DAV International Journal of Science

GROWTH AND REPRODUCTION OF *EUDRILUS EUGENIAE* AND *EISENIA FETIDA* IN TENDU (*DIOSPYROS MELANOXYLON ROXB.*) LEAF AS INFLUENCED BY SUPPLEMENTARY FEED

Kadam D.G.

Department of Microbiology, D.B.F. Dayanand College of Arts and Science, Solapur-413002, Maharashtra, India
(Corresponding author: *E-mail*- kadamdgin@rediffmail.com)

ABSTRACT

In the present study, influence of two supplementary feeds, viz. cow dung and press mud, on the growth of *Eudrilus eugeniae* and *Eisenia fetida* fed on tendu leaf residues was investigated. Cow dung and press mud were mixed separately with partially decomposed tendu leaf residues in different proportions as 5%, 10%, 20%, 30% and 40%. in plastic pots in triplicates. Three juveniles of either *Eudrilus eugeniae or Eisenia fetida* were added separately to respective pots and incubated at 28ºC temperature. The weight of the earthworm and the number of cocoons produced were assessed every week for a period of eight weeks. Both earthworms attained maximum weight in 40 % proportion of both the supplementary feeds. In cow dung mixtures *Eudrilus eugeniae* attained the highest weight of 3247.3±5 mg at a growth rate of 71.30 mg worm^{-1} day^{-1} while *Eisenia fetida* attained the highest weight of 762.0±10 mg at a growth rate of 13.4 mg worm^{-1} day^{-1}. In press mud mixtures, *Eudrilus eugeniae* gained maximum weight of 2297.2±38 mg at a growth rate of 63 mg worm^{-1} day^{-1} while *Eisenia fetida* attained maximum weight of 649.6±3.4 at a growth rate of 11.62 mg worm^{-1} day^{-1}. The average maximum rate of cocoon production by *Eudrilus eugeniae* was 7.0±0.6 and 4.12±0.2 cocoons worm^{-1} week^{-1} in 10% cow dung and press mud respectively while for *Eisenia fetida* it was 3.8 and 3.17 cocoons worm^{-1} week^{-1} in cow dung and press mud respectively. The study revealed that 10% concentration of both the supplementary feeds is quite adequate for vermicomposting of tendu leaf residues by both worms and cow dung is a better supplementary feed than the press mud and *Eudrilus eugeniae* is better candidate than *Eisenia fetida* for vermicomposting of tendu leaf residues.

KEY WORDS: *Eudrilus eugeniae, Eisenia fetida,* tendu leaf refuse, vermicomposting, supplementary feed,

INTRODUCTION

Tendu (*Diospyros melanoxylon* Roxb.) leaf is widely used in India in the form of rapper for making a crude smoking stick popularly called as 'Beedi'. Solapur city of Maharashtra State has a large number of small scale Beedi making industries. Large quantities of waste from these industries in the form of pared off leaf residues are just thrown away. This forms large heaps on roadside and at collection centers of Municipal Corporation. About 15 thousand tonnes of tendu leaf waste per year is available in Solapur city alone and it is one of the major causes of environmental pollution in the city area. Solid waste management of this tendu leaf waste by vermicomposting is proposed.

Vermicomposting not only helps in mineralization of nutritional elements present in the organic materials but also aids in effective disposal of organic wastes thereby controlling environmental pollution in our cities. There are several reports on processing of various kinds of organic wastes such as sewage sludge (Neuhauser, 1988; Dominguez, 2000), agricultural and domestic wastes (Kale, 1982; Albanell, 1988), and industrial wastes (Kavian, 1996; Elvira, 1999) through vermicomposting using various earthworm species. The rate of vermicompost output is likely to depend upon the earthworm species and the feed (Gajalakshmi, 2001).

Moreover, vermicomposting of such organic wastes as plant leaves cannot be achieved alone and these require some percentage of supplementary feed such as cow dung for earthworms to survive and accept the given material as feed (Kale, 1998). The process of decomposition of materials like plant leaves, which possess low nitrogen content, can be enhanced by mixing them with supplementary feed materials rich in nitrogen and other nutrients (Senapati and Dash, 1984; Abbasi and Ramasami, 1999). In this paper we investigated the effect of two supplementary feed materials viz. cow dung and press mud, on the growth and reproduction of two earthworms *Eudrilus eugeniae* and *Eisenia fetida* fed on tendu leaf residues.

MATERIAL AND METHODS

Earthworms: Adult, clitellate worms of *Eudrilus eugeniae* and *Eisenia fetida* were obtained from MPKV Regional Dry Land Agricultural Research Center, Solapur and maintained as stock in the laboratory at 28ºC temperature. Juvenile worms from this stock were taken when required.

Feed material used: Tendu (*Diospyros melanoxylon* Roxb.) leaf refuse was collected from a local household beedi making unit and shredded into small pieces of about 1 cm^2 and stored for further use.

Supplementary feed used: A required quantity of press mud was collected in sterile autoclavable bags from Shri Siddheshwar Sahakari Sugar Factory Limited, Kumathe near Solapur and transported to the laboratory. Cow dung was collected in disinfected plastic cans, tied with cloth. Both the supplementary feeds were stored at refrigeration temperature until further use.

Experimental setup: Partial decomposition of shredded tendu leaf residue was carried out for 45 days after mixing with 1% seed material consisting of fertile soil, sewage sludge, cow dung, press mud and paper-pulp effluent. Cow dung and press mud were mixed separately with partially decomposed tendu leaf residues in different proportions as 5%, 10%, 20%, 30% and 40%. The experiment was performed in plastic pots in triplicate. 150 g of each mixture was added into respective plastic pots (14 cm diameter × 6 cm height). Two sets were used separately for *Eudrilus eugeniae* and *Eisenia fetida*. Each set had two subsets with separately added cow dung and press mud in various proportions.

Juvenile worms of each species were washed with tap water, blotted with blotting paper. Three juvenile worms were added to respective pots after noting their weights. All the pots were covered with a cotton cloth and closed with the perforated lids, and incubated at 28ºC temperature. The moisture content of each pot was maintained between 70-80% by sprinkling distilled water regularly during course of the experiment. Additional feed mixture was supplied to each pot whenever needed. The worms from each pot were removed after every week, washed with distilled water and blotted with blotting paper. Fresh weight of earthworms was noted; the number of cocoons produced by them in each pot was counted and they were released into their respective pots. The counted cocoons were separated each time and placed in a petriplate with moist filter paper at the bottom. This Petri plate was kept in the respective plastic pot itself. The weight of the earthworms and the number of cocoons produced were assessed every week for a period of eight weeks. The results of the experiment are expressed as the average value of a single measurement on each of the three replicates.

Statistical analysis

Student's t-test was done to determine the number of days required for significant increase in body weight over initial body weight of the worms and difference in cocoon production rates of the worm in feed materials containing different proportions of supplementary feeds viz.cow dung and press mud.

RESULTS

Influence of supplementary feeds on *Eudrilus eugeniae*

The growth rates of *Eudrilus eugeniae* in tendu leaf residues with cow dung as supplementary feed in different proportions are summarized in Table 1. The earthworm attained maximum weight of 3247.3 ± 5.0 mg in 40% cow dung proportion at a growth rate of 71.30 mg worm^{-1}day^{-1}. Minimum weight of 1828.56 ± 21.0 mg of the earthworm was detected in 5% proportion. After initial increase in worm biomass, weight losses were observed after 6th week. In general, the biomass of *Eudrilus eugeniae* increased gradually with increase in cow dung concentration. Similar increase in growth rates of the worm was also seen with increase in cow dung concentrations except 10%.

The growth rates of *Eudrilus eugeniae* in tendu leaf residues with press mud as supplementary feed in 5%, 10%, 20% and 40% proportions are given in Table 1. The earthworm gained maximum weight of 2297.2 ± 38.0 mg with 40% press mud at a growth rate of 63.0 mg worm^{-1} day^{-1}. The minimum weight of 1694.6± 21 mg worm^{-1} was detected in 10%press mud concentration. In general, the growth rate of *Eudrilus eugeniae* was found to increase with increase in press mud concentration. The minimum growth rate of the worms (32.0 mg worm^{-1} day^{-1}) was found with 5% press mud. The rate of cocoon production of *Eudrilus eugeniae* in tendu leaf residues with different proportions of cow dung and press mud is given in Table 2. The maximum rate of cocoon production by *Eudrilus eugeniae* was 7.0±0.6 cocoons week^{-1} worm^{-1} in 10% cow dung. The lowest rate of 1.78±0.1 cocoons week^{-1} worm^{-1} of cocoon production was observed with 40% cow dung. Characteristically, *Eudrilus eugeniae* showed maximum growth rate in 40% cow dung proportion but the rate of cocoon production at this concentration was lowest. Similarly, the growth rate of the worm in 10% cow dung proportion was lowest (45.5 mg worm^{-1} day^{-1}) but the rate of cocoon production was maximum. The maximum rate of cocoon production by the worm was 4.12±0.2 cocoons worm^{-1} week^{-1} with 10% press mud. The lowest rate of cocoon production (1.37±0.1 cocoons worm^{-1} week^{-1}) was observed in 40% press mud proportion. Characteristically, like cow dung, the growth rate of the worm and the cocoon production showed opposite trends.

Influence of supplementary feeds on *Eisenia fetida*

The growth rates of *Eisenia fetida* in tendu leaf residues with cow dung as supplementary feed are summarized in Table 3. The earthworm *Eisenia fetida* attained maximum weight (762.0± 10 mg) in 40% cow dung proportion at a growth

rate of 13.38± 0.32 mg worm^{-1}day^{-1}. Minimum weight (370±28 mg worm^{-1}) of the worm was detected in 10% cow dung proportion with growth rate of 8±0.03 mg worm^{-1} day^{-1}.

Table 1: **Growth of *Eudrilus eugeniae* in different mixtures of tendu leaf residue with cow dung or press mud**

Mixture	Initial average biomass # (mg worm^{-1})	Maximum biomass achieved (mg worm^{-1})	Gain in biomass (mg worm^{-1})	Growth rate (mg worm^{-1} day^{-1})
95%TL + 5%CD	236.0 ±17.4	1828.56 ±21.0	1592.56 ±19.4	56.87 ±6.6
90%TL+10%CD	184.0 ±2.95	2095.00 ±9.0	1911.00 ±2.0	45.5 ±0.09
80%TL+ 20%CD	74.661 ±2.0	1937.77 ±7.0	1863.11 ±1.0	66.540 ±.12
70%TL + 30%CD	236.6 ±4.0	2256.1 ±29.36	2019.5 ±12.0	58.0 ±7.0
60%TL + 40%CD	252.33 ±9.64	3247.35 ±.0	2994.97 ±9.50	71.30 ±0.01
95%TL + 5% PM	663.3 ±37.4	2235.5 ±33.0	1572.56 ±6.5	32.08 ±3.8
90%TL + 10%PM	485.00 ±11.04	1694.66 ±21.0	1209.6 ±2.48	34.56 ±6.0
80%TL + 20%PM	665.66 ±14.9	2181.8 ±12.55	1515.94 ±0.03	36.09 ±2.1
70%TL + 30%PM	395.001 ±2.50.0	2262.0 ±14.90	1867.0 ±3.93	53.34 ±0.09
60%TL + 40%PM	534.33 ±14.97	2297.2 ±38	1762.871 ±5.5	62.95 ±0.35

TL = Tendu leaf
PM = Press mud; CD= cow dung
# = Mean of three replicates ± S.E.

Table 2: **Rate of cocoon production by *Eudrilus eugeniae* in different mixtures of tendu leaf residues and cow dung or press mud**

Mixture	Time (weeks)	Cocoons worm^{-1} week^{-1}
95%TL + 5% CD	8	3.94 ±0.38
90%TL + 10% CD	8	7.0 ±0.6
80%TL + 20% CD	8	3.87 ± 0.3
70%TL + 30% CD	8	3.75 ± 0.5
60%TL + 40% CD	8	1.78 ± 0.1
95%TL + 5% PM	8	3.31 ±0.1
90%TL + 10% PM	8	4.12 ± 0.2
80%TL + 20% PM	8	3.06 ±0.1
70%TL+ 30% PM	8	2.81 ± 0.3
60%TL + 40% PM	8	1.37 ±0.1

TL = Tendu leaf; PM = Press mud ; CD= cow dung
# = Mean of three replicates ± S.E.

Table 3: Growth of *Eisenia fetida* in different mixtures of tendu leaf residue with cow dung or press mud

Mixtures	Initial biomass (mg worm^{-1})#	Maximum biomass achieved (mg worm^{-1})	Gain in biomass (mg worm^{-1})	Growth rate (mg worm^{-1} day^{-1})
95% TL+ 5% CD	79.66 ±14.6	461.0 ±15.5	381.34 ±7.0	**9.07 ±0.05**
90% TL+ 10%CD	87.4 ±27.5	370.0 ±28.6	282.66 ±9.0	**8.05 ±0.03**
80% TL+ 20%CD	61.661 ±6	578.66 ±15.0	517.0 ±8.0	**10.55 ±0.25**
70% TL+ 30%CD	97.0 ±21.4	607.2 ±7.5	510.2 ±16.5	**12.150 ±07**
60% TL+ 40%CD	106.0 ±8	762.0±10	656.01 ±4.1	**13.38 ±0.32**
95% TL+ 5% PM	42.0 ±8.9	421.3 ±5.17	379.3 ±2.5	**9.03 ±0.02**
90% TL+ 10% PM	32.3 ±2.9	398.0 ±2.48	365.7 ±1.46	**7.46 ±0.01**
80% TL+ 20% PM	40.66 ±5.0	403.0 ±14.0	362.34 ±2.5	**8.62 ±0.04**
70% TL+ 30% PM	73.3 ±18.0	422.03 ±1.0	347.7 ±4.0	**9.96 ±1.2**
60% TL+ 40% PM	**80.0 ±5.2**	**649.6 ±3.80**	**569.6 ±1.6**	**11.62 ±0.03**

TL = Tendu leaf;
PM = Press mud ; CD= cow dung
# = Mean of three replicates ± S.E.

The growth rates of *Eisenia fetida* in tendu leaf residues with press mud as supplementary feed are summarized in Table 3. The earthworm *Eisenia fetida* attained maximum weight (649.6±3.8 mg worm^{-1}) in 40% press mud proportion at a growth rate of 11.62 mg worm^{-1} day^{-1}. The minimum growth rate of 7.46±0.01 mg worm^{-1} day^{-1} was found in 10% press mud concentration. The rates of cocoon production by *Eisenia fetida* fed on tendu leaf residues with different proportions of cow dung and press mud are summarized in table 4. In cow dung mixtures, the maximum rate of cocoon production was 3.8±0.3 cocoons worm^{-1} week^{-1} in 10%cow dung proportion. The lowest rate of cocoon production (0.75±0.05 cocoons worm^{-1}week^{-1}) was observed in 40% cow dung proportion. In press mud mixtures, the maximum

rate of cocoon production of 3.17± 0.3 cocoons worm^{-1} week^{-1}was found in 10% press mud proportion while the lowest rate of cocoon production (0.96±0.2 cocoons worm^{-1} week^{-1}) was observed in 40 % press mud proportion.

Table 4: Rate of cocoon production by *Eisenia fetida in* different mixtures of Tendu leaf residues and Cow dung or press mud

Mixture	Time (weeks)	Cocoons worm^{-1} week^{-1} #
95% TL+ 5% CD	8.0	1.49 ±0.1
90% TL +10% CD	8.0	3.8 ±0.3
80% TL+ 20% CD	8.0	2.30 ±.2
70% TL+ 30% CD	8.0	1.6 ±0.2
60% TL+ 40% CD	8.0	0.75 ±0.05
95% TL+ 5% PM	8.0	1.460 ±.2
90% TL+ 10% PM	8.0	3.17 ±0.3
80% TL+ 20% PM	8.0	1.98 ±0.1
70% TL+ 30% PM	8.0	1.37 ±0.1
60% TL+40% PM	8.0	0.96 ± 0.2

TL = Tendu leaf; PM = Press mud; CD= cow dung
# = Mean of three replicates ± S.E.

DISCUSSION

Eudrilus eugeniae could gain more biomass in tendu leaf residues with cow dung as compared to its biomass when press mud was used as supplementary feed. Thus, cow dung acts as better supplementary feed compared to press mud during vermicomposting of tendu leaf residues by *Eudrilus eugeniae*. The maximum weight gain of *Eudrilus eugeniae* in cow dung mixtures was 499 mg worm^{-1} week^{-1}, and in press mud mixtures 440 mg worm^{-1} week^{-1}, compared to the highest weight gains reported by other workers for *Eudrilus eugeniae* as 280 mg week^{-1} (Dominguez *et al.*, 2001) and as 150 mg week^{-1} (Reinecke *et al.*, 1992), and for *Eisenia andrei* as 80-90 mg week^{-1} (Elvira *et al.*, 1996).

The maximum rate of cocoon production by *Eudrilus eugeniae* was 7.0 cocoons worm^{-1} week^{-1} with 10% cow dung and 4.12 cocoons worm^{-1} week^{-1} with 10% press mud. The maximum rate of cocoon production in this study, using cow dung as well as press mud as supplementary feed, was significantly higher than 3.6, 0.7 and 3.22 cocoons week^{-1} that was reported for this worm by Dominguez et al. (2001), Neuhauser *et al.* (1979) and Reinecke *et al.* (1992) respectively. However, Rodriguez *et al.* (1986) found a similar higher rate of cocoon production at 7.0 cocoons earthworm^{-1} week^{-1} as obtained in the present study. The maximum weight gain of *Eisenia fetida* in cow dung mixtures was 94.0 mg worm^{-1} week^{-1} and 82.0 mg worm^{-1} week^{-1} in press mud mixture; compared to the highest weight gains reported for *Eisenia fetida* of 60-80 mg week^{-1} (Graff, 1974), of 180 mg week^{-1} in rubber leaf litters (Chaudhari, 2003) and 49.0 mg week^{-1} reported by Reinecke *et al.* (1992).

The maximum rate of cocoon production by *Eisenia fetida* was 3.8 cocoons worm^{-1} week^{-1} and 3.17 cocoons worm^{-1} week^{-1} in cow dung mixtures respectively. These rates are similar to those reported by Edwards (1988) as 3.8 cocoons worm^{-1} week^{-1}, 3.19± 0.1 cocoons worm^{-1} week^{-1} reported by Dominguez *et al.* (2003) for *Eisenia andrei* fed on sewage sludge plus card board mixtures. The rates of cocoon production by *Eisenia fetida* in present study are significantly higher than those reported by Chaudhari *et al.* (2003) as 1.3 cocoons worm^{-1} week^{-1} for this worm.

The results of the study show that the concentration of both the supplementary feed materials at which maximum cocoon production takes place is about 10%, which is much different than that at which maximum biomass is attained by the worm (40%). These results corroborate to earlier reports of Gajalakshmi *et al.* (2001) who found that spiking of paper feed with 14% cow dung or perhaps an even smaller fraction might be adequate to support earthworm in the paper-fed vermireactors. The results further reveal the basic aspect of growth of earthworm in cellulosic wastes or plant leaves and influence of nutritionally rich supplementary feeds like cow dung and press mud on cocoon production by the worms. Certain minimum concentration of cow dung or press mud might have stimulatory role in formation and release of cocoons. At higher concentrations, however, the rate of cocoon production is retarded but biomass or growth rate is enhanced. Comparison between *Eudrilus eugeniae* and *Eisenia fetida* in terms of their growth rates, maximum biomass attained and their cocoon production rates revealed that *Eudrilus eugeniae* is better candidate for vermicomposting of tendu leaf residues.

CONCLUSION

As the multiplication of earthworms is a more significant parameter in vermicomposting, it can be concluded that 10% concentration of both the supplementary feeds (cow dung or press mud) is quite adequate for vermicomposting of tendu leaf residues. However, cow dung is better supplementary feed material than the press mud because the rate of weight gain of earthworms and cocoon formation is higher in the former. Moreover, *Eudrilus eugeniae* is better candidate for vermicomposting of tendu leaf residues.

ACKNOWLEDGEMENT

The authors are thankful to Dr. G.Y. Parlekar, M.P.K.V's Regional Dry Land Agricultural Research Centre, Solapur for supplying the earthworms and to UGC for financial support.

REFERENCES

Albanell E., Plaixats J. and Cabrero T. (1998). Chemical changes during vermicomposting (*Eisenia fetida)* of sheep manure mixed with cotton industrial wastes. *Biol. Fertility Soils.* **6**: 266-269

Abbasi S. A. and Ramasami E. (1999). In: Biotechnological Methods of Pollution Control. University Press (India) Ltd., Hyderabad. Pp. 149-166.

Aranda E., Barois I., Arellano P., Irisson S., Salazar,T., Rodriguez J. and Patron J.C. (1999). Vermicomposting in the tropics. In: Lavelle, P., Brussard, L. and Hendrix, P. (eds.) Earthworm Management in Tropical Agrosystems. CABI Publishing, CAS International, Wallingford, UK, pp. 253-287.

Chaudhari P.S., Pal T.K., Bhattacharjee G. and Dey S.K., (2003). Rubber leaf litters (Hevea brasiliensis, var RRIM 600) as vermiculture substrate for epigamic earthworm, *Perionyx excavatus, Eudrilus eugeniae* and *Eisenia fetida. Pedobiologia.* **47:** 1- 4.

Dominguez J., Edwards C.A. and Ashby J. (2001). The biology and population dynamics of *Eudrilus eugeniae* (Kinberg) (Oligochaeta) in cattle waste solids. *Pedobiologia.* **45:** 341-353.

Edwards C.A. and Fletcher K.E. (1988). Interactions between earthworm and microorganisms in organic matter breakdown. Agriculture. *Ecosystems Environ.* **24** : 235-247.

Elvira C., Dominguez J. and Briones M.J.I. (1996). Comparison between *Eisenia fetida* and *Eisenia andrei*. Interactions and life cycles. *Pedobiologia.* **40:** 377-384.

Elvira C., Sampedro L. and Nogales R. (1999). Suitability of sludges from dairy and paper industries for growth and reproduction of *Eisenia andrei. Pedobiologia.* **43(6):** 766-770.

Gajalakshmi S., Ramasamy E.V. and Abbasi S.A. (2001). Towards maximizing output from vermireactors fed with cow dung spiked paper waste. *Biores. Technol.* **79**: 67-72.

Graff O. (1974). Gewinnung von Biomasse aus Abfallstoffen durch kulture des Kompostregen wurms *Eisenia fetida* (savigny, 1862). *Land bauforschung Volkenrode*. **2:** 134-142.

Kale R.D. (1998). Earthworm: Cinderella of Organic Farming. Prism Books Pvt. Ltd., Bangalore, India.

Kale R.D., Bano, K. and Krishnamoorthy R.V. (1982). Potential of *Perionyx excavatus* for utilizing organic wastes. *Pedobiologia.* **23:** 419 – 425.

Kavian M.F., Ghatnekar S.D. and Kulkarni P.R. (1996). Bio management of paper mill sludge using culture of red American earthworm (*Lumbricus rubellus*). *Indian J. Environ. Protection.* **16:** 330-333.

Neuhauser E.F., Kaplan D.L. and Hartenstein R. (1979). Life history of the earthworm *Eudrilus eugeniae. Revue d' Ecologie et Biologie du Soil.* **16:** 525-534.

Reinecke A.J., Viljoen S.A. and Saayman R.J. (1992). 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.* **24:** 1295-1307.

Rodriguez C., Canetti M.E., Reines M. and Sierra A. (1986). Life cycle of *Eudrilus eugeniae* (Oligochaeta: Eudrilidae) at 30ºC. Poeyana. Institute de Zoologia. Academia de Ciencias de Cuba. **326:** 1-13.

Senapathi B.K. and Dash M.C. (1984). Functional role of earthworms in the decomposer sub system. *Tropical Ecol.* **25**: 52-71.