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Effect of Photoperiodism on Feeding and Defecation in Compost Earthworm *Eudrilus eugeniae*

Sunitha N. Seenappa

ECO-BELT R and D PVT. LTD., #232, Managanahalli, Hosur Post, Bidadi Hobli, Ramanagara District- 562190, Karnataka, India.

Corresponding author: drsunithanseenappa@gmail.com

Abstract:

The effects of different fixed photoperiodic regimes on the rate of feeding and defecation in the epigeic oligochaete (Eudrilus eugeniae) has been investigated. The different photoperiods stipulated were Natural 12hr Light: 12hr Dark (natural LD 12:12), Reversal of 12hr Light: 12hr Dark (reversal LD 12:12), 24hr Light source (L 24), 24hr Dark (D 24) and control set (natural rhythm) were experienced by E. eugeniae in the course of the study. The experiments were carried out during the ambient winter (26 degree C ± 2) and all clitellate worms showed varied feeding and defecation activities. Worms fed actively only during night times under natural LD 12: 12. when exposed to reversal LD 12:12 revealed acclimatization to the changed conditions of day and night by the end of 2nd week and started feeding voraciously. Worms that were maintained in D 24 showed enhanced feeding rate with increased biomass over the worms that were maintained in natural LD 12:12 and natural rhythm (control set). ANOVA and ANCOVA tests applied revealed that the total darkness or diffused light without any disturbance influenced the feeding rate of worms that in turn showed higher production of defecation as vermicompost. The critical difference (C.D.) of ANOVA was 0.98(0.05%) and the difference for testing among treatments in ANCOVA was 781191.15(0.05). Resynchronization pattern were seen when changed to reversal LD 12:12 from natural LD 12:12. Observations revealed that worms were confused from day 1-4 when any changed photoperiodic devices were fixed other than their regular normal pattern of Light and Dark cycle and later got acclimatization into the induced photoperiodic cycles. The study apart from proving the exogenous factors on the photoperiodic effects also proven the importance of darkness to the worms in defecation that has importance in the conversion of given substrate at a faster pase.

Keywords: Photoperiodic effect, feeding rate, *Eudrilus eugeniae*, synchronization and re-synchronization.

1.0 Introduction:

Chronobiology' understands a variety of biochemical, physiological and behavioural activities with some kind of fixed regularity in the living community giving an opportunity to investigate the phenomena existing behind the biological(internal) clocks (Dunlap et al, 2004; Foster and Kreitzman, 2004; Bunney and Bunney, web search; Cassone, 2005). Circadian rhythms can be changed by environmental factors such as light, temperature and seasons apart from the regular pattern of 24hrs Light-Dark cycle said to be dependant on entraining factor (Palmer, 2002). Evidences have proven that most of the rhythms are of endogenous in origin directed by the nervous system and controlled by genes however in the lower organisms like earthworms with their limited capacity of nervous system show differential behaviour towards external factors like light, availability of food, habitat and seasonal variations (Burns, 1991, 1992;Young, 2005; Chuang and Cheng, 2008). Compost earthworms *Eudrilus eugeniae* are an important tool in the degradation and conversion of animal wastes into stabilized vermicompost (Lee, 1985). Vermicomposted cattle dung is in great demand in the Nurseries to reduce the cost of red soil and to avoid the soil borne diseases. In the present investigation, an attempt has been made to study the varied photoperiodic effect as an external factor on feeding and defecation of the worms and the better influencial option as a selective tool of photoperiodism that would enhance the production of their excreta as vermicompost for its value added manorial facts.

Photoperiodic effect on feeding rate of *Eudrilus eugeniae* was studied under laboratory conditions.

Under normal circumstances, it was observed that the compost earthworms feeding and defecating was observed during night on procurement of vermicompost on day-to-day basis. The effect of darkness assumed to have an influential role on the feeding activities and the effect of continuous light also assumed to have impact on feeding activities. Further altering the regular pattern of day and night cycle and their consequent effect was felt a necessity to understand the compost worms in terms of their productions of vermicompost. Thus in the present research an alternation of day and night cycle (reversal LD) was presented to observe the impairment and its duration further to study the acclimatization of the changed and altered photoperiodic effects on the defecation in the presence of cattle dung as feed additive and by use of clitellate worms during the ideal conditions of winter season.

2.0 Materials and Method:

2.1 Worm Maintenance and Experimental Boxes:

Adult clitellate Eudrilus eugeniae of 6-7 weeks old (Fig: 1) were collected from the culture room maintained under semi-natural conditions and were introduced into 15 plastic boxes at the rate of 6worms/box of dimension 15.0cm diameter with a depth of 7.5cm of aerated lids (Fig: 2). Ad libitum natural feed of partially-aerobically decomposed cattled dung of 3 weeks old (Fig: 3) was served as feed source.

2.2 Experimental Set Up:

Experiments were conducted in 5 sets of 3 replicates for 2 weeks depending on the presence/absence of light source provided and were labeled in the following way : –

(a) Natural 12hr Light: 12hr Dark cycle,
(b) Reversal of 12hr Light: 12hr Dark cycle,
(c) Continuous Light source (24hrs),
(d) Continuous Dark source (24hrs) and
(e) Control set (natural rhythm of day and night).

2.3 Light Source:

Sunlight during the day and fluorescent light at night to the sets when light source was needed depending on the experimental sets. To maintain total darkness the boxes were kept in the wooden case covered with black paper and were placed in the dark room.

2.4 Worm Biomass and Defecation Collection:

Weight of 6 worms in all the sets with replicates were recorded independently before to the start of the experiment and after the completion of the experiment. Earthworms Eudrilus eugeniae being surface casters, the defecated vermicompost was collected by drawing to the sides of the boxes with the help of a brush and the cast was then oven dried. In case of experimental sets (a) and (b) the vermicompost was collected once in every 12hrs and in the sets (c) , (d) and (e) at the completion of the experiment.

2.5 Experimental Design:

To analyse the data 2types of statistical analyses were employed: ANOVA (Analysis of Variance at 5% level) to the experimental sets of (a) and (b); and ANCOVA (Analysis of Covariance at 5% level) to the sets of (c), (d) and (e).

3.0 Results and Discussion:

The ecological values of biological rhythms i.e., ultradian, circadian and infradian seem to have adaptive significance in the living organisms. The meal timings in animals, life-span, synchronized life pattern of prey-predator relationships, feeding activity in bees, butterflies and humming birds have synchronization with the rhythm of flower opening and sunlight. All circadian rhythms are considered to be endogenous rhythms but sometimes under certain conditions their period of activity, amplitude, peak can be changed by environmental factors such as light, temperature and seasons. Circadian rhythms are the internal time keeping mechanism of periodic cycles of behaviour exhibited approximately every 24hrs in the living organisms. Entrainment and synchronization set in due to the environmental factors like temperature and/or light-dark cycles. Lower organisms like earthworms are the exciting tool for the study of photoperiodism. Last and Olive (1999) have recorded in Polychaete worms the photoperiodism control on growth as well as segment proliferation in relation to seasonal adaptations and the state of maturity. Earthworms are known to be the nocturanal animals hence their metabolic rate follow the day and night rhythm. In the present investigation, worms fed actively only during night times under natural 12hr Light : 12hr Dark cycle. When exposed to reverse of 12hr Light : 12hr Dark cycle revealed acclimatization to the changed conditions of day and night by the end of

2nd week and started feeding voraciously during artificial of night condition. Worms that were maintained for a week under total darkness without any disturbances, showed enhanced feeding rate with increased biomass over the worms that were maintained in control sets of natural 12hr Light : 12hr Dark cycle.

Table1: ANOVA Test for the results

Source of Variation	df	MSS
Between days	6	15.87*
Between treatments	5	389.13*
Between days x treatments	30	10.63*
Error	126	1.07
Total	167	--

(a) Days: CD = 0.4075

	D1	D2	D3	D4	D5	D6	D7
$\bar{X}$ =	1.106	1.57	0.96	1.35	1.88	1.92	2.23

(b) Treatments: CD = 0.3772

	T1	T2	T3	T4	T5	T6
$\bar{X}$ =	3.52	9.98	0.26	0.44	0.61	1.92

(c) Interaction: CD = 0.9982

Table 2: ANCOVA Test for the results

Source of variation	d.f.	Sum of squares and products			Deviations about regression	d.f.
		X2	XY2	Y2	$Y2 - \frac{(XY2)}{X2}$	---
Among treatments	(3 – 2) = 2	3.11	1.67	8.58	---	---
Error	(24 – 3) = 21	2.77	0.05	2.43	2.4291	20
Total	22	6.51	1.72	11.01	10.56	21
Difference for testing among treatment means					781191.15	1

Fig 1: Compost earthworm *Eudrilus eugeniae*

Fig 2: A view of the experimental boxes used

Fig 3: Cattle dung (of partially decomposed) of 3 weeks old

Observations revealed that worms were confused from day 1-4 when any changed photoperiodic devices were fixed other than their regular normal pattern of Light and Dark cycle and later got acclimatization into the induced photoperiodic cycles. The study apart from proving the exogenous factors on the photoperiodic effects also proven the importance of darkness to the worms in defecation that has importance in the conversion of given substrate at a faster pase. Using ANOVA(Table: 1) and ANCOVA(Table:2) it has been shown that the exposure to total darkness has a positive effect on the feeding activity and that has enhanced the worm biomass and vermicompost production. When the synchronized 12hr Light : 12hr Dark cycle was changed to reverse of 12hr Light : 12hr Dark cycle, there was resynchronization of the feeding pattern to induced light. This was very well noted in the tests conducted on feeding rate by changing the day and night artificially. It was observed that the worms were confused from Day 1 to Day 4 and later got stabilized in their feeding activity. The mean values between treatments shows a gradual increase relating to the gradual acclimation to the changed conditions; but, in the given time of 2 weeks, worms failed to reach to the level of natural 12hr Light : 12hr Dark cycle.

The enhanced feeding rate during the period of total darkness and drastic reduction in the feed consumption on changing the day and night pattern on the worms exposed to normal 12hr Light : 12hr Dark cycle has shown dependency of activity of worms on this exogenous factor. Based on this information it is possible to improve their rate of feeding and defecation which will enhance the rate of conversion of partially-aerobically decomposed biological wastes to abate organic pollution and in the production of organic vermifertilizer for arable soils.

4.0 Conclusion:

Compared to synchronized 12hr Light : 12hr Dark cycle and reverse 12hr Light : 12hr Dark, the worms showed feeding and defecation with increased biomass in continuous 24hrs Dark. The synchrony of the experimental sets of Natural 12hr Light: 12hr Dark (natural LD 12:12), Reversal of 12hr Light: 12hr Dark (reversal LD 12:12), 24hr Light source (L 24) and 24hr Dark (D 24) were acclimatized by the end of 2nd week proving the worms external influence and change in the internal circadian rhythm accordingly from the biological point. From the point of commercial value of compost earthworm utilization for the stabilization and conversion of bulky biological wastes into vermicompost, it may be advisable to maintain a 24hr Dark (D24) or partial, diffused light during the day for maximization of feeding, increased worm biomass and high rate of vermicompost productions.

5.0 Acknowledgement:

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