Effect of Cereal Crop Residues and Earthworm Species on Micro-Nutrient Content of Vermicompost

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Abstract – A pot culture experiment was carried out on quality of vermicompost as influenced by earthworm species and cereal crop residues during the year 2011-2012 at College of Agriculture, Latur. The experiment was laid out in factorial randomized block design with three replications consisting of three levels of earthworm species (control, *Eudrilus eugeniae* and *Eisenia foetida*) and five levels of cereal crop residues (wheat, maize, paddy, jowar straw and sugarcane trash). The vermicomposting samples were collected at different stages *viz.*, 35th, 50th, 65th, 80th and 95th days and analyzed for micronutrients. The results indicated that the quality of vermicompost was significantly influenced by earthworm species and cereal crop residues. The micronutrients *viz.*, Zinc, Iron Manganese, and Copper were found to be increased progressively throughout the vermicomposting of cereal crop residues. Among the different cereal crop residues, yield of vermicompost prepared from jowar straw was found superior in quality followed by wheat straw. Vermicompost obtained from jowar straw are rich in micronutrients as compared to all the other cereal crop residues. The quality of vermicompost obtained from earthworm species *Eudrilus eugeniae* was superior to *Eisenia foetida* because of their higher efficiency.

Index Terms – Vermicompost, Crop residues, Micronutrients, Eudrilus eugeniae.

1. INTRODUCTION

There is increasing awareness about sustainable agricultural system world-wide in view of energy storages, food safety, soil and environmental pollution arising out of chemical farming. It is possible to effect a quick change over to sustainable agriculture by harnessing vermiculture biotechnology in soil. Vermicomposting technology involves harnessing earthworms as versatile natural bioreactors playing a vital role in the decomposition of organic matter, maintaining soil fertility and in bringing out efficient nutrient recycling and enhanced plants growth. Hence, mass rearing, maintaining worm cultures and tapping of organic wastes for their maintenance has a good scope for developing. It is a cottage industry in developing countries like India where there is no girth of organic wastes. Earthworms are an incredibly varied and adoptable group of animals that are so common in our world that they often go unnoticed and unsung. In India large amount of crop residues produces annually. The present study aims to investigate the influence of cereal crop residues and earthworm species on micronutrient content of vermicompost prepared from locally available organic material like wheat straw, sugarcane trash, Jowar straw, Maize straw which included in cereals crops residues.

We use epigeic worms in vermicomposting because we can duplicate their ideal environment in a bin or bed, because they are voracious processors of organic debris, because they do well in high density culture, and because they are so very tolerant of a wide range of environmental conditions and fluctuations when a composting or vermicomposting system is in soil contact naturalized earthworms will be drawn to the system when and if it meets their environmental requirements. The worm casting in the vermicompost have 97 per cent utilizable nutrients by the plants and the castings have a mucous coating which allows the nutrients to “time release” earthworm is known to be a good biological element for recovery of vermicompost, vermicast, vermiwash and vermiprotein for the use in agriculture. The total nutrients in the worm worked waste material may be lower than the waste prepared, but available nutrients in vermicompost are more. Vermicompost act as a biofertilizer as well as it increase earthworm population in soil. It can be used to improve physical and chemical characteristics of soil. It is high time that the role of these creatures is fully appreciated so as to use them in composting. The use of compost will help in improving soil productivity by improving physical, chemical and biological properties.

2. MATERIALS AND METHODS

The experiment was conducted in vermicomposting shade at College of Agriculture, Latur during July 2011 to October 2011. Crop residues of Wheat (*Triticum astivum*), Maize (*Zea mayz*), Rice (*Oryza sativa*), Jowar (*Sorghum bicolar*) and Sugarcane (*Sachharam officinarum*) were used for experiment. The experiment was laid out in factorial randomized block design (FRBD) with three replications and fifteen treatments. Fourty five earthen pots of height 35 cm and top diameter 45 cm were used for decomposition of crop residues. Crop residues were collected from farm of agriculture college, Latur and other materials like plastic, stones *etc*. were separated from crop residues, the crop residues were chopped in to small pieces and dried. Earthen pots were filled with cereal crop residues along with soil and FYM in different layer. Soil and partially decomposed FYM were mixed in 1:3 proportions were taken. Pots were filled layer wise *i.e.* first layer of broken bricks, sand,

and layer of crop residues were made then layer of soil + FYM were added. After that again layer of well chopped crop residue was made. Finally pot was layered with cow dung slurry and at last, it was covered with crop residues. These pots were watered regularly and kept for pre-decomposition for 20 days. The content in pot was mixed every week. Filled pots were kept in shade to avoid contact of direct sunlight and protection from birds, rats and ants. Two species of earthworms namely *Eudrilus eugineae* and *Eisenia foetida* were brought from BAIF, Pune and used for vermicomposting. These earthworms were inoculated in pots after 20 days from pot filling. Each pot was inoculated with 100 earthworms including juveniles and adults. During composting period the samples were collected at an interval of 15 days. *i.e.* 35th, 50th, 65th, and 80th and 95th day with the help of soil tube auger. These samples were analyzed for micro-nutrients. Micronutrients *viz.*, Zn, Cu, Fe, and Mn were extracted with 0.005 M DTPA in aliquot of compost were estimated on Atomic Absorption Spectrophotometer by the method given by Elwell and Gridley (1967). The data obtained regarding the characters study was subjected to statistical analysis by following the procedure pertaining to Factorial Randomized Block Design (FRBD) as given by Panse and Sukhatme (1967).

3. RESULTS AND DISCUSSION

Periodical changes in micronutrients of vermicompost

A) Changes in total iron (Fe) content during vermicomposting of cereal crop residues.

As regards of periodical changes in total iron content during vermicomposting of cereal crop residues are presented in table 1.

Table 1: Periodical changes in total iron concentration (ppm) during vermicomposting of cereal crop residues.

Treatments	Vermicomposting stages (Days)				
Earthworm species (S)	35	50	65	80	95
S_1-Control	0.96	1.08	1.21	1.32	2.28
S_2-*Eudrilus eugeniae*	2.76	2.85	3.03	3.68	4.28
S_3-*Eisenia foetida*	2.16	2.25	2.62	3.30	4.10
SE+	0.18	0.16	0.18	0.19	0.27
CD at 5%	0.53	0.47	0.53	0.54	0.79
Crop residues (C)					
C_1-Wheat straw	2.03	2.13	2.34	2.87	3.65
C_2-Maize straw	1.99	2.12	2.29	2.78	3.52
C_3-Paddy straw	1.93	2.09	2.22	2.56	3.08
C_4-Jowar straw	2.06	2.14	2.51	3.11	4.56
C_5-Sugarcane trash	1.78	1.79	2.06	2.49	2.95
SE+	0.23	0.20	0.23	0.23	0.35
CD at 5%	NS	NS	NS	NS	1.02
Interactions (SXC)					
SE+	0.40	0.36	0.40	0.41	0.60
CD at 5%	NS	NS	NS	NS	NS
General Mean	1.96	2.06	2.29	2.77	3.55

The result indicated that concentration of iron by earthworm species was significantly affected at all the stages of vermicomposting. The concentration of iron was significantly higher with treatment S_2 (*Eudrilus eugeniae*) *i.e.,* 2.76, 2.85, 3.03, 3.68 and 4.28 ppm at 35th, 50th, 65th, 80th and 95th days of composting, respectively. However, the lower concentration of

total iron content was observed with treatment S_1 (control) at all the stages of vermicomposting. While, it was at par with treatment S_3 (*Eisenia foetida*) at 65th (2.63 ppm), 80th (3.30 ppm) and 95th (4.10 ppm) days of composting.

In case of cereal crop residues, the total iron concentration was found significant at only 95th days of vermicomposting while, it was non-significant at rest of the composting period. Iron content was obtained maximum (4.56 ppm) with the jowar straw (C_4) which was at par with wheat straw (C_1) with value 3.65 ppm at 95th days of composting followed by maize straw (C_2), paddy straw (C_3) and sugarcane trash (C_5) treatments with values 3.52, 3.08 and 2.95 ppm, respectively. The general mean of total iron concentration was increased from 1.96 to 3.55 ppm throughout the period of vermicomposting. Total iron content increased with time of vermicomposting. The interaction effect between earthworm species and cereal crop residues on iron content was found non-significant during vermicomposting. Chowdappa *et al.* (1999) resulted that available organic waste converted from Areca nut and Cocoa garden in to vermicompost using *Eudrilus eugeniae*, it was observed that micro-nutrient iron content was slightly higher in all vermicompost sample than the other normal compost. According to Garg *et al.* (2011) the concentration of iron increases with values 2.0 to 9.5 mg L^{-1} during the period of vermicomposting. Similarly, Vig *et al.* (2011) reported that the increase in concentration of iron was proportional to the concentration of sludge in the mixture and it was 2.65-13.4 per cent.

B) Periodical Changes in Total Zinc Content

The data regarding effect of composting with earthworms on the changes in total zinc content of different organic cereal crop residues are given in table 2.

The data (Table 2) revealed that zinc content of vermicompost was significantly influenced due to earthworm species at 50th, 65th, 80th and 95th days except at 35th days of composting. The inoculation of *Eudrilus eugeniae* (S_2) recorded signiicantly maximum zinc concentration *i.e.,* 0.38, 0.49, 0.76 and 1.60 ppm at 50th, 65th, 80th and 95th days of vermicomposting over rest of the treatments but it was at par with inoculation of *Eisenia foetida* (S_3) treatment except at 50th, 65th and 95th days of composting. However minimum zinc concentration was recorded with control.

Table 2: Periodical changes in total zinc (Zn) concentration (ppm) during vermicomposting of cereal crop residues.

Treatments	Vermicomposting stages (Days)				
Earthworm species (S)	35	50	65	80	95
S_1-Control	0.16	0.23	0.39	0.64	0.69
S_2-*Eudrilus eugeniae*	0.34	0.38	0.49	0.76	1.60
S_3-*Eisenia foetida*	0.23	0.36	0.42	0.58	1.52
SE+	0.02	0.02	0.02	0.03	0.10
CD at 5%	NS	0.05	0.06	0.09	0.29
Crop residues (C)					
C_1-Wheat straw	0.25	0.33	0.44	0.68	1.52
C_2-Maize straw	0.23	0.31	0.43	0.66	1.19
C_3-Paddy straw	0.22	0.30	0.42	0.63	1.03
C_4-Jowar straw	0.31	0.34	0.46	0.70	1.65
C_5-Sugarcane trash	0.21	0.29	0.36	0.61	0.94
SE+	0.02	0.03	0.04	0.04	0.13
CD at 5%	NS	NS	NS	NS	0.38
Interactions (SXC)					
SE+	0.04	0.05	0.06	0.07	0.22

CD at 5%	NS	NS	NS	NS	0.68
General Mean	0.25	0.32	0.43	0.66	1.27

Table 3: Interaction effect of earthworm species and cereal crop residues on total zinc content of vermicompost.

Species level	Level of crop residues (95th days)				
Treatments	C_1	C_2	C_3	C_4	C_5
S_1	0.72	0.71	0.70	0.76	0.57
S_2	2.20	1.14	1.08	2.55	1.03
S_3	1.67	1.63	1.37	1.81	1.13
SE+_	0.22				
CD at 5%	0.68				

Among the cereal crop residues, total zinc content of vermicompost was non-significantly affected at 35th, 50th, 65th and 80th days and remained significant at 95th days of composting. The composting with jowar straw (C_4) significantly recorded higher total zinc concentration (1.65 ppm) over rest of the treatments at 95th days but it was at par with wheat straw (1.52 ppm). The lower concentration of total zinc (0.94 ppm) was obtained with sugarcane trash (C_5). The mean of zinc concentration increased from 0.25 to 1.27 ppm during the period of vermicomposting.

The zinc content of vermicompost was significantly influenced by the interaction effect of earthworm species and cereal crop residues at maturity of vermicompost. The highest zinc content (2.55 %) was observed due to the interaction effect of *Eudrilus eugeniae* X jowar straw (S_2C_4). This interaction was at par with the interaction of *Eudrilus eugeniae* X wheat straw (S_2C_1) and found significantly superior over rest of all the interactions.

Chowdappa *et al.* (1999) reported that higher concentration of total zinc content was observed in vermicompost samples than the other normal compost using earthworm species *Eudrilus eugeniae*.

A similar finding recorded by Sharma *et al.* (2005) on the content of zinc in lantana and carrot vermicompost was 15.0 ppm to 11.3 ppm, respectively.

C) Changes in total copper content

The changes in total copper content as affected by earthworm species and cereal crop residues are given in table 4.

The data (Table 4) indicated that total copper content of vermicompost was significantly influenced by earthworm species at all the stages of composting. The inoculation with *Eudrilus eugeniae* (S_2) showed higher concentration of total copper *viz.*, 0.34, 0.41, 2.87, 3.02 and 3.37 ppm at 35th, 50th, 65th, 80th and 95th days of composting, respectively over control and it was remained at par with inoculation of *Eisenia foetida* (S_3) at 35th and 50th days of vermicomposting.

Table 4: Periodical changes in total copper concentration (ppm) during vermicomposting of cereal crop residues.

Treatments	Vermicomposting stages (Days)				
Earthworm species (S)	35	50	65	80	95
S_1-Control	0.15	0.18	0.33	0.81	1.71
S_2-*Eudrilus eugeniae*	0.34	0.41	2.87	3.02	3.37
S_3-*Eisenia foetida*	0.30	0.38	1.43	2.14	2.54
SE+_	0.02	0.03	0.19	0.22	0.23
CD at 5%	0.07	0.09	0.56	0.67	0.68
Crop residues (C)					
C_1-Wheat straw	0.27	0.32	1.97	2.09	2.62

C_2-Maize straw	0.25	0.31	1.36	2.04	2.54
C_3-Paddy straw	0.24	0.30	1.23	1.82	2.28
C_4-Jowar straw	0.29	0.37	2.14	2.30	3.19
C_5-Sugarcane trash	0.23	0.29	1.00	1.68	2.04
SE+	0.03	0.04	0.24	0.29	0.29
CD at 5%	NS	NS	0.72	NS	NS
Interactions (SXC)					
SE+	0.06	0.06	0.42	0.51	0.52
CD at 5%	NS	NS	NS	NS	NS
General Mean	0.26	0.32	1.54	1.99	2.54

Among the cereal crop residues, the copper content of vermicomposting was influenced non-significantly at 35th, 50th, 80th and 95th days but influenced significantly at 65th days of composting. The composting with jowar straw (C_4) was recorded significantly higher copper content (2.14 ppm) over rest of the treatments but it was at par (1.97 ppm) with wheat straw (C_1) at 65th days of composting. However, the lower concentration was found with sugarcane trash (C_5) during all the stages of vermicomposting. The total copper concentration ranges during period of vermicomposting from 0.26 to 2.54 ppm.

The interaction effect between earthworm species and cereal crop residues on copper concentration was found non-significant.

Chowdappa *et al.* (1999) observed that the micronutrient like copper content was higher with inoculation of *Eudrilus eugeniae* by using available organic waste converted from Areca nut and Cocoa garden into vermicompost.

Similar findings reported by Garg *et al.* (2011) and showed that the concentration of copper ranges from 2.0 to 9.5 mg L^{-1} at the end of vermicomposting.

D) Changes in total manganese content

The data pertaining to total manganese content (ppm) of the cereal crop residues and earthworm inoculation are given in table 5.

The data (Table 5) showed that there was significant variation found in manganese concentration due to inoculation with earthworm species at all the days of composting. The manganese concentration was recorded higher with *Eudrius eugeniae* (S_2) treatment over rest of the treatments at 35th, 50th, 65th, 80th and 95th days with the values 2.38, 2.45, 2.98, 3.42 and 3.76 ppm, respectively but it was at par with *Eisenia foetida* (S_3) treatment at 50th and 65th days of composting. However, the lower manganese concentration was recorded with control (S_1).

In case of cereal crop residues, the concentration of manganese increased significantly at 50th and 65th days but found non-significant at 35th, 80th and 95th days of composting. The maximum concentration of manganese was recorded with the composting of jowar straw (C_4) *viz.*, 2.21 and 2.78 ppm at 50th and 65th days of composting, respectively but it was at par with composting of wheat straw (C_1). Whereas, the lower total manganese content was recorded with sugarcane trash at all the stages of composting.

The interaction effect between composting material and earthworm species on change in total manganese content was observed to be statistically non-significant at all the stages of vermicomposting. Similar result was found by Agarwal (2009) observed that there were significant increased in total manganese (Mn) calcium (Ca) and magnesium (Mg) content of vermicompost as compared to aerobic compost and anaerobic compost. The higher manganese content was found 0.016 mg per g in vermicompost while, it was 0.005 mg per g in aerobic and 0.006 mg per g in anaerobic compost was recorded.

Chowdappa *et al.* (1999) resulted that available organic waste converted from Areca nut and Cocoa garden in to vermicompost using *Eudrilus eugeniae*, it was observed that micro-nutrient total manganese content was slightly higher in all vermicompost sample than the other normal compost.

Table 5: Changes in total manganese content during vermicomposting of cereal crop residues

Treatments	Vermicomposting stages (Days)				
Earthworm species (S)	35	50	65	80	95

S_1-Control	0.83	1.06	1.57	1.72	1.99
S_2-*Eudrilus eugeniae*	2.38	2.45	2.98	3.42	3.76
S_3-*Eisenia foetida*	2.03	2.40	2.79	2.93	3.03
SE+	0.08	0.04	0.07	0.09	0.10
CD at 5%	0.25	0.12	0.20	0.27	0.28
Crop residues (C)					
C_1-Wheat straw	1.78	2.07	2.74	2.79	3.03
C_2-Maize straw	1.72	1.89	2.32	2.70	2.92
C_3-Paddy straw	1.67	1.86	2.20	2.67	2.81
C_4-Jowar straw	1.91	2.21	2.78	2.88	3.08
C_5-Sugarcane trash	1.63	1.84	2.18	2.30	2.75
SE+	0.11	0.05	0.09	0.12	0.11
CD at 5%	NS	0.15	0.26	NS	NS
Interactions (SXC)					
SE+	0.19	0.09	0.15	0.21	0.22
CD at 5%	NS	NS	NS	NS	NS
General Mean	1.75	1.98	2.45	2.69	2.92

4. CONCLUSION

As compared to different cereal crop residues, jowar starw with inoculation of *Eudrilus eugeniae* which significantly influenced rate of decomposition and Chemical properties of vermicompost in case of micro-nutrients *viz.*, Fe, Zn, Cu and Mn were increased significantly followed by *Eisenia foetida*.

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