Vermicompost Impacts on Sustainable Agriculture: A Review

Kamal Mehta[1], Bhanu Gupta[2] and Amit Sharma[3]
[1,2,3] Assistant Professor, Jagdish Chandra D.A.V College, Dasuya, Distt. Hoshiarpur, (Punjab)-144205, India.

Abstract: Earthworms are well known for solid waste management as they can turn organic waste into gold through the process of vermicomposting. Vermicompost is an ecofriendly product of worm activity that is enriched with the mineral nutrients and Plant growth regulators, hence proved to be a potent biofertilizer for sustainable agriculture. It acts as good substitute for chemical fertilizer, improves soil qualities and reduces the requirement of growth regulators. Vermicomposting technology serves as boon for less-developed agricultural areas with low capital investment and can generates employment opportunities. This review paper highlights the effects of vermicompost on plant growth and development for sustainable agriculture.

Key Words: Vermicompost, Organic waste, Earthworms, Plant Growth Regulators, Microbes.

I. INTRODUCTION

Agro-Industrial sector yields a huge amount of solid waste comprising of biodegradable as well as non-biodegradable waste substances. The biodegradable waste part can be treated by the vermicomposting technology that involves the use of earthworms for the aerobic decomposition of organic waste materials within 40-45 days into humus-like material known as vermicompost. Earthworms are regarded as intestine of earth as they degrade the organic waste into simple small particles with the help of their grinding organ of the alimentary canal called gizzard. Vermicompost possess high concentration of nutrients even much higher than traditional compost thus, enhancing the productive qualities of soil. It improves the physical, chemical and biological characteristics of soil such as aeration, porosity, water retention capacity, pH, electrical conductivity and organic matter content [1]. The microbial growth on the decomposed organic matter produced due to the activity of earthworms causes liberation of gases like CO_2 along with the production of organic acids, it plays role in the fixation of soil pH near neutrality [2]. A major part of biodegradable substances after the worm activity get transformed into humus, hence the vermicompost acts as good donor of humus to the soil and thereby, helps to increase the fertility power of the soil. It has been investigated and proved in the field experiments conducted on Red earthworm (*Lumbricus rubellus)* involving the various types of agricultural, municipal and dung waste [3]. Furthermore, vermicompost contains 17-36% of humic acid and 13-30% fulvic acid of the total concentration of organic matter [4]. Humic acid in the vermicompost may be complexed with metals like iron and copper. The comparative composition studies on the soil and vermicompost has revealed that humic acid present in both of them is biochemically and functionally similar irrespective of the nature of organic substrate used for making vermicompost [5,6]. Other components of the vermicompost may vary in their quality and quantity depending upon the type of organic matter employed for preparation of vermicompost, for example, animal waste degraded by the worms contains more percentage of mineral nutrients like Nitrogen, Phosphorus, calcium and potassium as compared to plant waste substrate [7,8]. Presence of phosphatase enzyme in the gut of earthworms further increased their utility in the agriculture as this enzyme activity enhances the quantity of phosphorus mineral in the vermicompost (64% higher in comparison to organic substrate) [10].Vermicompost have many outstanding biological properties as evident from the fact that it is rich in Soil benevolent microbes such as bacteria, actinomycetes, fungi and cellulose-degrading bacteria [11,12] [Table I].

II. VERMICOMPOST EFFECTS ON PLANT GROWTH AND DEVELOPMENT

Vermicompost is a good additive in agriculture as it supports plant growth and development starting from the stage of seed germination to the plant maturity in comparison to those in control commercial plant growth media [13]. It has been found experimentally in case of plants such as *Chrysanthemum, Salvia, Petunia, Pisum, Lathyrus, Lycopersicon esculentum, Triticum aestivum, Daucos carota, Brassica oleracea var. capitata* [13]. For getting best results for plant growth and produce vermicompost substitution may be done in appropriate percentage into the soil. When substitution is done in more quantity, plants may show reduction or inhibition in its growth due to increase in the electrical conductivity of soil, owing to the presence of salts and excessive nutrient levels. Therefore, vermicompost should be applied at moderate concentrations in order to obtain maximum plant yield. The comparative growth studies that have been performed on Raspberries, cabbage and soybean (*Glycine max)* by substituting the soil with vermicompost in different proportions indicated more vegetative and reproductive growth in them as compared with organic fertilizers [14]. Visible phenotypic changes have been reported with respect to shoot size, length of roots, flowering and fruit quality as well as quantity. Vermicompost application in the agriculture fields has significantly increased their productivity by improvements in the soil characteristics. Similarly, greater growth rate has been recorded among garden cress plants *(Lepidium sativum)* on treatment with vermicompost [15]. Agricultural productivity analysis showed that vermicompost addition to the soil in combination with inorganic fertilizers produce synergistic or cumulative effect as reported in field trial experiments on okra (*Abelmoschus esculentus*), banana, tomato (*Lycopersicon esculentum*) peppers *(Capsicum anuum grossum*) [16-19].

III. VERMICOMPOST AND SOIL PROFILE

Vermicompost applications resulted into quantitative and qualitative increase in the micronutrients in the soil as compared to animal or farmyard manure [20] (Table I). Field studies showed that vermicompost application has significantly increased the amounts of organic carbon, stabilizes the soil pH, makes soil more porous with increase in water holding capacity as well as microbial populations [21]. Microbial populations in the soil act as a source for plant growth regulators such as auxins, gibberellins, cytokinins, ethylene and abscisic acid due to their interactions with earthworms [22]. The plant growth regulators have been reported concentrated in the tissues of earthworm species such as Red earthworm (*Lumbricus rubellus)*,Canadian night crawlers (*Lumbricus terrestris)* and Red wiggler or tiger worm (*Eisenia fetida)* that clearly showed the relationship between concentrations of plant growth regulators in the soil and vermicompost [23]. These plant growth regulators possess average longevity up to 70 days in the soil if not exposed to sunlight [24]. Few species of microbes present in the vermicompost symbiotically associate with the external surface of roots and its lateral branches forming rhizosphere associations. It increases the availability of insoluble minerals by making them solubilised with microbial enzymes in the soil as well as increases the nutrient absorption power of roots. In addition to above advantages provided by microbes present in vermicompost other byproducts such as antibiotics may be produced by them in the soil which give immunity to the plants against diseases. The activity of microbes in worm castings has been found to be 10 to 20 times high in comparison to their activity in the soil and decomposing organic matter. Vermicompost application in the fields promotes seed germination, plant growth and crop yield, improves root growth and structure and enriches soil with plant hormones such as Auxins and Gibberellic acid.

Table I: Comparative analysis of Physical, Chemical and Biological Characteristics of Vermicompost and Farm Yard Manure

Contents	Vermicompost	Farm Yard Manure
Nitrogen (% age dry weight)	2.2-3.0	0.5
Phosphorus (% age dry weight)	0.4-2.9	0.2
Potassium (% age dry weight)	1.7-2.5	0.5
Calcium (% age dry weight)	1.2-9.5	Traces amount
Other Mineral Nutrients (Mg, Fe, Cu)	0.5-1.7	Traces amount
Soil benevolent Microbes	Bacteria (5.7 x 10^7), Fungi (22.7 x 10^4) and Actinomycetes (17.7 x 10^6)	Low in number
Porosity	High	Less
Aeration	High	Less
Water holding Capacity	High	Less
p^H	Neutral	Acidic
Humic Acid (%)	17-36	-
Fulvic Acid (%)	13-30	-
Plant Growth Hormones	Auxins, Cytokinins and Giberllins	-

IV. CONCLUSION

Vermicompost application in appropriate quantities to the fields can increase growth, flowering and yields of almost each type of plant such as Ornamental, fruit and crops in sustainable manner. It may be more helpful in quality produce, reducing cost of agricultural inputs by reducing the use of chemical fertilizers, pesticides and synthetic plant growth regulators in addition to improving inherent capacity of soil without deleterious effect on the environment. It also decreases the bioavailability of toxic heavy metals in the soil increase the soil microflora, aeration and water holding capacity.

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Authors details-

[1] **Kamal Mehta**
Assistant Professor, P.G Department of Zoology,
Jagdish Chandra D.A.V College Dasuya, Distt. Hoshiarpur, Punjab, India

[2] **Bhanu Gupta** (Corresponding author)
Assistant Professor, P.G Department of Mathematics,
Jagdish Chandra D.A.V College, Dasuya, Distt. Hoshiarpur, Punjab, India

[3] **Amit Sharma**
Assistant Professor, P.G Department of Mathematics,
Jagdish Chandra D.A.V College Dasuya, Distt. Hoshiarpur, Punjab, India