



Original Research Article

Effect of vermicomposting period, substrate quantity, cow dung composition and their interactions on *Eisenia Fetida* during vermicomposting

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A B S T R A C T

Vermi-technology is increasingly becoming popular in various applications. The work focused on the factors that affect the earthworm growth rate in terms of changes in length and mass during vermicomposting. The study looked at 3 parameters which included vermicomposting period (days), cow dung composition (% (v/v)) and substrate quantity (kg). The study was carried out at Harare Institute of Technology for a period of 50 days between April and May 2014. *Eisenia fetida* were used as earthworms and the substrate comprised of food waste and cow dung of varying compositions. Vermicomposting periods of 30-50 days, substrate quantities of 2.5-5kg and cow dung composition of 20-40% (v/v) were employed in 0.59m X 0.31m worm bins. A loading rate of 150 worms/m² was used for earthworms with an average length of 50 mm and mass of 1g. 2³ factorial designs were used to determine the optimum conditions required for increase in earthworm length and mass. STATISTICA, a statistical software was used to determine the significant effects at 75% confidence interval. Pareto charts and contour plots were used to quantify the results at a p-value of 0.25. Increasing the vermicomposting period, the substrate quantity and the cow dung composition increased the earthworms' length and mass by a factor of more than 3. At the same time, increasing the cow dung composition and the interaction between increase in vermicomposting period and increase in substrate quantity also resulted in increased earthworm mass by a factor of 2.8. Earthworms' growth in vermicomposting is promoted by increase in vermicomposting period, substrate quantity and substrate composition.

Keywords

Cow dung,
Earthworms
growth,
Substrate
quantity,
Vermicompos-
ting period

Introduction

Vermicomposting technology has been widely used as an organic waste management technique (Manyuchi and Nyamunokora, 2014; Manyuchi et al., 2014; Manyuchi and Phiri, 2013a).

Vermicomposting is the bio-conversion of organic waste into solid and liquid bio-fertilizers through the earthworms gut which act as the bio-reactor (Manyuchi and Nyamunokora, 2014; Manyuchi et al., 2014;

Manyuchi and Phiri, 2013a). Various earthworm species such as *Megascolex Maurittii*, *Eisenia Fetida*, *Eudrilus Eugeniae*, *Perionnyx Excavatus*, *Lampito Maurittii*, *Eisenia Andrei*, *Lampito Rubellus* and *Drawida Willis* has been used in vermicomposting and have been reported to grow in number and size during vermicomposting (Manyuchi and Phiri., 2013a;).

These earthworms can be further applied in other vermi-technologies such as vermifiltration and vermi-remediation on top of vermicomposting (Manyuchi and Phiri , 2014; Manyuchi and Phiri., 2013a; Manyuchi and Phiri., 2013b). This work therefore focused on the effect of vermicomposting period, substrate quantity and composition as a measure of promoting *Eisenia Fetida* earthworms' growth for the use in the various vermi-technologies.

Materials and Methods

Materials

The experiments were carried out at Harare Institute of Technology. *Eisenia Fetida* earthworms were used and these were obtained from the Institute vermicomposting project which has been on-going since 2011 (Manyuchi and Nyamunokora, 2014; Manyuchi et al., 2014; Manyuchi and Phiri, 2013a). The earthworm breeding was done in 8 0.59m x 0.31m worm bins and earthworms were loaded at 100-200 worms/m² (Ansari and Rajpersaud, 2012). An average of 150 worms/m² was used at standard conditions. The earthworms had an average weight of 1g and length of 50mm. Cow dung was obtained from a nearby farm and the substrate waste comprised of canteen waste.

Methods

Vermicomposting periods of 30-50 days

were considered (Manyuchi and Phiri., 2013a;), cow dung composition was added at 20-40% (v/v) and substrate quantity in the worm bins was varied between 2.5-5kg (Manyuchi and Phiri., 2013a;).

Center conditions for vermicomposting period of 40 days, cow dung % (v/v) of 30% and substrate quantity of 3.75 kg were also investigated. The vermicompost pH and electrical conductivity (EC) were continually monitored using an HI Hanna Instrument. The moisture content was determined by an AND moisture analyzer.

Statistical Design

Statistica was used for statistical results analyses to determine the effect of vermicomposting period, cow dung composition, substrate quantity and their interactions at 75% confidence interval with an alpha value of 0.25 on the earthworm mass and length. 2³ full factorial designs were used at low and high levels as indicated in Table 1.

Center conditions for vermicomposting period of 30 days, cow dung % (v/v) of 30% and substrate quantity of 3.75 kg were used as the basis in generation of the contour plots with DV representing design variable on the contour plots.

Results and Discussion

The pH during the vermicomposting period ranged between 6.6-8.1, electrical conductivity ranged between 520180- 71 840 μ S/cm. Furthermore, moisture content varied between 7.12-13.28. These conditions were ideal for vermicomposting which promoted earthworm breeding (Manyuchi and Phiri., 2013a;).

Effect of vermicomposting period, substrate quantity, cow dung composition and their interactions on earthworm mass

Effect of cow dung composition on earthworms' length

The earthworms' length increased significantly with increase in cow dung composition from 20-40% (v/v). According to the Pareto chart in Fig 1, cow dung composition had an effect of 4.94 on earthworms' length at 75% confidence interval. The increase in earthworms' length with increase in cow dung composition can be seen in Fig 2 and Fig 3.

Effect of vermicomposting period on earthworms' length

The earthworms' length increased significantly with increase in vermicomposting period from 30-50 days. According to the Pareto chart in Fig 1, vermicomposting period had an effect of 4.14 on earthworms' length at 75% confidence interval. The increase in earthworms' length with increase in vermicomposting period can be seen in Fig 2 and Fig 4.

Table 1: 2³ Experimental design used in determining the earthworm growth

Experiment number	Vermicompost period (days)	Cow dung (% v/v)	Substrate quantity (kg)
1	30	20	2.5
2	50	20	2.5
3	30	40	2.5
4	50	40	2.5
5	30	20	5
6	50	20	5
7	30	40	5
8	50	40	5
Center conditions	40	30	3.75

Fig.1 Pareto chart on effect of vermicomposting period, substrate quantity, cow dung and their interactions on earthworms' length

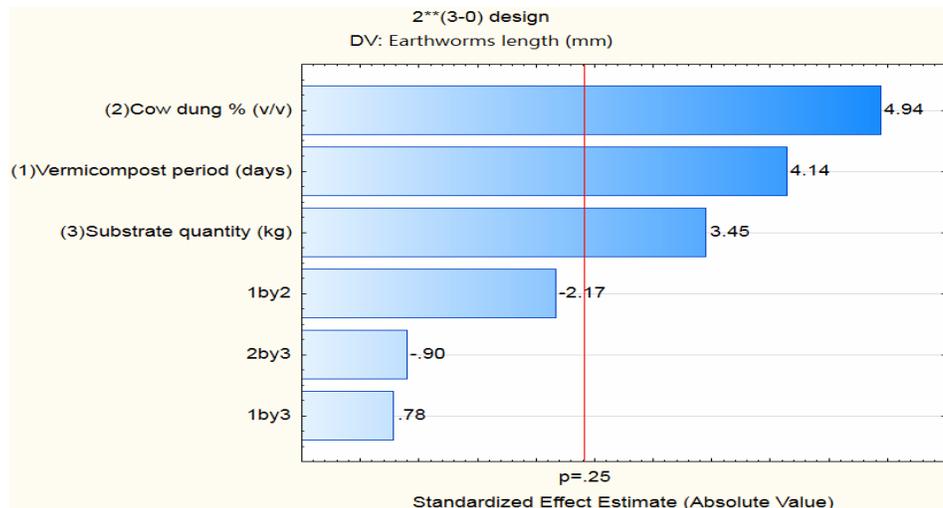


Fig.2 Effect of vermicomposting period and cow dung composition on earthworm length at substrate quantity of 3.75kg

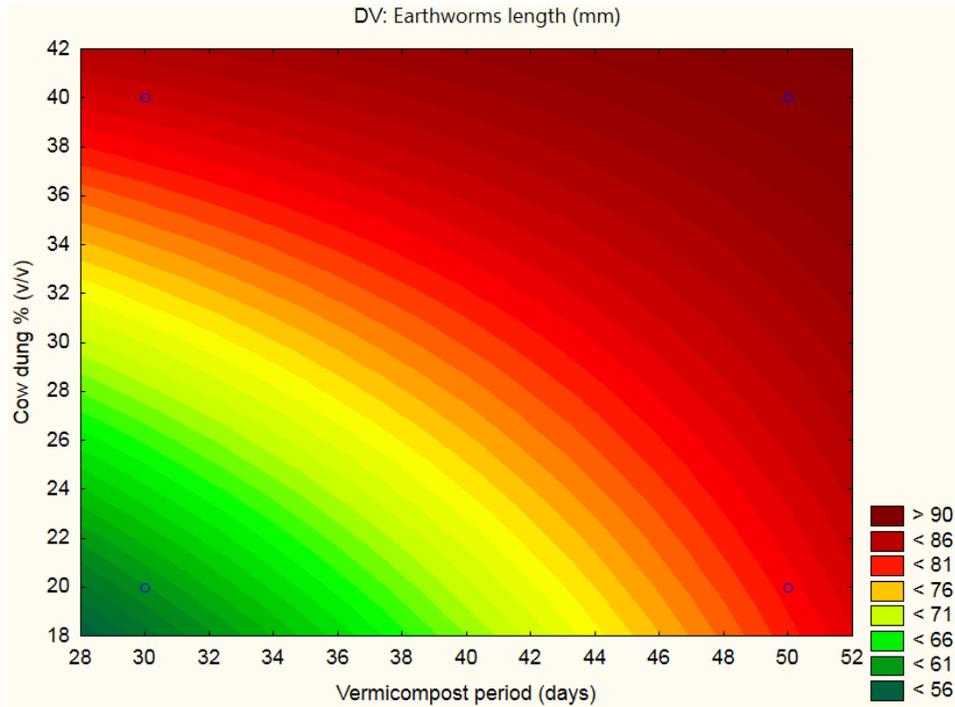


Fig.3 Effect of cow dung composition and substrate quantity on earthworms' length at vermicomposting period of 40 days

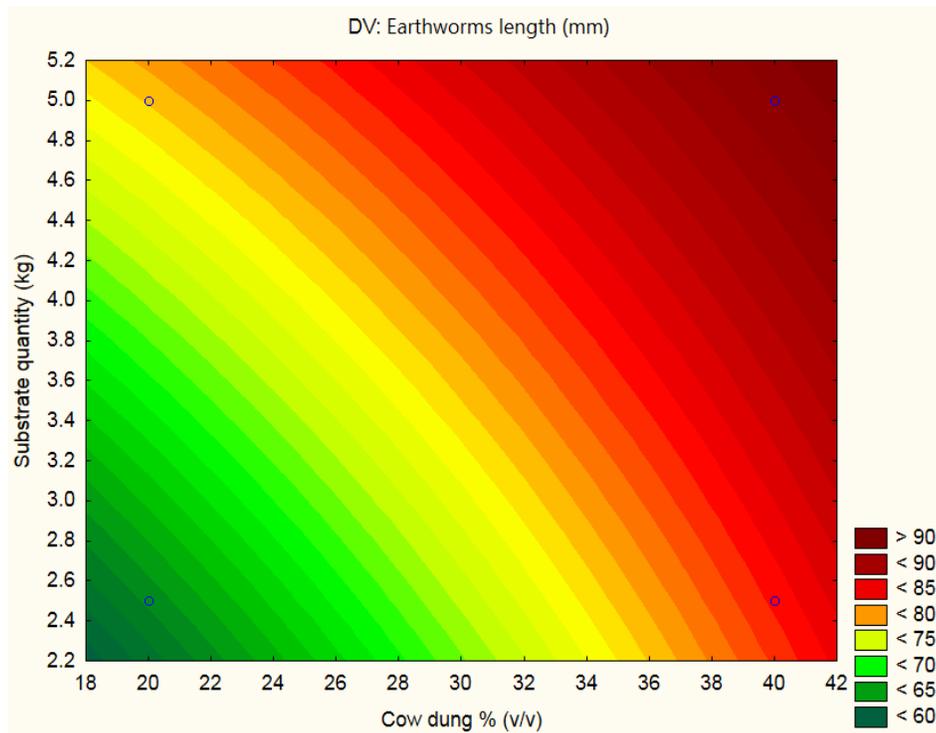


Fig.4 Effect of vermicomposting period and substrate quantity on earthworms' length at cow dung composition of 30 % (v/v)

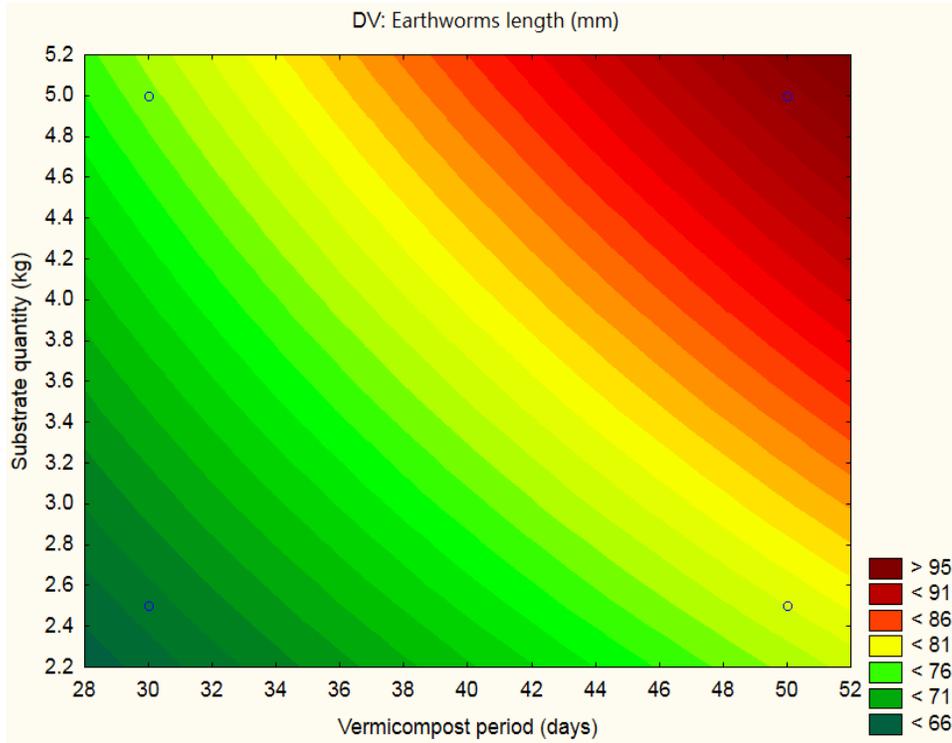


Fig.5 Pareto chart on effect of vermicomposting period, substrate quantity, cow dung and their interactions on earthworms' mass

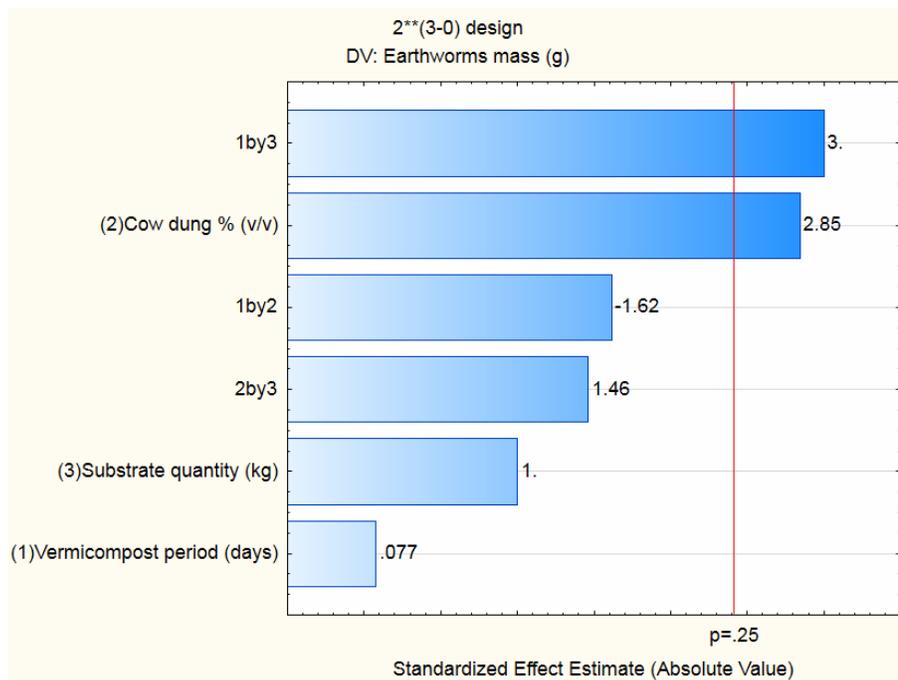


Fig.6 Effect of cow dung composition and substrate quantity on earthworms' mass at vermicomposting period of 40 days

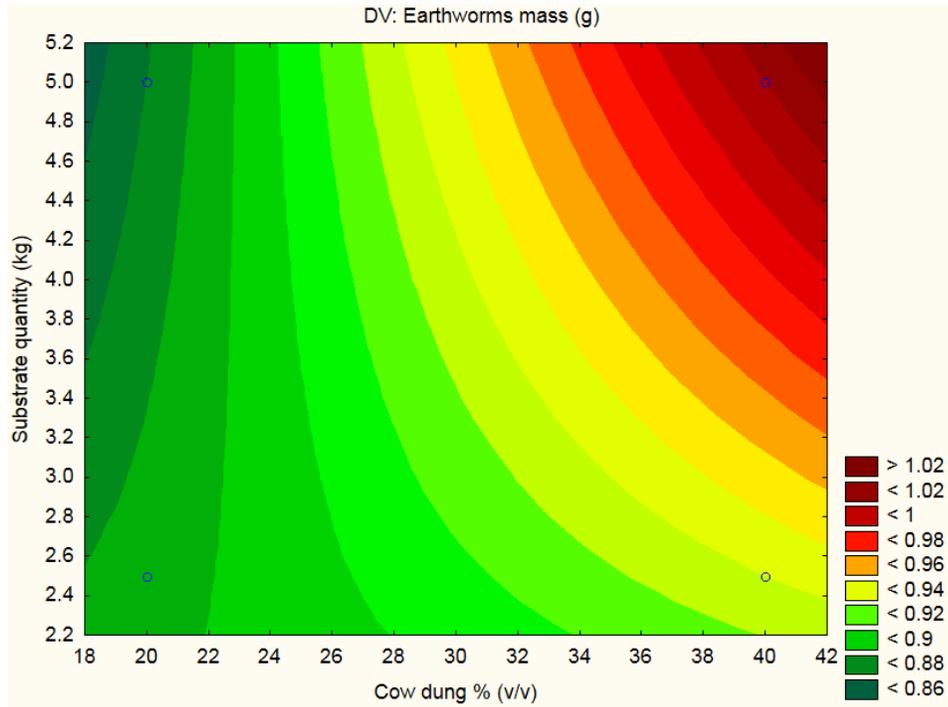
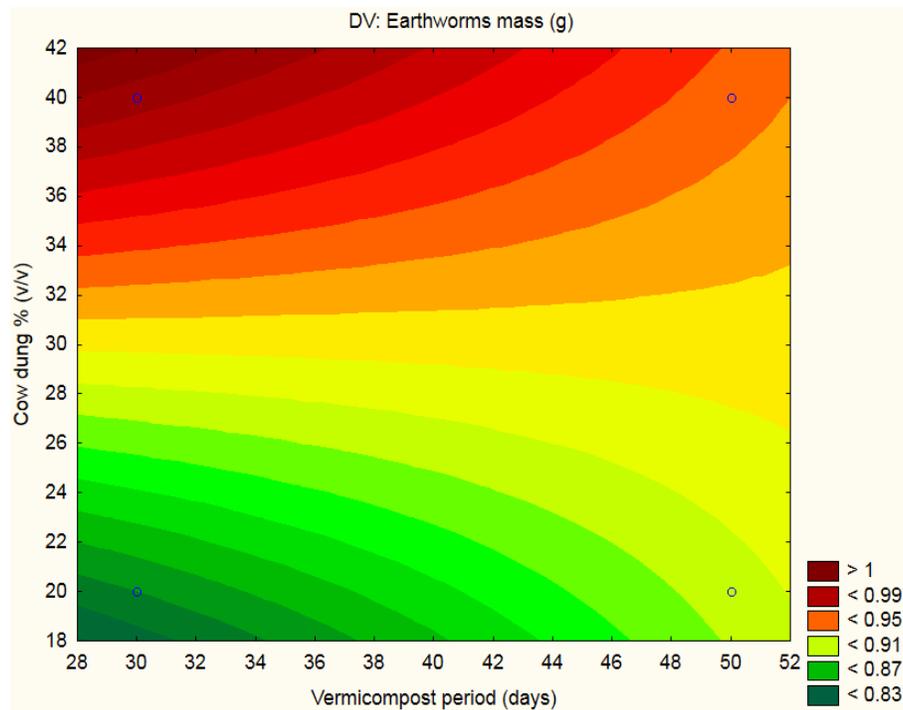


Fig.7 Effect of vermicomposting period and cow dung composition on earthworms' mass at substrate quantity of 3.75kg



Effect of substrate quantity on earthworms' length

The earthworms' length increased significantly with increase substrate quantity from 2.5-5kg. According to the Pareto chart in Fig 1, substrate quantity had an effect of 3.45 on earthworms' length at 75% confidence interval. The increase in earthworms' length with increase in substrate quantity can be seen in Fig 3 and Fig 4.

Effect of parameters interactions on earthworms' length

The interaction of vermicomposting period and cow dung composition, vermicomposting period and substrate quantity as well as substrate quantity and cow dung composition did not have a significant effect on the earthworms' length. This can be seen in the Pareto chart of effects in Fig 1 and 75% confidence interval.

Effect of vermicomposting period, substrate quantity, cow dung composition and their interactions on earthworm mass

Effect of cow dung composition on earthworms mass

The earthworms' mass increased significantly with increase in cow dung composition from 20-40% (v/v). According to the Pareto chart in Fig 5, cow dung composition had an effect of 2.85 on earthworms' length at 75% confidence interval. The increase in earthworms' mass with increase in cow dung composition can be seen in Fig 6 and Fig 7. Cow dung has also been reported to have a positive impact on *Eisenia Fetida* growth by several authors (Siddique et al., 2005; Garg et al., 2005; Bishit et al., 2007; Birundha et al., 2013).

Effect of vermicomposting period, substrate quantity and their interactions

Vermicomposting period, substrate quantity, interaction between vermicomposting period and cow dung composition as well as interaction between substrate quantity and cow dung composition did not have an effect on the increase of earthworms mass. This is clearly shown by a Pareto chart of effects in Fig 5 at 75% confidence interval.

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