* 2008). It appears to retain more nutrients for longer period of time and work as 'slow release fertilizer' in soil. Barley and Jennings (1959) reported that earthworms significantly contribute nitrogen (N) contents to soil by over 85%. Worms increase nitrogen levels in soil by adding their metabolic and excretory products (vermicast), mucus, body fluid, enzymes and decaying tissues of dead worms. They also contribute nitrogen indirectly through fragmentation of organic materials and grazing on soil microorganisms. Kale and Bano (1986) reports as high as 7.37% nitrogen (N) and 19.58% phosphorus as P_2O_5 in vermicast. Suhane (2007) showed that exchangeable potassium (K) was over 95% higher in vermicompost. There are also good amount of calcium (Ca), magnesium (Mg), zinc (Zn) and manganese (Mn). Vermicompost contain enzymes like amylase, lipase, cellulose and chitinase, which continue to break down organic matter in the soil (to release the nutrients and make it available to the plant roots) even after they have been excreted. Annual application of adequate amount of vermicompost also lead to significant increase in soil enzyme activities such as 'urease', 'phosphomonoesterase', 'phosphodiesterase' and 'arylsulphatase' and the soil has significantly more electrical conductivity (EC) and near neutral pH (Tomati *et al.*, 1987).

3.2. Vermicompost increases plant growth rate: Vermicompost also helps the crops to attain maturity and reproduce faster, it shortens the 'harvesting time' (Singh *et al*., 2008). There is an extensive scientific literature (Atiyeh *et al.*, 2000a–c; Arancon *et al*., 2003a, b, 2004a, b; Buckerfield and Webster, 1998; Edwards and Arancon, 2004a, b) demonstrating that additions of low application rates of vermicomposts, into bedding plant in the greenhouse, or as amendments to field soils, improve plant growth and yields significantly. Solid vermicomposts have been shown to increase the germination rates of growth, flowering, and yields of a wide range of crops such as petunias, marigolds, chrysanthemums, tomatoes, peppers (Arancon *et al.,* 2004a), maize and wheat (Gutierrez-Miceli *et al., 1988*), strawberry (Singh *et al.,* 2008), black-gram (Parthasarathi *et al*., 2008) for both greenhouse and field crops.

3.3. Vermicompost control plant pathogen and pest: Vermicomposts have also been shown to suppress attacks by soil and foliar transmitted plant diseases, such as Pythium, Rhizoctonia, Plectosporium and Verticillium, significantly in both the field and greenhouse. Vermicomposts can also suppress arthropod pests such as caterpillars: including cabbage white caterpillars, tomato hornworms, and cucumber beetles, as well as sucking arthropods: such as scale insects, mealy bugs, aphids and spider mites (Arancon *et al.*, 2005, 2006). A literature reviewed by Mistry and Mukherjee (2015) investigated the effects of vermicompost tea on plant pest control. The aerated, vermicompost 'teas' suppressed the plant diseases *Fusarium, Verticillium, Plectosporium,* and *Rhizoctonia* to the same extent as the solid vermicomposts. Vermicompost 'teas' also suppressed populations of spider mites (*Tetranychus urticae*) and aphids (*Myzus persicae)* significantly. Finally,

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Vol.2.Issue.3.2015 (July-Sept.) **ISSN:2394-2606**

it has been shown at The Ohio State University that vermicomposts and vermicompost teas can suppress attacks by plant parasitic nematodes such as tomato cyst eelworm and root knot nematodes such as *Meloidogyne*, on tomatoes and other vegetable crops dramatically (Arancon *et al.*, 2003c).

3.4. Vermicompost increases quality of crop: Organic fruits and vegetables have been found to be highly nutritious, rich in antioxidants, organic acids and poly-phenolic compounds than chemically grown food and can be highly beneficial for human health (Sinha *et al.*, 2011; Winter and Davis, 2006; Anonymous, 2000; Benbrook, 2005; Bourne and Prescott, 2002). Smith (1993) reported high mineral contents in organic foods. Shankar and Sumathi (2008) studied tomato grown on vermicompost and reported that it had significantly higher total antioxidants, total carotene, iron (Fe), zinc (Zn), crude fibre and lycopene content than the other organically grown tomatoes. Higher value of vitamin C was estimated in organic apple, cabbage, carrots, beetroots, spinach, tomato, turnip, celery, lentil, lettuce, pepper, potato and pears (Shankar and Sumathi, 2008).

3.5. Vermicompost lower cost for food production: Vermicompost can be produced 'on-farm' at low-cost by simple tecnique, while the chemical fertilizers are high-tech and high-cost products manufactured in factories (Munroe, 2007). The use of vermiculture could be significantly low by more than 60 to 70% as compared to chemical fertilizers and the food produced will be a 'safe chemical-free food' for the society.

3.6. Vermiculture: Destined to bring revolution in Organic Farming: With high population pressure many countries has forced to use chemicals and fertilizers to increase the food productivity. The prolonged application of chemicals and pesticides has resulted bio-magnification, destroy faunal diversity, along with soil and environmental pollution. American scientists predict that up to 20,000 Americans may die of cancer, each year, due to the low levels of 'residual pesticides' in the chemically grown food (UNEP/GEMS, 1992). Presently in many developed countries farmers are being encouraged to organic farming. Organic farming in India more than 4000 years back date and native to this country. Organic farming is a system which avoids the use of synthetic fertilizers, pesticides, growth regulators, and livestock feed additives. The objectives of environmental, social, and economic sustainability are the basics of organic farming (Ramesh *et al.,* 2005). The key characteristics includes maintaining sustainable soil health, organic matter levels, soil microbial diversity, NPK level, increase water holding capacity, recycling of organic materials and controlling diseases and pest. Organic farming systems with the aid of 'Vermiculture Biotechnology' promoted by earthworms which was visioned by Sir Charles Darwin centuries ago calling them as 'friends of farmers' can resolve the diverse problems related to safety, security and productivity of food. Earthworms can contribute 20 to 40 kg nitrogen/ha/year in soil, in addition to other nutrients and growth regulators (Darwin, 1881).

4. CONCLUSION

Vermicomposts and vermicompost 'teas' that can be produced from organic wastes, such as food and animal wastes increasing high microbial populations; thereby potentially posing a risk of contaminating crop plants with human pathogens due to introduction of pathogenic bacteria. Food poisoning is caused by the presence of pathogenic bacteria in food items. Prominent among such pathogenic bacteria are *Salmonella*, *Campylobacter*, *Taenia soleum, Citrobacter freundii* and *Escherichia coli* strain *0157*. All these bacteria are prevalent in animal guts and in their excreta. So vermicompost does not satisfy Soil fertility and crop nutrient management practice standard. The producer must manage plant and animal materials to maintain or improve soil organic matter content in a manner that does not contribute to contamination of crops, soil, or water by plant nutrients, pathogenic organisms, heavy metals, or residues of prohibited substances (NOSB Compost Task Force Recommendation, 2004). Geier (2001) opines that there is no other farming method so clearly regulated by standards and rules as organic agriculture. The organic movement has decades of experience through practicing ecologically sound agriculture and also in establishing inspection and certification schemes

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Vol.2.Issue.3.2015 (July-Sept.) **ISSN:2394-2606**

to give the consumers the guarantee and confidence in actuality. In India, there are two accreditation systems for authorizing Certification and Inspection agencies for organic certification. National Programme on Organic Production (NPOP) promoted by Ministry of Commerce is the core programme which governs and defines the standards and implementing procedures. National Accreditation Body (NAB) is the apex decision making body. Certification and Inspection agencies accredited by NAB are authorized to undertake certification process. The NPOP controlled by Agricultural Processed Foods Export Development Authority (APEDA) looks after the requirement of export and when controlled by Agriculture Marketing Advisor, Directorate of Marketing and Inspection looks after domestic certification. Currently 20 certification agencies have been authorized to undertake certification process Details of the system are available at www.apeda.com/npop. In 2006, India's organic certification process under NPOP has been granted equivalence with European Union and Switzerland. Organic farming can provide good quality food without adverse effect on human health and environment. Organic farming systems with the aid of 'Vermiculture Biotechnology' promoted sustainable agriculture. Farmers can set up a vermiculture unit in own farm by using agriculture waste and can supply adequate bio-fertilizer for organic farming without harming environment. Government should be encourages to farmers for organic farming. There is a need to make awareness in farmers and common people about the benefit to consume of organic food and on the other hand the ill effect of using pesticide and chemical fertilizer.

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Vol.2.Issue.3.2015 (July-Sept.) **ISSN:2394-2606**

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Journal of Advanced Studies in Agricultural, Biological and Environmental Sciences (JABE) www.jabe.in

A Peer Reviewed & Refereed, International Open Access Journal

Vol.2.Issue.3.2015 (July-Sept.) **ISSN:2394-2606**

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