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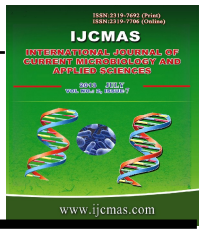

Original Research Article

Influence of temperature on growth and reproduction of earthworm *Eudrilus eugeniae*

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A B S T R A C T

Filter mud has significant fertilizer value but due to prohibitive cost of sludge disposal, it is dumped in open where it adversely affects the ambient environment. Conversion of industrial wastes in to beneficial vermicompost not only solves solid waste accumulation but also yield highly nutritive organic manure. Filter mud with cow dung were vermicompost by using the earthworm *Eudrilus eugeniae* in different temperature 23±1ºC, 26±1ºC and 29±1ºC. The earthworm growth, metabolism, reproduction and vermicomposting ability was high in TT_2 reactor. Hence, the present study concludes that the growth and reproduction in earthworm is high in filter mud-cow dung mixture, when the reactor is kept at 26±1ºC.

Keywords

Filter mud; *Eudrilus eugeniae;* vermiwash; vermicast; vermicompost.

Introduction

Eudrilus eugeniae is an epigeic earthworm of African origin. This worm has been used in monoculture or polyculture with other species of earthworm to produce vermicomposts, vermicast, vermiwash etc. To help the farmers to practice the culture of *E. eugeniae,* and the ideal ecological conditions that favors good growth, eco-physiological studies are to be made. For a good vermicomposting, growth and proliferative potential of earthworm must be high. These physiological parameters are influenced by ecological conditions. Environmental factors like temperature, moisture content, nature of substrate and nutrient content in vermibed plays a major role in influencing the growth and reproduction. Suthar (2010a) reported that the earthworm productivity was high when the temperature and vermibed characteristics were at optimum level. The reproduction pattern is directly related to the feed in the vermibed. Yadav and Garg, (2011) also confirmed the influence of vermibed substrate on reproduction. The qualities of initial feed substrate determine the physico-chemical characteristics of vermicompost prepared.

Hait and Tare (2011) reported that

environmental conditions i.e. Temperature, (10-30^{0}C), Relative Humidity (50 - 90%) and stocking density (0-5kg /m^2) had profound effects on the biology of the earthworm *E. fetida.* It has been shown that earthworm reproduction and copulation frequency are greatly influenced by the temperature and moisture level (Hand, 1988).

Temperature affects the incubation period of cocoons (Bhattacharjee and Chaudhuri, 2002). Reinecke *et al*., (1992) reported a mean incubation period of 17.8 days and 15.3 days for cocoons of *P. excavatus*, incubated at 25^0 C and at 27^{0}C respectively. They further reiterated that temperature higher than 25^{0}C decreased the mean incubation period in the epigeic worm *E. eugeniae.* According to Holmstrup *et al*., (1991), the threshold temperature for hatching should be regarded as an adaptation to the particular habitat condition in which the species lives. Suthar (2008) reported that the quality of the substrate material used or fluctuating temperature are responsible for weight gain in *E. eugeniae.*

Hence, in the present study, the influence of temperature and vermibed substrate on reproductive physiology of *E.eugeniae* was studied.

Materials and Methods

Preparation of Vermibed

Filtermud was procured from a sugar mill, Dharani Sugars, Tirunelveli District. Fresh filtermud was kept in shade for 2-3 weeks before using for the eco-physiological studies. The partially degraded filtermud was then blended with saw dust as a bulking agent to increase the C/N ratio. To the blended filtermud, cow dung an organic nutrient was mixed (1:1V/V). The obtained vermibed mixture was used as the raw material for reproductive studies.

Cow Dung

Cow dung was commonly available in this region of Tirunelveli (Tamilnadu) , Urine free cow dung collected separately in quantities enough for experimental use were sundried and powdered.

The vermibed mixture was kept in a plastic container for 3 weeks for initial composting, thermal stabilization and initiation of microbial degradation and softening of waste mixture. The waste mixture in different bedding was turned out periodically (after 3 days) for aeration and to remove odour from decomposing wastes (Suthar, 2010b).

Experimental Setup

The experiments were conducted in triplicate in perforated cylindrical plastic containers of capacity 2L.The containers were kept in different temperature 23±1ºC, 26±1ºC and 29±1ºC.The moisture was kept constant 65±5%.

For experimentation 500g pre-conditioned filtermud with cow dung (dry weight basis) was filled in the container. Twenty *E.eugeniae* earthworms (4 weeks old) having individual live weight of ~ 270-297 mg were released into each experimental container. The experimental containers were kept in triplicate for each temperature treatment. For the present experiments the experimental bedding were kept in 3 different chambers, where the temperature were 23±1ºC, 26±1ºC and 29±1ºC. The temperature in the room was strictly maintained by using a thermostatical controller. The relative

humidity inside the chamber was 65±5%.

To find out the influence of temperature on reproductive activity, three different temperature regimes were maintained but other ecological conditions remained same. The earthworm mortality was observed for initial critical periods (initial 15 days of experimental starting) and data of mortality were recorded for different experimental temperature regime.

The biological characteristics like growth, clitellum development and cocoon production in worms after each treatment were recorded periodically for 9 weeks. The feed in the container was turned out, then earthworms and cocoons were separated from the bed by hand sorting, after which they were counted and weighed after washing with water. Then the earthworms and the feed (but not cocoons) were returned to their respective container. The earthworms were weighed with full gut (Yadav and Garg, 2011). At the end of the experiments the growth rate and cocoon production ability by *E.eugeniae* in different temperature were analyzed statistically.

Results and Discussion

The total number of earthworms recovered and their biomass after 8 weeks of vermicomposting in different temperature showed that temperature influenced the biomass gain in earthworm. (Table. 1) Earthworms are poikilothermic animals and the temperature influences the growth rate. The earthworm *E.eugeniae* attained the maximum biomass after the 7th week at the temperature 26±1°C but at 29±1°C the worms attained the maximum live weight after 8th weeks. Further the growth rate of a worm per day was 17.43±1.4 mg at 26±1°C whereas it was 9.8±1.5 mg and 12.49±1.1 mg at 23±1^{0}C and 29±1^{0}C temperature regime respectively. Growth rate (biomass gain worm per day) was in the order TT_2>TT_3>TT_1 in different treatments of temperature. Hence optimum temperature for growth of *E.eugeniae* was 26±1^{0}C. At the end of the experiment biomass of the worms were 2.63, 2.24, 2.38mg fold, higher than initial biomass in treatment TT_1, TT_2 and TT_3 respectively.

Table.2 describes the reproductive potential of *E.eugeniae* in different treatments; clitellum was developed up to 4th week in treatment (TT_2) and in 5th week in remaining treatments. Higher growth rate in TT_2 treatment may be due to more physiological activity in an optimum temperature. Further reduced growth rate at 23±1^{0}C and 29±1ºC indicates that the temperature at minimum and maximum inhibit temperature tolerance and leads to physiological or metabolic changes. Hait and Tare (2011) reported that temperature influences the biology of the earthworm by modifying metabolic activity.

Total number of cocoons produced by worms was also found influenced by temperature variation. The maximum cocoons were produced in treatment TT_2 (2024±44) and minimum was observed in TT_1 (1216±31).

The number of cocoons produced in treatment TT_2 was significantly different from other treatments ($P<0.05$). There was a decline in cocoon produced with low and high temperature regimes. The worm reproduction rate were (Number of cocoons produced per worm) 12.61±1, 8.34±0.5 and 9.74±0.5 in treatment TT_2, TT_1 and TT_3 respectively. The cocoon production by worms ceased in 8th and 9th week in treatment. The cocoon production/

Table.1 Growth of *E.eugeniae* in different temperature treatments (Mean±SD, n=6)

S. no	Temperature Regime ^{o}C	Mean initial biomass/ Earthworm (mg)	Maximum biomass achieved/ earthworm (mg)	Duration of maximum biomass achieved (week)	Net biomass gain/ earthworm (mg)	Growth rate worm /day (mg)
TT_1	23±1	270±3.4	817±11.3	8	547*	9.8±1.5
TT_2	26±1	297±4.1	1116±16.4	7	819*	17.43±1.4
TT_3	29±1	284±5.2	921±4.9	8	637*	12.49±1.1

(* Statistically significant P<0.05)

Table.2 Fecundity of *E.eugeniae* in different Treatments (Mean±SD, n=6)

S.No	Treatment temperature $^{\circ}$C	Clitellum development started in (week)	Cocoon production started in (week)	Total No. of cocoons after (9 weeks)	Reproduction rate (cocoons/ worms)	Cocoon production ceased in (week)	No. of cocoon production/ worm (week)
TT_1	23±1	4^{th}	5^{th}	1216±31	8.34±0.5	9^{th}	0.9±0.05
TT_2	26±1	4^{th}	4^{th}	2024±44	12.61±1.0	8^{th}	1.45±0.07
TT_3	29±1	4^{th}	5^{th}	1527±26	9.74±0.5	9^{th}	1.0±0.05

/week was highest in TT_2 and it was significantly different from other treatments ($P<0.05$).

Dominguez and Edwards, (2004) reported that high temperature (above 30°C) promoted microbiological activity in the vermicomposting system, that tended to consume the available oxygen, and thus had negative effects on earthworm activity.

The difference in the reproductive characteristics of *E.eugeniae* at different temperature confirms that the worms need an optimum temperature in the vermibed to discharge their reproductive activities. The present study indicates that the temperature at a range 26±1ºC is an ideal temperature in the filter mud vermibeds-cow dung to activate metabolic activity and lead to maximum reproductive action. Further the organic supplement also induced a good growth in the worm. Hence, the present study concludes that the growth and reproduction in earthworm is high in filter mud-cow dung mixture, when the reactor is kept at 26±1ºC.

Vermicomposting was a waste management technique that promoted the conversion of organic waste into valuable product. Influence of temperature increased in biological characteristics like growth, clitellum development and cocoon production. The present study indicated that the temperature at the range 26±1ºC was an ideal temperature to activate metabolic activity and induces maximum reproduction action.

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