

Growth And Reproduction Of Earthworm, *Lampito Mauritii* In Flyash: A Lignite Waste

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Abstract

Fly ash is an important solid waste around thermal power plants. It creates problems leading to environmental degradation due to improper utilization or disposal. To reduce the cost of disposal of flyash and best utilization, it was planned to convert the flyash into valuable vermin compost. This study explored the potential role of indigenous earthworm *Lampito mauritii* to convert the flyash into best manure. The different combination of flyash mixed with jackfruit leaf litter and cow dung they are C – Control, T₁ (FA + JLI + CD) 2:4:4, T₂ (FA + JLI + CD) 3:3.5:3.5, T₃ (FA + JLI + CD) 4:3:3, T₄ (FA + JLI + CD) 5:2.5:2.5, T₅ (FA + JLI + CD) 6:2:2. Among this treatment the T₂ showed the best result in which higher N, P, K and lower organic carbon were observed.

Keywords: Vermi compost, *Lampito mauritii*, Flyash, Growth, Reproduction.

Introduction

The earthworms are useful to people in various ways: for farmers as a friend and benefactor for vermicompost producers, as an organic waste decomposer, for environmentalist as a pollution preventer, for toxicologist as a biological indicator of pollution, for geologist to identify soil types, for biologist as a hermaphrodite annelid, for soil scientist as a soil fertility conserver, for the agronomist as a plant productivity restorer, for biochemist as an invertebrate with a high content of protein, for ecologist as an animal with cosmopolitan distribution, for aborigines as feed and medicine and for poultry breeder and aqua culturist as a source of food for chicken and fishes.

Lampito mauritii is an Indian anecic worm used extensively for the management of organic wastes. Dash and Senapathi, (1980) studied the morphology of cocoons and the effect of soil moisture and temperature on the hatchling process and emergence pattern of juveniles

of *L. mauritii* in the field. *L. mauritii* was chosen as an indicator species in India because of its wide spread occurrence in aerable and pasture lands and its consequent vulnerability to surface applied pesticides, making it an ideal candidate for assessment of agroecosystem contamination (Kavitha *et al.*, 2008).

Fly ash, a resultant of combustion of coal at high temperature, has been regarded as a problematic solid waste all over the world. Fly ash consists of many small, glass-like particles ranging in size from 0.01 - 100 µm (Davison *et al.*, 1974). In the thermal power station of the Neyveli Lignite Corporation Ltd., ash pond spreads over an area of more than 45 ha and causes serious environmental hazards besides occupying fertile, cultivable land (Senthilkumar *et al.*, 2001). Fly ash is a serious source of air pollution since it remains air borne for a long period of time and causes health hazards (TERI, 1998). Besides being a health hazard, fly ash also degrades the environment. The coal combustion product generated each year in India is more than 100 million ton (Jamwal, 2003) of which 4 million ton is released into the atmosphere. The disposal of such a huge amount and is usually disposed in basins or land fills near the power plants.

In the study of Vijayakumar and Narayanaswamy (2001) have applied 40 kg of fly ash/ha and they reported 100% survival of earthworms in FA application. Bhattacharya and Chattopadhyay (2001) observed that the growth of earthworms in cow dung and fly ash mixture. Ananthakrishnasamy (2004) has reported the survival of earthworms in three different ratios of CD + FA mixtures. The reproduction, zoo mass and vermicast recovery of *E. fetida* in different combinations of FA+ CD were reported by Gupta *et al.*, (2005). More recently Sarojini *et al.*, (2009) analysed the growth and reproduction of *Eisenia fetida* during vermicomposting fly ash with bedding material.

In the present study, an attempt has been made to find out the possibility of utilization of fly ash for vermiculture and to study the influence of fly ash in combination with jackfruit leaf litter and cow dung as organic waste degradation on the growth and reproduction of *L. mauritii*. Further, it is also aimed to determine the best combination that could support the maximum growth, cocoon production and hatchlings production of *L. mauritii* during the period of study.

Materials and Methods

Collection and maintenance of *L. mauritii*

L. mauritii were obtained from stock culture maintained in the Department of Zoology, Annamalai University. The worms were stocked in Plastic containers and cow dung with clay loam soil was used as substrate to maintain the earthworms. Moisture content of 60-70% was continuously maintained by sprinkling water and covered with nylon mesh.

Collection of fly ash

Fly ash was collected from thermal power station-I, Neyveli Lignite Corporation, Neyveli, Tamilnadu.

Collection of Leaf litters

At present cashew leaf litter and jackfruit leaf litter were collected from villages surrounding Neyveli, Tamil Nadu and stored in jute bags.

Collection of cow dung

The urine and straw free cow dung was collected from dairy yard at the Faculty of Agriculture, Annamalai University. It was sun dried, powdered and stored in jute bags.

Experimental media and inoculation of worms

The flyash mixed with JLI and cowdung in 5 different combinations were prepared in the following manner.

Treatments	Proportions	Weight (g)
C-Control	CD	1000g
T1-FA+JLI+CD	2:4:4	200+400+400
T2-FA+JLI+CD	3:3.5:3.5	300+350+350
T3-FA+JLI+CD	4:3:3	400+300+300
T4-FA+JLI+CD	5:2.5:2.5	500+250+250
T5-FA+JLI+CD	6:2:2	600+200+200

15.0 grams of clitellate *L. mauritii* worms were introduced in plastic troughs. The plastic troughs were covered with nylon mesh and maintained at room temperature $27 \pm 2^{\circ}\text{C}$

with 60-70% moisture. The feed mixtures were sprinkled with water as and when required (For each treatment six replicates were maintained).

Growth and Reproduction of *L. mauritii*

Earthworms growth (biomass) and reproduction (cocoon and hatchling number) were recorded upto 90 days with 15 days interval like 15, 30, 45, 60, 75 and 90 days. Every time cocoons and hatchlings were counted by hand sorting and the biomass of worms weighed using electronic balance and recorded.

Statistical analysis

Earthworm mean biomass, reproduction, standard deviation (SD), percent increase or decrease (biomass) over initial values were calculated. Further, the data were analyzed statistically (significance of difference of 0.05 level) by using two way analysis of variance, (ANOVA).

Results and Discussion

The data on the growth (Biomass) and reproduction (Cocoons and hatchlings production) of earthworm *L. mauritii* cultured in fly ash mixed with JLI leaf litters and cow dung for a period of 90 days are presented in Tables 1-3. The role of FA with JLI and CD on the biomass (gram) of *L. mauritii* are presented in Table 1. The total worm biomass significantly increased ($p < 0.05$) from 0 day to 90th day in control and in all treatments, but the rate of biomass production decreased after 60th day (ie. 75th and 90th day). The highest rate of biomass production was found maximum in T₂ (i.e. 76.62 percentage increased over the initial on 60th day). The efficiency of treatments support the biomass of *L. mauritii* were found to be ranked in the following order, T₂ (20.1±1.87) > T₁ (19.8±1.59) > C (19.6±1.54) > T₃ (18.0±1.31) > T₄ (16.3 ±1.92) > T₅ (15.2±1.36) on 90th day.

Table 1. Role of fly ash with jackfruit leaf litter – cow dung on the biomass (gram) of *L. mauritii* ($p < 0.05$)

Substrate proportions	Vermicomposting days						
	0	15	30	45	60	75	90
C	15.09±1.38	17.4±1.09 (15.30)	19.9±1.35 (31.87)	22.4±1.24 (48.44)	24.6±1.51 (63.02)	21.2±1.22 (40.49)	19.6±1.54 (29.88)
T ₁	15.04±1.07	17.8±1.18 (18.35)	20.5±1.71 (36.30)	23.8±1.75 (58.24)	25.5±1.46 (69.54)	21.8±1.23 (44.94)	19.8±1.59 (31.64)
T ₂	15.06±1.08	18.2±1.39 (20.84)	21.1±1.08 (40.10)	24.8±1.76 (64.67)	26.6±1.53 (76.62)	22.0±1.29 (46.08)	20.1±1.87 (33.46)
T ₃	15.0±1.10	16.1±1.32 (7.33)	17.6±1.65 (17.33)	19.0±1.59 (26.66)	20.3±1.46 (35.33)	18.8±1.37 (25.33)	18.0±1.31 (20.0)
T ₄	15.02±1.45	15.8±1.08 (5.19)	16.3±1.92 (8.52)	17.6±1.72 (17.17)	18.5±1.42 (23.16)	17.7±1.81 (17.84)	16.3±1.92 (8.52)
T ₅	15.05±1.36	15.2±1.28 (0.99)	15.7±1.73 (4.31)	16.1±1.86 (6.97)	16.8±1.16 (11.62)	16.3±1.92 (8.30)	15.2±1.36 (0.99)
ANOVA							
Analysis of variance		Sum of square		Mean of square		F-value	
Rows		171.2093		34.24186		18.1209	
Columns		199.5409		33.25682		17.59962	

C – Control, T₁ (FA + JLI + CD) - 2:4:4, T₂ (FA + JLI + CD) - 3:3.5:3.5, T₃ (FA + JLI + CD) - 4:3:3, T₄ (FA + JLI + CD) - 5:2.5:2.5, T₅ (FA + JLI + CD) -6:2:2

Initial (0) – Worm unworked substrates, Mean± SD of six observations, () – percentage increase over the initial

Table 2. Role of fly ash with jackfruit leaf litter – cow dung on the cocoon production (number) of *L.mauritii* ($p < 0.05$)

Substrate proportions	Vermicomposting days							Total
	0	15	30	45	60	75	90	
C	-	9.0±1.41	10.4±1.27	17.6±1.46	22.1±1.13	19.5±1.84	16.3±1.33	94.9±1.90
T ₁	-	9.3±1.67	11.1±1.69	18.8±2.49	23.3±1.97	19.6±1.97	17.1±1.57	99.2± 0.50
T ₂	-	9.6±1.68	12.5±1.70	19.3±1.18	24.8±2.11	20.1±1.57	19.8±2.40	106.1±1.28
T ₃	-	7.2±1.57	8.1±1.58	10.2±1.95	13.8±2.16	11.3±1.69	6.8±1.34	57.4±1.95
T ₄	-	-	1.6±0.74	5.1±2.03	7.2±1.69	6.6±1.49	-	20.5±1.70
T ₅	-	-	-	1.0±0.0	2.1±1.06	-	-	3.1±1.34

ANOVA			
Analysis of variance	Sum of square	Mean of square	F-value
Rows	5487.113	1097.423	5.624245
Columns	14811.16	2468.527	12.6511

C – Control, T₁ (FA + JLI + CD) - 2:4:4, T₂ (FA + JLI + CD) - 3:3.5:3.5, T₃ (FA + JLI + CD) - 4:3:3, T₄ (FA + JLI + CD) - 5:2.5:2.5, T₅ (FA + JLI + CD) -6:2:2

Initial (0) – Worm unworked substrates, Mean± SD of six observations, () – percentage increase over the initial

Table 3. Role of fly ash with jackfruit leaf litter – cow dung on the hatchlings production (number) of *L.mauritii* (p < 0.05)

Substrate proportions	Vermicomposting days							Total
	0	15	30	45	60	75	90	
C	-	-	16.2±1.36	17.3±1.31	24.1±1.48	33.1±1.75	30.2±1.17	110.9±1.67
T ₁	-	-	17.1±1.77	21.3±1.97	26.9±2.11	31.6±0.63	29.8±0.96	126.7±1.17
T ₂	-	-	18.4±1.49	23.2±2.11	29.1±1.86	33.5±2.21	32.4±1.77	136.6±1.71
T ₃	-	-	10.0±1.29	14.8±1.88	19.4±1.97	20.2±1.69	16.1±1.95	80.5±1.72
T ₄	-	-	2.1±1.46	4.6±1.97	9.5±1.70	14.2±1.95	1.1±0.37	31.5±1.70
T ₅	-	-	-	-	1.1±0.37	5.8±2.11	-	6.9±2.16
ANOVA								
Analysis of variance	Sum of square		Mean of square		F-value			
Rows	7157.384		1431.477		5.022437			
Columns	28841.4		4120.2		14.45601			

C – Control, T₁ (FA + JLI + CD) - 2:4:4, T₂ (FA + JLI + CD) - 3:3.5:3.5, T₃ (FA + JLI + CD) - 4:3:3, T₄ (FA + JLI + CD) - 5:2.5:2.5, T₅ (FA + JLI + CD) -6:2:2

Initial (0) – Worm unworked substrates, Mean± SD of six observations, () – percentage increase over the initial

The mean number of cocoon production varies in control (CD alone) and in treatments. The inoculated adult clitellate worms were started to produce cocoons at different days in different treatments similar to that of CLL. Among different FA mixtures, worms cultured in T₂ were observed to have increased number of cocoons (106.1±1.28) and it was followed by T₁ (99.2±0.50), C (94.9±1.90), T₃ (57.4±1.95), T₄ (20.5±1.70) and T₅ (3.1±1.34) respectively. The number of hatchlings observed in different FA mixture and control (CD alone) on 30th day onwards. Among the various mixtures, more hatchlings were obtained in the T₂ (i.e. 136.6±1.71 total number). The efficiency of different treatments to support the hatchlings production could be ranked in the following order T₂ (136.6±1.71) > T₁ (126.7±1.17) > C (110.9±1.67) > T₃ (80.5±1.72) > T₄ (31.5±1.70) > T₅ (6.9±2.16) respectively.

The maximum growth, cocoon and hatchlings of earthworms were found in the 3:3.5:3.5 FA mixtures of both leaf litters. The growth and reproduction of earthworms are highly influenced by the quality and availability of feed, various physicochemical parameters, etc. (Reinecke and Hallatt, 1989). The feed which provide earthworms with sufficient amount of easily metabolizable organic matter and non assimilated carbohydrates favour the growth and reproduction in earthworms (Edwards and Fletcher, 1988; Anandhakrishnasamy *et al.*, 2007). Growth and reproduction of earthworms require OC, N, P and cellulose which are obtained from litter, grit and microbes (Parthasarathi and Ranganathan, 2000; Pramanik *et al.*, 2006).

Karmegam and Daniel (2000) have reported elevated biomass and increased number of cocoons in *E. fetida* when they fed with *G. maculate* leaf litter + CD mixture than the other varieties of leaf litter + CD mixture. The best results could due to the palatability, fine texture and higher content of nitrogen in the substrate. Garcia and Fragosa (2003) have observed a higher growth of earthworm *P. coretherus* in the saw waste and fresh leaves (mixture) which had higher N content than the other food varieties. Manimegala *et al.* (2008) in *E. fetida* observed highest growth and they added in leguminous leaf litter it could be due to higher N content. In the FA mixtures effectively supported the growth and reproduction of *L. mauritii*. From various treatments and control in the leaf litter mixtures, the T₂ mixture showed highest growth and reproduction. This clearly revealed that the biochemical environment in these beddings were more acceptable than other treatments.

Falling in line with the present study Sarojini *et al.* (2009) have indicated that the highest growth and reproduction of *E. fetida* in BM alone and 10% FA mixture with bedding material seems to be the better combinations than 20, 30, 40 and 50% FA. Manimegala *et al.* (2009) stated the highest growth and reproduction of *L. mauritii* were observed in T₂ (3:3.5:3.5) FA mixture with cashew leaf litter and CD than the other mixtures. This could be due to contribution of more quantities of nutrients and addition of more quantity of bedding materials. Dharani *et al.* (2010) supports the usefulness of earthworm species *E. eugeniae* for efficient vermicomposting of fly ash and also *E. eugeniae* showed good biomass gain. The growth and reproduction of *L. mauritii* and *P. excavatus* in the vermicompost 1:1:1 ratio of poultry waste + cowdung + pressmud was the optimum waste mixture reported by Meharaj and Manivannan (2015). Chaulagain *et al.* (2017) reported that cowdung mixed with sawdust and cowdung mixed with leaf litter, both are recommended as suitable feeding material for rearing *E. foetida* and producing vermicompost.

Conclusion

Burned lignite flyash waste from thermal power plants are invariably used as soil amendment in farmlands for agriculture as it is rich in nitrogen (N) and other plant nutrients. It is also disposed in landfills. Vermicomposting of flyash results in a change in its hazardous and toxic nature, earthworms leave the capacity to 'detoxify' and 'disinfect' hazardous materials.

ACKNOWLEDGEMENT

The authors are thankful to the Head, Department of Zoology and authorities of Annamalai University for providing laboratory facilities.

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