

# EFFECT OF TEMPERATURE ON THE DEVELOPMENT OF 3 TYPES OF ORGANIC WASTE TREATMENT WORMS IN THE NORTH OF VIETNAM

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## ABSTRACT

Three species of worms commonly cultured in Vietnam, including three species of epigeic earthworms *Eisenia fetida*, *Perionyx excavatus* and *Eudrilus eugeniae* were used in this study to compare the rate of increase in worm weight, number of cocoons, and number of worms, hatching cocoons, the mass of vermicompost in 12 months in the North of Vietnam. Waste used in the study is cow dung treated by EM. The results show that temperature greatly affects the yield of worms, the amount of vermicompost formed in the area with a widely temperature range. Specifically, *Eudrilus eugeniae* develops best in the summer, at 25-35°C, but they almost stop reproducing and developing in winter, especially in the temperature range of 5°C-13°C. *Eisenia fetida* and *Perionyx excavatus* handle well all months, especially *Eisenia fetida*. However, vermicompost and mass of worm were lower than *Eudrilus eugeniae* in summer and autumn.

**Keywords:** *Eisenia fetida*, *Perionyx excavatus*, *Eudrilus eugeniae*.

## 1. INTRODUCTION

Earthworm have long been used as an excellent waste decomposition. Many types of worms have the ability to process organic waste, creating a rich nutrients fertilize for plants, including epigeic species. Among these types, there are three types of worms introduced by Vietnamese farmers to create organic fertilizers, including *Eisenia fetida*, *Perionyx excavatus* and *Eudrilus eugeniae*. They are used for treating organic waste and creating vermicompost (Edwards, 1998, Edwards C. A., et al, 1996, Reinecke et al., 1980,1992, and Giraddi et al., 2002).

However, depending on the regions, different types of worms will be selected. However, this selection is completely based on the availability of the farms. That is, from a farmer who initially buys a earthworm species, they will feed them and sell them to other households near them, they don't care what the types of worm, and the quality worm, the factors affecting the growth of earthworm. Over time, a certain type of worm will be common in a certain area. For example, the North and Central often feed *Eudrilus eugeniae*, the South feeds *Perionyx excavatus* and *Eisenia fetida*. However, in the North, almost all farms do not have enough worm and vermicompost to supply the market. This study was conducted to assess the level of waste treatment of worms in the North, giving advice to farms about type suitable worm for them, bringing economic and environmental efficiency.

## 2. MATERIALS AND METHODS

The study was conducted in Thai Nguyen University of Technology, Vietnam during the period January, 2021 to December, 2021.

The study used 3 species of earthworms that were feed in the North: *Perionyx excavatus* (P.E), *Eisenia fetida* (E.F) and *Eudrilus eugeniae* (E.E) to compare the criteria and assess the suitability of each type in the North.

10 kg of biomass including earthworms and substrate was put into 70cm\*35cm\*20cm tank, with a drainage hole at the bottom. We put in this tank the same mass of worms, of course, different in number of worms, including 100 grams of earthworms and 900 grams of substrate. The adult worms (reaching the maximum size and uniformity) were counted and placed in the substrate, which was completely removed from the worms and cocoons prior to the experiment.

Waste used in this study is dried cow dung (moisture 40%), mixed with water and pre-treated with EM (Effective Microorganismas). The initial amount of waste put into treatment is 3 kg, the experiment is conducted with each phase of 10 days, recording the weight of worm manure after being treated, the number of cocoons, the treatment time and the temperature of environment.

A fertility study in different temperatures was conducted at the same time as the above this study. The number of cocoons is formed by a pair of adult worms in 10 days, incubation time until the cocoon hatch. In which, 10 worm cocoons are selected, separated, washed with clean water, then put in wet paper, checked the time the cocoon hatch, the number of young worm hatched in these 10 worm cocoons. After the data is collected, it is processed and the mean and error values are calculated.

### 3. RESULTS AND DISCUSSION

Weather data is shown in Table 1, growth rate data is shown in Table 2 and reproductive rate is calculated in Table 3.

**Table 1. Temperature during the experiment**

Season	Month	Temperature (°C)	Time of reserch	Average temperature (°C)	Max temperature (°C)	Min temperature (°C)
Winter	11,12,1,2	0-23	29/1-7/2	13.6	9	18
Spring	3,4	20-25	20/3-29/3	20.5	16	24
Summer	5,6,7	20-38	20/6-29/6	32.5	27	40
Autumn	8,9,10	20-35	20/9-29/9	28.4	24	34

The climate in the North has a high temperature fluctuation range and is not as stable as the South. In winter, the temperature can be as low as 0°C, in summer it can reach 43°C. With such a temperature fluctuation range, the reproduction and development of worms is greatly affected, especially in winter and summer.

**Table 2. Growth in different temperatures**

Seasons	Cocoons/pair			Incubation period (days)			Hatching percentage			Number of earthworms/10cocoons		
	P. E	E. F	E.E	P. E	E. F	E.E	P. E	E. F	E.E	P. E	E. F	E.E
Winter	2.7	4.5	6.2	20.5	17.8	17.1	65.1	75.8	72.3	7.5	14.6	18.2
Summer	3.2	4.8	7	20.9	18.2	16.4	68.9	78.2	89.7	7.9	16.8	21.8
Autumn	3.5	5.0	7.7	20.4	18.1	16.2	75.3	78.6	90.2	8.5	16.9	19.8
Spring	2.8	4.3	5.8	19.8	18.3	16.5	67.2	77.2	78.6	8.7	14.7	18.6

In Table 2, the number of worm cocoons produced by a pair in 10 days was significantly different between the 3 species, the lowest being *Perionyx excavatus* and the highest being *Eudrilus eugeniae*. However, they are different in each season, corresponding to different temperature ranges. All three species show a decrease in the number of cocoons in winter, and increase in autumn and summer. This is explained by temperature affecting the growth, development and mating ability of worms. Worms tend to breed below the food layer, in winter, the weather temperature decreases, they eat more slowly, on the contrary, in summer, the air temperature is too high, they all tend to go under and disperse in the deeper layers, so the possibility of meeting and mating is reduced. In the autumn, when the temperature is relatively stable, they eat faster, concentrate more on the upper part, so, the ability to mate increases. Regarding incubation time, there is no significant change between seasons of the year, only significant differences between types, in which, *Perionyx excavatus* has the longest time (19.8 days), and fastest time is *Eudrilus eugeniae* is (16.2 days). This result is quite similar to the report of Edward (1998). Similarly, the hatching rate also increased gradually from *Perionyx excavatus*, *Eisenia fetida* to *Eudrilus eugeniae* (65.1%-90.2%). The proportions in each species also fluctuate, with the most eggs being hatched and summer and autumn, which shows that they are very dependent on the temperature. Regarding the number of worms hatched in a cocoon, on average from 2-3 children (JaswinderSingh, 2018). In this study, the number was less, and at least in *Perionyx*

*excavatus*, the number in the previous study range was *Eudrilus eugeniae* (21.8 worms/10 cocoon). Thus, temperature affects cocoon hatching time and hatching rate.

**Table 3. Reproduction at different temperatures**

Seasons	Number of worms			Vermicompost weight (kg)			Waste conversion rate			Treating time (h)		
	<i>P. E</i>	<i>E. F</i>	<i>E.E</i>	<i>P. E</i>	<i>E. F</i>	<i>E.E</i>	<i>P. E</i>	<i>E. F</i>	<i>E.E</i>	<i>P. E</i>	<i>E. F</i>	<i>E.E</i>
Winter	1500	1000	200	2.1	2.2	2.2	70.0	73.3	73.3	115.2	110.4	127.2
Summer	1500	1000	200	2.3	2.4	2.6	76.7	80.0	86.7	98.4	91.2	60.0
Autumn	1500	1000	200	2.4	2.5	2.6	80.0	83.3	86.7	105.6	98.4	69.6
Spring	1500	1000	200	2.3	2.3	2.4	76.7	76.7	80.0	100.8	103.2	76.8

All activities of worms are affected by temperature. The optimal temperature for *Eisenia fetida* is 20°C-25°C, but the temperature range exists quite wide, from 0°C-43°C, humidity range 75%-85%, however, below 10°C, they often reduce treating waste. (Reinecke et al., 1990, Suthar S., 2009).

With *Eudrilus eugeniae*, maximum growth can be reached at 30°C, the growth rate of worms slows down at temperatures below 17°C and above 35°C (Sunitha, N. D., 1995).

The incubation period for epigeic worms in the tropics of the three species is 13–27 days. In addition, factors such as substrate temperature, air humidity, substrate moisture, material and age of the worms are also consideredly effected on reproductive rate, cocoon hatching and waste disposal capacity (Edwards, 1998).

The number of worms put into the substrate varied due to the different mass of the worms between species, of which the largest species was *Eudrilus eugeniae* from Table 3, it can be seen that the mass of vermicompost formed between species is quite similar (from 2.1 to 2.6), corresponding to the same metabolic rate (70%-86.7%). However, this ratio was higher in *Eudrilus eugeniae*, then decreased in *Eisenia fetida*, and *Perionyx excavatus*. Treating time varied significantly between species, typically the correlation between *P.excavatus* (115hours) and *E.eugeniae* (60hours). However, in terms of the influence of season and temperature, from the mass of vermicompost, the waste conversion rate and the treatment time of worms are low in winter, increase in spring and summer, and reach the highest level in autumn. All types of worms are very sensitive to temperature. The most suitable temperature for earthworms is in the range of 20°C-30°C. Depending on the types of food, the worms have other growth rates. At a too low temperature, they will stop eating and possibly die; or when the temperature gets too high, they also leave or die. The reproduction and development of worms is also affected by the season of the year, in winter, the rate of body weight gain, reproduction and cocoon hatching rate are lower than summer and autumn [33].

It can be seen that the red worms (*Eisenia fetida*) are more suitable for the northern weather Vietnam. Their reproduction, ability of waste treatment and growth are all higher than *Perionyx excavatus* and slightly lower than *Eudrilus eugeniae*. However, they can grow and develop better than the other two types in the winter, which will help farmers still provide enough fertilizer for agriculture, which *Eudrilus eugeniae* can hardly meet in the winter with adverse weather conditions, such as too hot or too cold.

#### 4. CONCLUSIONS

Indicators of earthworm including weight gain rate, number of cocoons produced in each pair, hatching rate, amount of waste treatment and waste conversion rate were compared between three species. In this study, *Eisenia fetida* were identified as earthworms capable of adapting to the high temperature fluctuations in the North region. This will be a very meaningful study for the worm waste treatment industry in Vietnam.

#### 5. ACKNOWLEDGEMENT

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