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Role of Earthworm (*Eisenia fetida*) on Organic Waste Management and Pollution Control in Indian Thar Desert

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ABSTRACT

Earthworm, a non-chordate wormlike animal, belonging to phylum Annelida, inhabits in moist and organic rich soil. From the period of its origin, it has been working silently for health of the earth beneath our feet. India is an agriculture dominant country therefore, a huge quantity of agricultural wastes and animal manure dumped every year and it pollutes the environment considerably. In present study, an earthworm species *Eisenia fetida* was used to convert different organic wastes into valuable bio-fertilizers. Agricultural waste and cattle manure were used as vermibed of *E. fetida* for preparing vermicompost. The earthworms convert the organic waste into a valuable asset. The present observations showed that pH, electrical conductivity, water holding capacity, organic carbon, total nitrogen, carbon/nitrogen ratio, available phosphorus and potassium of vermicompost is enhanced significantly as compared to organic waste applied for the vermibed. The vermicompost is used in organic farming. Since, the adverse effects of chemical fertilizer have been proved on soil as well as human health, an alternate should be required. Therefore, vermicompost is a most suitable bio-fertilizer for agriculture, forestry, horticulture and other similar sectors and also minimize pollution from the organic wastes.

Keywords: Eisenia fetida, Thar Desert, Organic Waste Management, Pollution Control, Vermicompost

I. INTRODUCTION

India is an agro based economic country. Every year there is a huge amount of agricultural wastes generated and the waste either dumped or burnt. Generally, Wheat straw and Paddy straw is fed to cattles but in Hariyana and Panjab state mostly it is burn in winter season which creates a serious problem of fog in the area. In the case of burn, it also produces toxic gases such as CO2, SO2, CO ect. and caused air pollution, while dumping agrowaste releases greenhouse gases such as methane, H2S etc. Similarly, the decomposing organic wastes leached to underground water and pollute the underground water resources as well as drained to rivers, lakes and ponds and eutrophication caused. There is tremendous increase in agrowastes with the increase in agricultural production. These agrowastes also pollute the surrounding environment leading to diseases in animals and man. The wastes also act as a reservoir of fungal diseases of next crop. Thus, there is a warranted need to convert agricultural wastes into assets i.e. vermicompost. This problem could be overcome by adopting vermicomposting of the agrowastes, which demands development of a suitable technology for proper recycling of organic wastes. Use of vermicompost rejuvenates the exhausted soil fertility, enriches the available nutrients to sustain soil quality and enhances water holding capacity and biological resources (Chaoui et al., 2003; Arancon et al., 2006). Application of earthworm resources in conversion of agricultural, urban and industrial wastes into vermicompost is much liked method of recycling organic substrates worldwide (Edwards, 1998; Prabhu et al., 1998; Sangwan et al., 2008; Panwar and Tripathi, 2013).

Available nutrients in vermicompost are much higher than traditional garden compost (Dickerson, 2004). Vermicompost is also helpful in reducing the population of soil pathogenic microorganisms (Dominguez and Edwards, 1997) and inducing nitrogen fixation (Mba, 1987; Tereshchenko, 2002). Several workers have documented the use of organic waste in vermicomposting such as sewage sludge (Neuhauser et al., 1988), pig manure (Chan and Griffiths, 1988; Wong and Griffiths, 1991), combined sewage sludge and municipal refuse (Grapelli et al., 1983), cotton industry waste (Albanell et al., 1988), industrial and vegetable waste (Bano et al., 1987), animal and vegetable waste (Edwards, 1988; Tripathi and Bhardwaj, 2004; Suthar and Singh, 2008; Babita Devi M., 2017), paper and sludge waste (Butt, 1993) and leaf litter (Thangaraj, 2015). Use of various earthworm species in vermicomposting is popularized still much study is need to evaluate composting potentials of E. fetida for agricultural wastes. Scanty information is available on composting of Wheat and Paddy crop waste by earthworm in desert climate. At this juncture, a suitable technology should be developed to convert these waste into asset.

Under the above circumstances, experiments were conducted to decompose the agrowaste with cowdung by employing E. fetida earthworm species.

II. METHODS AND MATERIAL

Different types of crop grown on a large scale particularly in western parts of Rajasthan in India. Wheat and Paddy straw were collected from agricultural farm of village-Chhila, tehsil-Phalodi of Jodhpur district and Surewala, district Hanuman Garh, Rajasthan respectively. and Paddy straw is dumped in huge quantity after each harvesting. Partially decomposed straw was collected from one season old harvested pool. Air dried cowdung was taken from a cow owner of Adeshwar Nagar of Jodhpur city. The materials were filled in bags and brought to the vermiculture laboratory. The earthworm species Eisenia fetida was collected from a farmer's vermiculture centre of village Chhila with a small amount of culture material in perforated bags and prepared a cowdung vermibed as stock culture.

The collected Wheat straw, Paddy straw and cowdung were left for one week at room temperature. Dried cowdung was powdered on hard surface, whereas Wheat and Paddy straw was grinded in mixer-grinder after thorough chopping. The powdery materials were sieved by 1mm (palatable size for earthworm) pore sized sieve separately and stocked in plastic bags for use in vermicommposting.

Three sets in triplicate of vermibeds (500g each) were prepared using powdered Wheat straw, Paddy straw and cowdung in equal ratio in plastic containers (30 cm x 25 cm) and moistened to stabilize within 48 hours. In the experimental set, 25 mature worms of each species (E. fetida) were inoculated separately. One set of control bedding material (without earthworm) was run simultaneously. The plastic containers for culture were perforated at 2-3 places to assist leaching of excess water. However, leached water was collected in other containers and reused for watering the vermibeds so as to prevent the washout of nutrients. The vermiculture experiment was conducted for 60 days. During composting period, 60-70% moisture was maintained by spraying water on the bedding regularly. The temperature of vermibed was 30± 3 °C and wet jute cloth was used to maintain the temperature of vermibeds.

During decomposition, changes in pH, electrical conductivity, water holding capacity, organic carbon, total nitrogen, carbon/nitrogen ratio, available phosphorus and potassium were observed after an interval of 15 days of worm working viz., 0, 15, 30, 45 and 60 day. For this purpose, 10g dry weight basis samples were collected from each experimental as well as control vermibed in plastic pouches. The pH and electrical conductivity of bedding materials were measured with the help of a digital pH meter. Walkley-Black method (1934) was used for determination of organic carbon. Total nitrogen was measured by Kjeldahl method as described by Jackson (1967) employing Kel plus system (Kes-20 and Distyl-EM). Available phosphorus was estimated as described by Anderson and Ingram (1993) and exchangeable potassium was determined by the method of Simard (1993). The temperature of vermibeds was recorded with the help of thermometer (MEXTECH multi-thermometer). Moisture of bedding substrates was estimated by oven drying method.

The collected data was subjected to statistical analysis. A one way analysis of variance (ANOVA) was performed to test the level of significance. The level of significance was set at 0.05.

III. RESULTS AND DISCUSSION

Wheat straw, Paddy straw and cowdung mixed bedding material showed significant changes ($P<0.001$) in physicochemical properties of control and experimental group with respect to decomposing period. In the control bedding, the values of pH, electrical conductivity, total nitrogen, phosphorus and potassium did not vary significantly ($P>0.05$). But water holding capacity increased significantly ($P<0.05$) by 1.48 fold. In contrast, organic carbon and carbon/nitrogen ratio decreased significantly ($P<0.05$) by 12.66% and 22.15% respectively.

After inoculation of E. fetida in the bedding material, water holding capacity, total nitrogen, phosphorus and potassium increased significantly ($P<0.001$). However, pH, organic carbon and carbon/nitrogen ratio decreased significantly ($P<0.001$) from 0 day to 60 days. The pH value decreased by 13.68%. Organic carbon and C/N ratio decreased by 52.92%, 49.82% and 79.18% respectively. On the other hand, electrical conductivity, water holding capacity, total nitrogen, phosphorus and potassium increased by 2.03, 2.24, 2.40, 1.71 and 2.32 fold respectively after 60 days of worm working as compared to initial (0 day) values.

Decreasing of pH value in vermicompost may be due to formation of acids such as fulvic and humic acid during decomposition and mineralization of substrate. It reached to near neutral value (6.81 in *E. fetida* casting). This is in agreement to the work of Lee (1985) who reported that pH of earthworm cast is generally close to neutral. Decreasing trends in pH of bedding materials is also supported by other workers (Mitchell, 1997; Gunadi and Edwards, 2003; Ndegwa *et al*., 2000; Atiyeh *et al*., 2000; Khwairakpam and Bhargava, 2007). Change in pH could be due to production of CO_2 and organic acids and microbial decomposition during vermicomposting (Selladurai et al., 2010). Electrical conductivity of the substrate increased from its initial level to the end of 60 days period of composting. It might be because of loss of organic matter and release of different salts in available form such as ammonium, phosphate and potassium. A similar finding was reported previously by other researchers (Wong *et al*., 1997; Khwairakpam and Bhargava, 2007).

The decrease in carbon and increase in total nitrogen in the bedding materials are in agreement to the work of Vincesles and Loquet (1997), Ansari (2008), Ananthakrishnasamy *et al.* (2009), Nath *et al*. (2009) and Selladurai *et al.* (2010). They reported a substantial loss in organic carbon and remarkable increase in total nitrogen content in *Eisenia fetida* worked vermicompost during a period of ten months. Similarly, Karmegam and Daniel (2000) reported decrease in organic carbon and C/N ratio, and gain in nitrogen, phosphorous and potassium in *E. fetida* composted leaf litter for 75 days. Earthworms induce the process of mineralization and decomposition through fragmentation and reduction of organic particles. The process of mucus production and nitrogenous excrements and release of CO_2 during respiration enhances the level of nitrogen and lowers the C/N ratios (Senapati *et al.*, 1980; Tripathi and Bhardwaj, 2004; Thangaraj, 2015; Babita Devi M., 2017). Variation in degree of decomposition and mineralization may be due to the fact that substrate quality may also strongly influence the decomposition and the composition of the decomposer community (Swift *et al*., 1979). The most important work on breakdown of animal, vegetable and industrial organic wastes by *E. fetida* was carried out by Edwards (1985) who reported *E. fetida* as an efficient vermicomposting species.

IV. CONCLUSION

Wheat and Paddy crop wastes were decomposed and converted in vermicompost using an earthworm species Eisenia fetida. Physicochemcal parameters such as pH, Water holding capacity, Electrical conductivity, Organic carbon, Total nitrogen, Carbon/Nitrogen ratio, Phosphorus and Potassium of vermicompost were evaluated and found significantly changed as compared to initial values. E. fetida may be used for conversion of the agrowastes into valuable bio-fertilizer and may overcome to the problem of pollution from agrowastes in desert region of India.

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