Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2015; 3(3): 191-195

Received: 16-04-2015
Accepted: 19-05-2015

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Vermicomposting efficiency of earthworm species from eastern Haryana

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Abstract
Vermicomposting has gained momentum in recent years due to its manifold benefits. Earthworms are known to degrade organic matter, but all species are not having the same potential to degrade organic matter. So selecting a suitable earthworm species is the first important step of vermicomposting activity. Therefore, for selecting local or native species of Eastern Haryana for vermicomposting a thorough study was conducted to explore the diversity of earthworms. During the present survey earthworm species such as *Metaphire posthuma, Perionyx simlaensis, Octocheatona beatrix, Dichogaster bolaui* and *Drawida nepalensis* were recorded and inoculated to see their efficiency in reduction of organic waste materials. Vermicomposting of 60 days resulted both in large population size as well as higher decomposition of waste material. On the basis of C/N ratio it may be concluded that *Dichogaster bolaui* and *Perionyx simlaensis* species will be utilized in vermi-technology as one of the important components of organic farming and sustainable agriculture in Haryana.

Keywords: Earthworms, Diversity, Vermicompost, Native

1. Introduction
Low level of soil fertility is one of the main constraints in boosting up agricultural production in India. The energy crisis in the country has resulted in a steep increase in the price of fertilizers which in turn hits the small and marginal farmers. Under such situation, recycling of waste is the only alternative for providing a renewable supplementary source of nutrients for crop plant in the countryside. In India crop residues, tree wastes, animal wastes, urban and rural wastes, agro-industries by-products etc are the major manorial resources and can be converted into bio-fertilizers if used scientifically. Otherwise, these wastes pose environmental problems like foul smell, occupying large spaces, production of disease carrier microbes. Biological material like earthworm is a boon to minimize the pollution caused by mismanagement of these organic wastes by enhancing the process of degradation of complex substance. It is essential to use appropriate species of earthworms in waste management.

Importance of vermiculture dates back when Darwin [1] for the first time realized the role of earthworm in agriculture and called them as ‘ploughman of the earth’. These vermiresources have vast and diversified potentials for waste recycle bio-fertilizer production, land reclamation, environmental detoxification and food sources. These bio- fertilizers can replace chemical fertilizer to some extent and create a better environment for the growth of plants. Vermi- technology has gained momentum in recent years due to its manifold benefits. It is an eco-friendly and cost effective technology using earthworms as bioreactors for converting organic materials into valuable compost. According to Sangwan *et al.* [2] the cost of crop production may be reduced significantly if vermicompost are integrated in nutrient management in agricultural field. Research on vermicomposting by using various wastes has been successfully going on throughout the world [3-16].

There are number of earthworm species present in the soil and among them indigenous species are better adapted to local area. So choosing a suitable earthworm species for that particular area is the first important step of any vermicomposting activity. Therefore, on the basis of this, the native species of Eastern Haryana were used for the present study.

2. Materials and Methods
The vermicomposting experiment was conducted from October (2014) to November (2014) in campus area of Kurukshetra University, Kurukshetra, Haryana (India).

2.1 Collection of earthworms

Earthworms were collected from different habitats of Haryana (India) during the year 2012-2015 which due to cropping pattern comes under sugarcane- belt region. The collected worms were washed with water, preserved in 4-10% formalin depending upon their size and were identified by Dr. Paliwal, Officer in charge National Zoological Survey of India, Solan, (Himachal Pradesh, India). Earthworms were categorized according to their feeding habits before culturing in the laboratory (Table1& Plate1).

Table 1: Earthworm species used in vermicomposting

Ecological category	Species	Habitats	Family
Epigeic	*Dichogaster bolaui* *Perionyx simlaensis*	Sewage Irrigation channels	Octochaetidae Megascolecidae
Endogeic	*Drawida nepalensis* *Octochaetona beatrix*	Garden and nurseries Cultivated fields	Monoligastridae Octochaetidae
Epi-anecic	*Metaphire posthuma*	Cultivated fields, Sewage, Grassland, Garden, Non-Cultivated areas	Megascolecidae

Note: all species were recorded abundantly from the survey sites

Plate 1. Earthworm species used for decomposition of organic wastes

2.2 Preparation of vermibeds

Five different vermiculture sets were maintained by using different earthworm species: Set1: *P. simlaensis*; Set2: *D. bolaui;* Set3: *D. nepalensis;* Set4: *O. beatrix;* Set5: *M. posthuma.* Efficiency of those species were evaluated by vermicomposting in circular plastic containers (28cm diameter and 30 cm depth) using a mixture of organic wastes viz., Farmyard manure (cow-dung and discarded cattle feed), kitchen waste, crop residue and paper waste in equal proportion by weight. Kitchen waste and crop residues in the culture used were dried and chopped. The selected waste was then mixed in equal proportion. The main characteristics of vermibed was as follows: Waste media: [pH, 6.0; EC, 1.4ms/cm; ash content (25%); TOC, 53.87(%); TKN, 0.7(%); C/N ratio 72.79; TP, 0.87 (%); K, 1.26 (%)]; Soil: [pH, 7.8;TOC, 0.58(%); TKN, 0.08(%); C/N ratio, 7.25; TP, 0.05 (%); K, 0.02(%) and Cow-dung [pH, 7.8 ± 0.2; TOC, 22.58(%); TKN, 0.57(%); C/N ratio, 39.37; TP, 0.23 (%); K, 0.55(%)]. Experiment was conducted in triplicate for each species. Before introducing earthworm species culturing containers were given the base of 2cm pebble layer followed by 100gm of soil and 100gm of partially decomposed cow-dung. Ten adult worm of each species were separately released above this layer. After that each container was filled with 1.5kg organic waste, and covered with moist jute bag. Each culture containers were kept inside vermiculture house (shaded place) at a temperature 27±3˚C for 60 days. Water was sprinkled on alternate days to maintain appropriate moisture content.

Parameters observed

After 60days vermicompost was prepared and total earthworms were counted. Efficiency of each species was determined based on waste mixture characteristics viz., pH, and electric conductivity, organic carbon (OC), total nitrogen (TKN), organic matter, available phosphorous (P), exchangeable potassium (K) and C/N ratio using methods [17-20]. Percent decomposition was also calculated as described by [21].

2.3 Statistical analysis

One way ANOVA was done to determine any significant difference among the parameters analyzed in vermicomposting. Duncan multiple ranged test was performed as a post hoc analysis to compare the data. All the reported data are the mean of three replicates. All statements reported in this study are at the P < 0.05 levels.

3. Results and Discussion

Table 2 shows the various parameters studied during the vermiculture of five species belonging to different ecological categories. All the species showed different potential for the reduction of organic materials used.

Table 2: Chemical composition of vermiculture media after 60days by different species of Eastern Haryana

Treatment	pH	EC	OC	TKN	OM	Tot. Ash	P	K	C/P ratio
1	7.2±0.09^{a}	1.67±0.03^{a}	22.26± 0.27^{d}	1.35±0.07^{a}	39.49±1.05^{d}	40.10±0.48^{a}	1.20±0.02^{a}	1.69±0.09^{a}	18.58±0.59^{cb}
2	7.1±0.12^{ab}	1.61±0.08^{a}	21.92±0.11^{d}	1.48±0.01^{a}	37.76±0.19^{d}	41.53±0.28^{a}	1.25±0.03^{a}	1.85±0.12^{a}	17.56±0.35^{c}
3	6.5±0.02^{c}	1.48±0.07 ^{a}	34.73±0.15^{a}	1.10±0.03^{b}	63.27±0.27^{a}	27.11±0.89^{c}	1.1±0.09^{ab}	1.36±0.28^{a}	32.31±2.93^{a}
4	6.8±0.01^{bc}	1.53±0.01^{a}	28.91±0.09^{b}	1.20±0.04^{b}	49.81±0.16^{b}	29.04±0.37^{bc}	1.2±0.04^{b}	1.45±0.25^{a}	29.31±0.31^{a}
5	6.9±0.13^{abc}	1.58±0.06^{a}	26.29±0.27^{c}	1.2±0.05^{b}	45.29±0.48^{c}	29.96±0.75^{b}	1.13±0.03^{ab}	1.5±0.41^{a}	23.22±0.36^{b}

Mean value followed by different letters are statistically different (ANOVA; Duncan multiple-ranged test, p<0.05) pH: After 60 days of vermiculture the end products from all treatments showed fall in pH value from its initial value. The pH was within the range of 6.5±0.02 - 7.2±0.09 which is within the optimal range for plant growth. There was decrease in pH from the initial alkaline condition towards slightly acidic. This may be due to mineralization of nitrogen and phosphorus into nitrates / nitrites and orthophosphates [22]. The pH values for each treatment varied significantly ($P< 0.05$).

EC: All the treatments revealed gradual increase in EC from initial value 1.4±0.05ms/cm to 1.67 ± 0.03 – 1.48±0.07ms/cm in all the studied treatment. This increase may be due to loss of weight of organic matter and release of different mineral salts in available forms [23]. There was no significant variation ($P< 0.05$) in EC for all the treatments.

OC: The reduction in organic carbon of the source was revealed in all the five treatments. The combustion of carboneous substance was enhanced by the species *D. bolaui* resulting in reduction of organic carbon 2.32 times in this treatment. Difference in organic carbon and organic matter in all treatments was observed which might be due to significant difference in per cent decomposition of the waste mixture and population build- up (Fig. 2) trend of the different species. After *D. bolaui*, the maximum carbon reduction was obtained by *P. simlaensis* (2.28times), followed by *M. posthuma* (1.93 times), *O. beatix* (1.75 times) and *D. nepalensis* (1.46 times). The difference in OC content at the end of experiment day was significant ($P< 0.05$) for all the treatments. But treatment 1 and 2 did not vary significantly. The reduction in organic carbon was possibly achieved by respiratory activity of earthworms and microorganisms [23, 15].

TKN and C/N ratio: Total N content resulted highest amount in treatment 2 (2.11 fold increase in N and 4.96 times decrease in C/N ratio) whereas lowest was recorded in case of *D. nepalensis* (1.57 fold increase in N and 2.28 times decrease in C/N ratio) treatment. The decrease in C/N ratio might be related to increase in earthworm population which led to higher rate of substrate utilization and rapid decrease in organic carbon. The release of CO_2 from carbon part in the process of respiration, mucus and nitrogen excrements, increase the nitrogen level and decline the C/N ratios [24-25]. C/N ratio is an important criteria of a good manure that can be easily assimilated by plants and should lie between 10 and 20 [26]. In our studies, the C/N ratios were found to be more than 20 except where *D. bolaui* and *P. simlaensis* were used (14.65 and 16.09, respectively) (Fig. 1). Significant variation ($P< 0.05$) was seen in all the treatments. Populations build up being slower; C/N ratio remained at higher level in treatment 3, 4, and 5. All these species are having different ecological categories (Table 1) and their big size also limited their activity for decomposition. According to the classification given by Bouche [27] and Julka [28] epigeic species are litter dwellers and mainly feed on organic rich matter. They are very active and reproduce fastly. Present result supports the earlier observations. Whereas, endogeic species mainly form burrows, feed on soil and organic matter and are slow decomposers as compared to epigeic species.

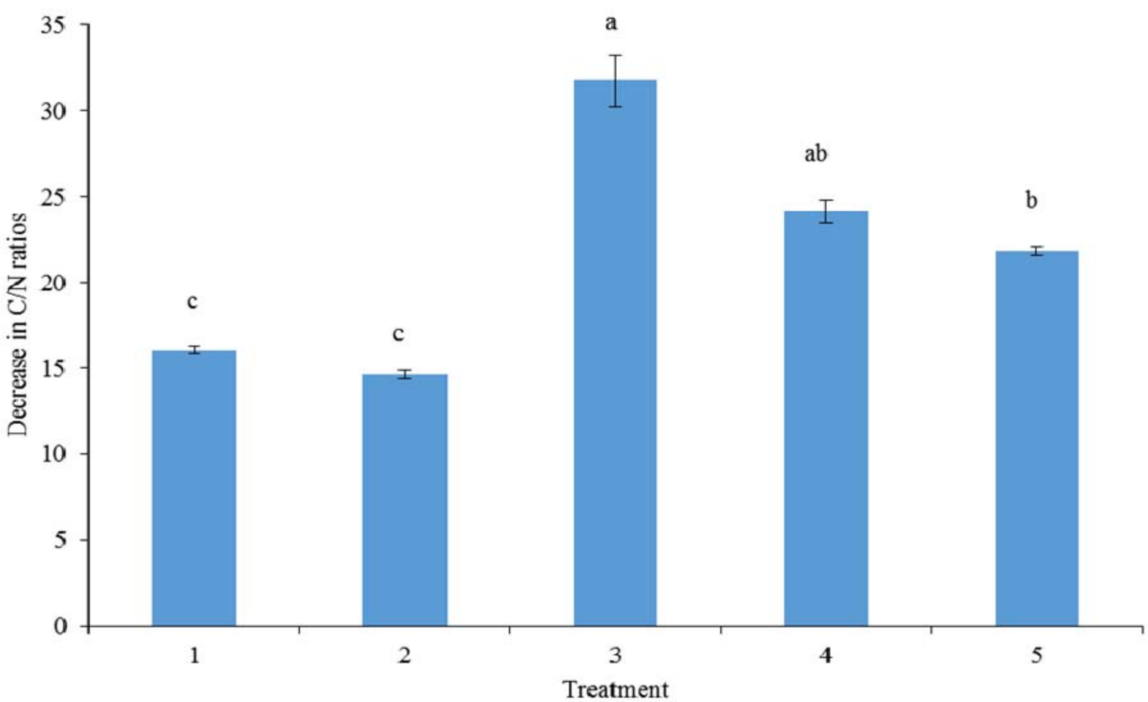

Fig 1. Decrease in C/N ratios by different treatments. 1: ***P. simlaensis*****; 2:** ***D.bolaui*****; 3:** ***D. nepalensis*****; 4:** ***O. beatrix*****; 5:** ***M. posthuana***

TP and K: Vermicomposting accelerates the mineralization of metabolites and subsequently enriches the end product with more available form of soil nutrients. As data indicate TP and K content was highest in *D.bolaui* followed by *P. simlaensis, M. posthuma*, *O. beatrix* and *D. nepalensis*. The differences in both the contents obtained from different treatments were not significant ($P< 0.05$). Hatanaka *et.al* [29] stated that the ratio of organic matter and ash content were important factor to monitor whether composting process was completed or not, and this ratio should be approximately 2. Our data revealed that in case of *D. nepalensis* (org matter: ash content- 2.3) conferred incomplete composting by this species, whereas in remaining treatments the value was below 2 suggesting completion of composting process.

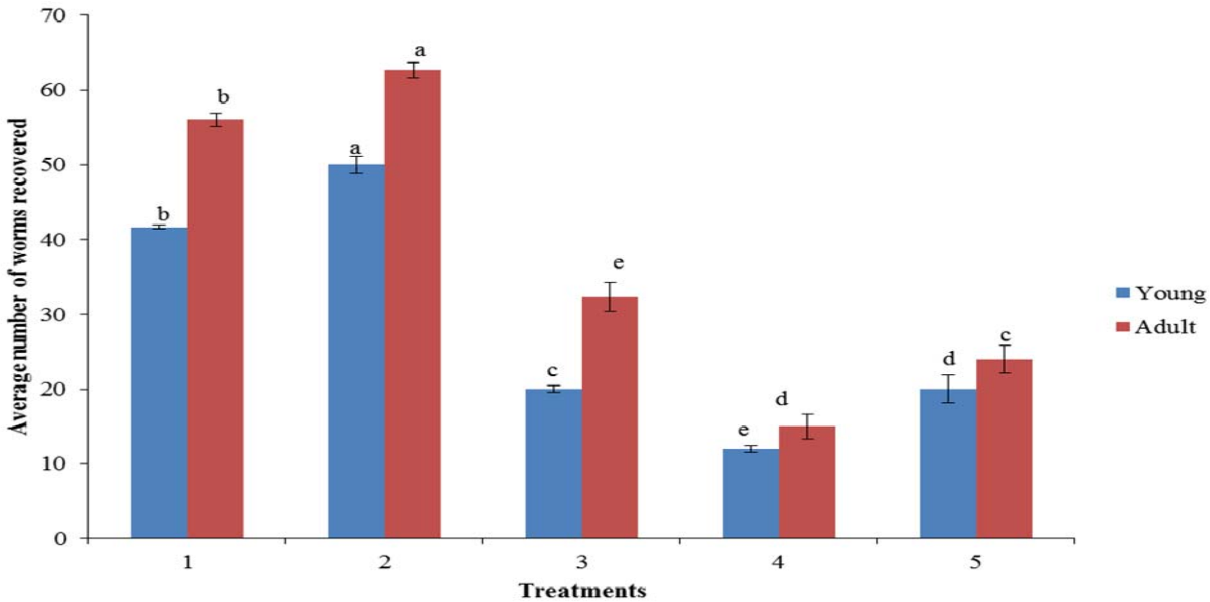

Fig 2. Average number of worms recorded after 60 days of culturing. Mean value followed by different letters are statistically different (ANOVA ; Duncan multiple-ranged test, $p<0.05$)

4. Conclusion

On the basis of chemical analysis, the present observations indicated that *D. bolaui* and *P. simlaensis* were efficient species in performance over other species in terms of reduction of C/N ratio and increase in nitrogen content of vermibed (decomposition and mineralization). Epigeic worms are capable of converting all the organic waste into manure. Our result confirmed that the quality and composition of substrate influenced the efficiency of earthworms for composting process.

5. Acknowledgements

Dr. Poonam Bhardwaj is grateful to the Department of Science and Technology, Government of India, New Delhi for providing financial support under Women Scientist (WOS-A) scheme to complete the present research work.

6. References

1. Darwin CR. The formation of vegetable mould through the action of worms, with observations on their habits, John Murray, London, 1881, 298.
2. Sangwan P, Kaushik CP, Garg VK. Growth and yield response of marigold to potting media containing vermicompost produced from different wastes. Environmentalist 2010; 30:123-130.
3. Reinecke AJ, Viljoen SA, Aayman RJ, The suitability of *Eudrilus eugeniae, Perionyx excavatus and Eisenia fetida* (Oligochaeta) for vermicomposting in southern Africa in terms of their temperature requirements. Soil. Biol. Biochem 1992; 24(12):1295-1307.
4. Elvira C, Sampedro L, Benitez E, Nogales R. “Vermicomposting of sludge from paper mill and dairy industries with *Eisenia andrei*: a pilot scale study”. Bioresour. Technol.1998; 64:205-211.
5. Kale RD. “Earthworms: Nature’s gift for utilization of organic wastes”. In: CA Edwards (ed.), “Earthworm Ecology”, 2nd ed., CRC Press, 1998, 355-373.
6. Ranganathan LS, Parthasarathi K, Precocious development of *Lampito mauriti* (Kinberg) and *Eudrilus eugeniae* (Kinberg) reared in pressmud. Pedobiologia 1999; 43:904-908.
7. Chaudhuri PS, Pal TK, Bhattacharjee G, Dey SK. “Rubber leaf litters (Hevea brasiliensis, var RRIM 600) as vermiculture substrate for epigeic earthworm, *Perionyx excavatus*, *Eudrilus eugeniae* and *Eisenia fetida*”, Pedobiologia 2002; 47:796-800.
8. Dominguez J, “State-of-the art and new perspectives on vermicomposting research”. In: CA Edwards (ed.), “Earthworm Ecology”, second ed. CRC Press, 2004, 401-424.
9. Tripathi G, Bhardwaj P. Comparative studies on biomass production, life cycles and composting efficiency of *Eisenia fetida* (Savigny) and *Lampito mauritii* (Kinberg), Bioresource Technology 2004a; 92:275-283.
10. Tripathi G, Bhardwaj P. Decomposition of kitchen waste amended with cow manure using epigeic species (*Eisenia fetida*) and an anecic species (*Lampito mauritii*). Bioresource. Technology 2004b; 92:215-218.
11. Gajalakshmi S, Ramasamy EV, Abbasi SA. “Composting-vermicomposting of leaf litter ensuing from the trees of mango (*Mangifera indica*)”, Bioresour. Technology 2005; 96:1057-1061.
12. Munnoli PM, Silva JA, Bhosle S. Dynamics of the soil earthworm- Plant Relationship: A Review In: Dynamic soil, Dynamic Plant4 (special issue1), Global Science Books, 2010, 1-21.
13. Dominguez J, Edwards CA. Relationship between composting and vermicomposting. In: Edwards, C.A., Arancon, N.Q., Sherman, R. (eds.), Vermiculture Technology – Earthworms, Organic Wastes, and Environmental Management. CRC Press, Boca Raton, 2011, 11-26.
14. Yadav A, Garg VK. Recycling of organic wastes by employing *Eisenia fetida.* Bioresource Technology 2011; 102:2874-2880.
15. Negi R. Suthar S. Vermistabilization of paper mill wastewater sludge using *Eisenia fetida*. Bioresource Technology 2013; 128:193-198.
16. Gupta R, Yadav A, Garg VK, Influence of vermicompost application in potting media on growth and flowering of marigold crop. Int. J. Recycl. Org. Waste Agricult 2014; 3:47.

17. Walkley A, Black CA. An estimation of the Digtjareff method for determining soil organic matter and proposed modification of chromic acid titration method. Soil Sci 1934; 37:29-38.
18. Jackson ML. *Soil Chemical Analysis*, Prentice Hall of India Pvt. Ltd., New Delhi, India, 1973.
19. Olsen SR, Cole CV, Watanabe FS, Dean LA. Estimation of available phosphorous in soils by extraction with sodium bicarbonate. Circ. US Dep. Agric, 1954, 939.
20. Simard RR. Ammonium acetate extractable elements. In: Martin, R., Carter, S., (Eds), Soil sampling and methods of analysis. Lewis Publisher, Florida, USA, 1993, 39-43.
21. Goswami B, Kalita MC. Efficiency of some indigenous earthworms species of Assam and its characterization through vermitechnology. Indian Journal of Environ. Ecoplan 2000; 3:351-354.
22. Ndegwa PM, Thompson SA, Das KC. Effects of stocking density and feeding rate on vermicomposting of biosolids. Bioresource Technology 2000a; 71:5-12.
23. Garg VK, Gupta A, Satya S. Vermicomposting of different types of waste using *Eisenis fetida* a comparative study. Bioresource Technology 2006; 97:391-395.
24. Senapati BK, Dash MC, Rana AK, Panda BK. Observation on the effect of earthworm in the decomposition process in soil under laboratory conditions. Comp. Physiol. Ecol 1980; 5:140-142.
25. Ndegwa PM, Thompson SA, Das KC. Effect of C to N ratio on vermicomposting in the treatment and bioconversion of biosolids. Bioresource. Technol 2000b; 76:7-12.
26. Edwards CA, Bholen PJ. Biology and ecology of earthworms. 3rd edition. Chapman and Hall, London, England, 1996, 1-427.
27. Bouche MB. “Strategies lombriciennes”. Ecological Bulletin (Stockholm) 1977; 25:122-132.
28. Julka JM. *The Fauna of India and the Adjeacent Countries*. Megadrile: Oligochaeta (Earthworms). Haplotaxida: Lumbricina: Megascolecoidea: Octochaetidae,. Zoological Survey of India, Calcutta, 1988, XIV+ 400.
29. Hatanaka K, Ishioka Y, Furuichi E, Cultivation of *Eisenia fetida* using dairy waste sludge cake: In Earthworm Ecology: from Darwin to Vermiculture. (Eds. Satechel, J.E.). Chapman and hall, 1983, 49-57.