

## Optimum weather conditions for efficient vermicomposting of coconut leaves by *Eudrilus* sp. in coastal tract of Kerala

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### Abstract

Production of vermicompost from coconut leaves by earthworm as well as harvesting of earthworm biomass for further use have been developed by the Central Plantation Crops Research Institute (CPCRI) as one of the important alternate uses of coconut leaves. The vermicomposting by *Eudrilus* sp. normally takes three months for completion and is carried out throughout the year in cement tanks. A study was undertaken during 2002 – 2004 to record the influence of prevailing weather conditions on the efficiency of coconut leaf vermicomposting in the coastal tract of Kerala. It was observed that vermicompost turnover, *Eudrilus* number and worm biomass harvested were negatively correlated to atmospheric temperature (-0.87, -0.74, -0.74 respectively, N=8) and positively to relative humidity (0.89, 0.79, 0.79 respectively). Rainfall, though did not have a direct correlation, softened the leaf tissues, which improved the vermicomposting efficiency. The optimum weather conditions for efficient vermicomposting of coconut leaves was observed to be 28 – 32 °C temperature (max.) and relative humidity (forenoon) of the range 90 – 95 %. Increase in temperature above 32 °C combined with fall in relative humidity below 90% reduced the efficiency of the process. The favourable weather conditions for effective vermicomposting coincided with the monsoon and post-monsoon periods (June to Aug. and Sept. to Nov.) and the adverse conditions were summer and pre-monsoon periods (Dec. to Feb. and March to May). The income from the sale of earthworms and compost, for a farmer, was estimated to be high (approximately Rs. 6,572/- per unit area) during the conducive weather circumstances when compared to the unfavourable situation (Rs. 3,685/- per unit area).

**Key words:** Coconut leaves, *Eudrilus* sp., weather, vermicomposting

### Introduction

Production of vermicompost by earthworms and harvesting of earthworm biomass has gained importance in recent times as a gainful method of recycling of farm and urban wastes (Graff, 1982; Edwards *et al.*, 1985; Amoji *et al.*, 1998). The vermicompost thus produced is used as a low external organic input for improving soil health and fertility and enhancing crop production (Lee, 1985). The earthworms produced are used for further composting of farm wastes. A coconut garden of one ha area with 175-200 palms generates about 6-8 tons of leaf biomass waste annually. Vermicomposting of coconut leaf waste by a native strain of an epigeic earthworm, *Eudrilus* sp., has been standardized at CPCRI (Prabhu *et al.*, 1998) and extensively adopted by many coconut farmers in southern states of India. The

vermicomposting of coconut leaves can be carried out throughout the year in cement tanks, pits in ground and by heaping on ground.

Earthworms, like all life forms, require particular environmental parameters within which they flourish and do efficient conversion of substrates to vermicompost. But there is paucity of information on the vermicomposting efficiency of agro wastes by *Eudrilus* sp. in tropical and subtropical conditions (Kale *et al.*, 1982). The Central Plantation Crops Research Institute (CPCRI) is situated in Kasaragod District (Northern part of Kerala State) and has a coastal tropical climate. The present study is an attempt to record the influence of the prevailing climatic conditions of Kasaragod on the vermicomposting of coconut leaves in cement tanks and predict the optimum weather conditions for efficient

composting and higher production of earthworms.

### Materials and Methods

Large scale vermicomposting of coconut leaves was done in cement tanks of 7.5 x 2.5 x 1 metre dimensions (l x b x h) located in CPCRI (12° 30' North Latitude, 75° E Longitude and 10 metres above MSL; approximately 250 metres away from the Western Sea Coast (Arabian Sea). The tanks had slanting roof made of thatched coconut leaves which prevented sunlight and rainwater falling directly inside them.

The process of production of vermicompost and earthworms from coconut leaves in cement tanks involved three stages :

(i) **Preliminary decomposition** : In this first stage, senescent and fallen coconut leaves were collected from the Institute farm and heaped inside the tank with abaxial surface up, to about 30 cm height. A layer of fresh cow-dung slurry (25-30 kg) was spread uniformly over the stacked coconut leaves. Three such layers (coconut leaves + cow dung slurry) were accommodated in the tank. Approximately 1000 kg of coconut leaves were put inside the tank and 100 kg of fresh cow dung slurry was spread. Water was sprinkled regularly to keep the substrate at 50-60 % moisture. The surface was mulched with grass or coconut leaves to prevent moisture loss. The whole material was allowed to undergo preliminary decomposition for two to three weeks period.

(ii) **Vermicomposting** : After the initial decomposition of the substrate, 1000 numbers of *Eudrilus* sp. were introduced into the tank for vermicomposting. Water was sprinkled frequently to keep the moisture at 50 – 60 % level. The earthworms converted the partially degraded material to matured compost in 60 – 75 days time.

(iii) **Harvesting of matured compost and earthworms** : Watering was stopped 10 to 15 days prior to harvesting. The undegraded material (coconut leaf petioles and midribs) were removed from the tanks. The matured vermicompost was heaped in the centre. The earthworms were sorted by hand, counted and separated. The amount of vermicompost produced was assessed based on the volume of undegraded material removed and matured compost heaped in the tank.

The vermicomposting of coconut leaves was carried out in three to four tanks, at least thrice, during 2002 to 2004 throughout the year, covering all the prevailing weather conditions.

**Weather data** : The weather data viz. maximum

and minimum temperature, forenoon and afternoon relative humidity and precipitation were taken from the Meteorological Unit attached to CPCRI.

**Statistical analysis** : The efficiency of vermicomposting of coconut leaves and the influence of weather factors on this process was statistically analyzed by standard procedures and the correlation coefficients between vermicomposting yield components and weather factors were worked out.

### Results and Discussion

The results of the vermicomposting of coconut leaves during the different periods are given in Table 1 in terms of mature compost produced, earthworm numbers and biomass harvested. The earthworm biomass was calculated by multiplying the total number of earthworms with 1.8 g, the value being the average weight of a fully grown earthworm. The weather parameters during the corresponding periods are given in Table 2.

Table 1. Turnover of mature vermicompost, earthworm numbers and biomass from coconut leaves (average of the experiments conducted at least 2 times during 2002-2004 with 4 replicates each time)

Year	Months	Compost Produced (kg)	Earthworms harvested (Numbers)	Wormbiomass (kg)
2002-	March — May	557.00	727.00	1.30
2004	June — August	710.00	5017.00	9.00
	Sept — Nov	657.00	5143.00	9.26
	Dec-Feb	620.00	1300.00	2.36

Table 2. Weather parameters corresponding to the vermifarming period during 2002-2004 (average readings)

Year	Month	Temp (°C)		Humidity (%)		Rain fall(mm)
		Min	Max	F/N	A/N	
2002-	March — May	24.5	33.2	85.4	65.2	145.6
2004	June — August	23.2	29.3	93.3	84.5	782.1
	Sept — Nov	22.9	31.3	92.0	71.0	215.4
	Dec- Feb	19.5	32.5	87.3	53.0	12.7

F/N : Forenoon ; A/N : Afternoon

When the correlation among the vermicomposting components and weather parameters are worked out, it is clearly observed that mature vermicompost produced, earthworm number and biomass harvested is significantly correlated to atmospheric temperature and relative humidity (Table 3). Temperature (max) negatively influences the production of compost (-0.87), earthworm numbers (-0.74) and its biomass (-0.74) while relative humidity is positively correlated to compost produced (0.89), earthworm numbers (0.79) and its

biomass (0.79). Rainfall did not show any connection to these factors. Lavelle (1983) reported that the structure of earthworm community is mainly determined by temperature and it is the moisture in the growing habitat that significantly controls the reproduction and activity of the vermicomposting earthworms (Reinecke and Venter, 1995).

In the large scale coconut leaf vermicomposting, the moisture in the cement tanks is maintained approximately at 50–60% of the substrate volume by watering. The temperature inside the tank was recorded to be 2–4 °C above the outside environment temperature. This difference remained more or less constant during different weather conditions. However, from this study, it appears that despite this, the atmospheric temperature and relative humidity significantly influences the earthworm activity.

The tables 1 and 2 indicate that during the periods when temperature (max.) is in 28 – 32 °C range and forenoon humidity is above 90 % which coincide with monsoon (June – Aug) and post monsoon season (Sept–Nov.) in the Western Coastal tract, the *Eudrilus* sp. is capable of multiplying to higher numbers and convert larger volumes of substrate to mature compost. The microenvironment in the cement tanks is congenial for the earthworm activity, which results in 60 – 75% mature vermicompost production. The earthworm number also increases substantially (>4-5 times the initial population) leading to higher earthworm biomass production (9 to 10 kg) because of the favourable weather conditions.

However, when the temperature (max.) goes above 32 °C and relative humidity falls below 90 % during the summer (Dec- Feb) and pre-monsoon seasons (Apr-May), it possibly creates unfavourable temperature and moisture conditions within the cement tank, resulting in lowered earthworm multiplication and lesser mature compost production. This situation occurs despite the increased frequency of watering to maintain moisture above 50 % during the summer months.

Efficient activity, reproduction and multiplication of *Eudrilus eugeniae* has been reported during the lower temperature and higher relative humidity season (Amoji *et al.*, 1999). They have suggested that in order to use *E. eugeniae* efficiently for vermifarming of farm and solid wastes, monsoon months in semi arid regions (Gulbarga) of Karnataka appears to be most congenial for *E. eugeniae*, when mean range of temperature and RH were 25.9 to 27.7 °C and 65.6 to 84.3 % respectively, followed by winter. Their work also suggests that summer is not suitable, since there would be high and wide range of

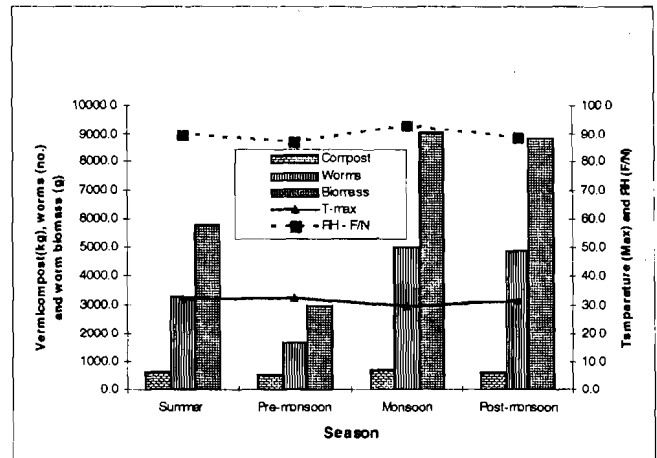


Fig. 1. Influence of different seasons on Vermicompost produced, *Eudrilus* numbers and biomass harvested

Summer : December to February

Pre-monsoon : March to May

Monsoon : June to August

Post Monsoon : September to November

temperatures (26.9 to 35.4) and low and high fluctuating relative humidity (29.1 – 76.8 %). Though the Western Coastal areas of Kerala do not experience winter season *per se*, the weather parameters during the monsoon and post-monsoon periods are comparable to the winter in the hinterland of Southern States, and our observation of better *Eudrilus* activity corroborates this observation. This *Eudrilus* sp. is a native strain, isolated from CPCRI Farm. From our studies, we can predict that it performs very well at 28 to 32 °C temperature range and at relative humidity higher than 90 %. The increase in temperature above 32 °C and reduction of relative humidity below 90 % drastically affects the performance of the *Eudrilus* sp. in vermicomposting of coconut leaves (Fig.1). Additionally, higher temperature inhibits the maturity of the earthworms, which in turn, prevents cocoon production resulting in no reproduction and multiplication of the worms (Viljoen and Reinecke, 1989).

Careful perusal of weather data reveals that at the time of introduction of earthworms in the cement tank during the summer/pre-monsoon months, the temperature (maximum) is above 33 °C, which is 3 – 5 °C above the optimum activity temperature range of the worms. We observed that the temperature inside the cement tank touched 35 to 38 °C during this period. The high temperature coupled with low relative humidity could be producing a heat shock to the worms, curbing their maturity, cocoon production and reducing composting activity.

Though, through this study, it is understood that rainfall does not have any direct role to play, there are

Table 3. Correlation of vermifarming parameters with weather factors (N = 8)

Vermifarming (1,2,3)/ Weather Parameters (4,5,6,7,8)	1 Compost produced (Kg)	2 Earthworms harvested(nos.)	3 Worm biomass (Kg)	4 Temp. (Min.)	5 Temp. (Max.)	6 Humidity (F/N)	7 Humidity (A/N)	8 Rainfall (mm)
Compost produced(kg)		0.9098*	0.9103*	- 0.3358	- 0.8707*	0.8903*	0.5346	0.1380
Earthworms harvested(nos.)			1.0000*	- 0.2756	- 0.7421 <sup>j%</sup>	0.7962 <sup>j%</sup>	0.4870	0.0664
Worm biomass(Kg)				- 0.2761	- 0.7423 <sup>j%</sup>	0.7962 <sup>j%</sup>	0.4867	0.0660
Temp. (Min.) (°C)					0.1166	- 0.4578	0.4008	0.6158
Temp. (Max.) (°C)						- 0.8705*	- 0.8369*	- 0.5399
Humidity (F/N)							0.5415	0.1985
Humidity (A/N)								0.8578*
Rainfall (mm) †								

\* Significant at 1%    <sup>j%</sup> Significant at 5%

certain indirect actions that can influence the efficiency of vermicomposting of coconut leaves. The foremost is that the relative humidity and temperature in atmosphere is correlated to rainfall (Table 3), and these two factors are the important weather parameters that affect vermicomposting process. Secondly, rainfall activates the microbial decomposition of leaves that have fallen on the ground enhancing the preliminary decomposition process in cement tanks. At the stage when earthworms are introduced, the substrate may have undergone sufficient softening for the worms to consume them immediately. Whereas, during the summer months, the preliminary microbial decomposition may begin only after the leaves are stacked in the cement tanks and moistened sufficiently. Perhaps the worms do not get the necessary softened substrate during such periods for their initial burst of activity, resulting in lower compost turnover.

The vermicompost and earthworms are sold in the Institute through the sales counter at Agricultural Technology Information Centre (ATIC) @ Rs. 5.50/ kg Rs. 0.55/worm, respectively. Through simple

calculations (Table 4), it can be observed that a farmer can earn approximately Rs. 6,572/ tank through the sales of compost and worms during the favourable climatic periods as compared to Rs. 3,685/- during unfavourable periods. Weather, therefore, influences the economic returns to the practicing farmers too.

### Conclusion

Vermicomposting of coconut leaves can be carried out throughout the year. However, it has been observed that the temperature and relative humidity significantly influence the composting efficiency of the *Eudrilus* sp. From this study, it can be stated that the optimum weather conditions for efficient vermifarming of coconut leaves by *Eudrilus* sp. in coastal tract of Kerala is 28 – 32 °C temperature (max.) and more than 90% relative humidity. These weather conditions prevail during monsoon to post monsoon period i.e. June to Nov. in this tract. Farmers can earn better income, during this period, from vermicomposting of coconut leaves.

Table 4 : Estimate of income from a unit area (cement tank of 7.5 x 2.5 x 1 m dimensions) of coconut leaf vermicomposting during favourable and unfavourable weather periods\* <sup>j%</sup>

Period	Vermicomposting output	Selling price at CPCRI (Rs.)	Income from sale (Rs.)	Total income (Rs.)
<b>Favourable weather conditions</b> (30-32 °C temp. and 80-90% RH)	685 kg compost* 5100 worms*	5.50/ kg compost 0.55/ worm	3767.50 2805.00	6,572.50
<b>Unfavourable weathe conditions</b> (32-34 °C temp. and below 80 % RH)	580 kg compost <sup>†%</sup> 900 worms <sup>†%</sup>	5.50/ kg compost 0.55/ worm	3190.00 495.00	3685.00

\* It is assumed that coconut leaves and cow dung are available with the farmer, free of cost, and family labour is utilized for vermifarming.

<sup>j%</sup> One time expenditure on consumption of tank and procurement of earthworms is not taken into consideration.

\* Average values obtained during the period June to August and September to November in the years 2002 and 2003.

<sup>†%</sup> Average values obtained during the period Dec. to Feb and March to May in the years 2002, 2003 and 2004.

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