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# Production of Vermicompost from Domestic Waste Using Epigeic Earthworms *Eudrilus Eugeniae* and Evaluation for Field Trial on Bhendi (*Abelmoschus esculentus* (L.) Moench)

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**Abstract:** The present research was conducted with the objective to manage the Domestic organic waste by converting into compost by using earthworms and also evaluation of nutritional value of the vermicompost such as potassium, nitrogen phosphorus and C:N ratio which are essential for soil fertility and plant growth. The compost was also subjected to field trial to evaluate its potential to improve soil fertility and product yield. An experimental study was conducted to obtain the vermicompost using Domestic solid waste such as fruit, vegetable and paper wastes. This experiment evaluated the effects of various vermicompost amounts (0%, 10%, 20%,25%, and 50%) of the total weight of the mixture of soil and vermicompost) and earth worms (0, 10, and 20 individuals/pot) on Bhendi phytomass and macroelements concentration when applied to soil. The earthworm species used for this process was *Eudrilus eugeniae*. Moisture content was maintained by spraying proper percentage of water. The partially decomposed Domestic waste was converted into castings by earthworms. The castings obtained on the top surface of the bin were in the range from 60 to 90 days depending on the type of solid waste used. The castings obtained were sieved, dried, tested and used as Bio-fertilizer. Thus, the vermicomposting process helps in the management and disposal of Domestic solid waste in a safe, economic and useful manner. In this study we also analyzed cost effectiveness of this vermicompost production and it shows promising profit with low cost investment. The present study covers environment cleaning, vermicompost production business, Soil fertility improvement for farmers and Enhancement of crop product yield.

**Keywords:** Vermicompost, Plant debris, Soil fertility, Earthworms, Domestic solid waste, Plant growth

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## Introduction

The increase in population (India) causes an increase in the quantity and type of urban and rural organic solid wastes. Such wastes are undesirable pollutants to the environment and time could even be a health menace. As far as rural wastes are concerned, there are enormous

quantities of organic materials that are not utilized (Danilo *et al.*, 2010). Vermicomposting is a green technology that converts organic wastes into nutrient rich organic fertilizer, Vermicompost (VC), when used as fertilizer, not only bears positive impact on soil quality, plant growth and yield but also enhances nutritional value of crops produced. Vermicomposting is the process of producing compost by utilizing earthworms to turn the organic waste into high-quality compost that consists mainly of worm cast in addition to decayed organic matter (Ismail, 2005; Devi and Prakash, 2015). Today vermicompost is an important component of organic farming systems, because it is easy to prepare, has excellent properties and is harmless to plants. Vermicompost improves the physical, chemical and biological properties of the soil as well contribute to organic enrichment (Chauhan and Singh, 2013). Vermiculture is ecofriendly since earthworms feed on anything that is biodegradable, vermicomposting then partially aids in the garbage disposal problems. No imported inputs required, worms are now locally available and the materials for feeding are abundant in the locality as market wastes, grasses, used papers and farm wastes. It is also highly profitable, both the worms and castings are saleable. Nowadays chemical fertilizers are being used in high quantities which degrade soil quality in long run (Abu *et al*., 2015). Many researchers have reported positive changes in soil quality and soil productivity by application of VC as compared to chemical fertilizers (Ansari and Sukhraj, 2010). Many have testified significantly greater crop production through Vermicompost amendment. The present research was conducted with the objective to manage the solid organic waste by converting into compost by using earthworms and also evaluation of nutritional value of the vermicompost so produced. As far as wastes are concerned, there are enormous quantities of organic materials that are not utilized. Vermicomposting technology is a fast growing one with its pollution free, cost effective and efficient nature.

## Materials and Methods

### *Vermiculture compost production*:

This study, carried out at KK Natural Fertilizers (Ltd) Dhammampatti, Tamil Nadu during 2019–2020, consisted of different stages, viz. building of a vermicompost unit at Dhammampatti, procurement of a composting Epigeic earthworm, *Eudrilus eugeniae* and production of vermicompost using Domestic solid waste, dry green leaf and cow manure.

### *Construction of the vermicompost unit*:

A vermicompost unit of 3 × 4 × 3 feet (w × h) was built in a shaded area. The vermicomposting units were set up at the vermicompost unit using the Vermitech Pattern reported by Ismail (2005). Concrete unit of 3 × 4 × 3 feet (w × h) was built as containers for culturing the earthworms. The concrete units had the drainage holes (2 × 2 cm) to facilitate the effective water drainage as shown in the Figure 1. The roof of the station was made of sheets with underneath isolation paper to ensure a cool environment. The walls of the vermicompost station were built of wired mesh to facilitate air flow.

### *Preparation of Culture bed*:

The culture bed was prepared as described by Ismail (2005). As shown in Figure 2, First layer is a basal layer of vermin-bed comprising broken bricks, then a layer of sand to the thickness of 6–7.5 cm was set up to ensure proper drainage. Second layer was Loamy soil up to the height of 15 cm, which was moistened. The earthworms, *Eudrilus eugeniae*, were inoculated into this layer. Third layer: Lumps of fresh/dry cattle dung were scattered over the soil. Fourth layer: The soil was then covered with domestic solid waste, dry green leaf up to 10 cm thickness. The entire unit was covered with banana leaves to protect the earthworms from sunlight and birds. It was kept moist by sprinkling of water twice a week

Fig. 1: Vermiculture Composting pits.

Fig. 2: Inoculation of earth worms in to composting tank.

and turned once a week, up to the harvest of the vermicompost.

*Procurement of Eudrilus eugeniae*:

In this, two hundred (200) composting earthworms, *Eudrilus eugeniae* (Epigeic species), were procured from the TNAU Coimbatore, India. The earthworms were cultured for 120 days in one unit and were used for the production of vermicompost from solid waste and cow manure as shown in Figure 2. The domestic waste was collected from the municipality waste yard, Attur, India. The lawn was mowed and stored and the cow manure was procured. The domestic waste consisted of 5 kg cow manure and 2 kg dry solid waste on a weekly basis.

*Compost analysis*:

After hundred and twenty (120) days, the following parameters of the vermicompost were analyzed: (i) the total population of earthworms by passive method (Edwards and Bohlen, 1996)--physically separating the earthworms from the vermicompost; (ii) The total amount of the vermicompost produced (weight in kg); (iii) Chemical analyses using the methods applied in

the laboratory: pH-$H_2O$ using a pH meter, total organic carbon (TOC in %) by Titrimetry using the Walkley– Black method; total nitrogen (N in %) using the Kjeldahl method; C: N ratio; total phosphorus (P in %) determined by the colorimetric method using a spectrophotometer.

*Compost field trial on Abelmoschus esculentus (L.) Moench*:

After successful production of vermicompost, it was analyzed for physicochemical and biological properties to enriching the soil fertility. The compost so formed was also tested on field trial study on some vegetable plant Bhendi to evaluate its efficacy to improve crop yield by improving the soil fertility, this test was done by taking some small land area in association with one TNAU under the departmental extension activity names as Lab to Land program. The 3 feet x 3 feet land space is used for each verity of vegetable crop and also one 3 feet x 3 feet land space used as control without adding this vermicompost all of these setup as shown in Figure 3. This experiment was carried out for the period of 3 months until the crops give rise to product to analyze growth parameters and product yield.

*Statistical analysis*:

All the reported data are the Mean values of three replicates. Two way analysis of variance (ANOVA) was done to determine any significant difference among the parameters analyzed in vermicompost.

## Results and Discussion

*Compost formation*:

The process of vermicomposting activity showed significant changes in the physical and chemical properties of plant debris, cattle dung and paper waste material that can be an important tool for natural organic compost farming. The compost formed can be identified by seeing the color which changes from brown to black. This is one of most important physical characteristic used to confirm the compost formation seeing by naked eyes and the compost so formed is shown in Figure 3.

*Compost Analysis*:

The compost so formed in the last step was subjected to detailed analysis such as -- weight loss, color change, degradation, odour, microbial growth, earthworms multiplication etc. In addition to this some very important nutritional components of the compost was analyzed to know their role in improving soil fertility and to enhance crop yield. Table 1 clearly indicates that vermicompost technology reduces the amount of waste and also increased the nutrient content of the vermicompost to be used in agricultural practices. Weight loss was found in three material of plant debris, cattle dung and paper waste by the degrading activity of earth worm *Eudrilus eugeniae*. The content of N-total was increased as the process of composting days increases and significantly different from the previous initial days. This is caused by the weathering process of mineralization of organic matter involving the performance of enzymes that hydrolyze the protein complex that will increase the nitrogen content in the vermicompost (Anwar, 2009). On the other hand, there is a simultaneous addition of nitrogen by worms in the form of mucus and excretory material, this process occurs in a high intensity so that the content of nitrogen will increase (Pattnaik and Reddy, 2010). The content of C-organic was decreased as the days increased. It indicates that the decomposition took place. The decomposition process is the release of carbon from complex into more simple bonds due to the use of C elements by the organism to get their life energy through respiration and biosynthetic processes, releasing $CO_2$ to organic material so that the organic materials that have undergone the decomposition process will have lower levels of Carbon (Nagavallemma *et al.*, 2004). The C/N ratio decreased as the days increased. It indicates that the decomposition took place well. The decline of C/N ratio was caused by the decreasing number of carbon as well as the increasing number of nitrogen. The decomposition process is the release of carbon from complex into more simple bonds due to the use of C elements by the organism to get their life energy through respiration and

Fig. 3: Vermicompost.

Table 1: Showing analysis of Vermicompost with different parameters

| S. No. | Parameters | 30 days | 60 days | 120 days | Quality |
|---|---|---|---|---|---|
| 1. | pH | 7.2 | 7.2 | 7.1 | Excellent |
| 2. | Temperature | 33 | 36 | 38 | Good |
| 3. | Nitrogen | 0.23 | 0.46 | 0.75 | Excellent |
| 4. | Phosphorus | 0.74 | 1.39 | 2.27 | Good |
| 5. | Potassium | 0.12 | 0.24 | 1.38 | Excellent |
| 6. | Carbon | 12.65 | 7.89 | 5.11 | Moderate |
| 7. | C: N | 21.12 | 12.36 | 5.98 | Good |

biosynthetic processes, releasing $CO_2$ to organic material so that the organic materials that have undergone the decomposition process will have lower levels of C, compared to the C levels of raw materials (Nagavallemma *et al.*, 2004). The decreasing amount of C/N ratio is also due to the increasing content as the result of mineralization, a process that changes the organic nitrogen into inorganic nitrogen through the weathering process which involves the work of enzymes that hydrolyzes protein complexes, as well as the nitrogen that was produced from the worms' excrement (Anwar, 2009).

*Economic analyses*:

Cost–benefit analysis of vermicomposting is as follows: the total cost of setting a vermicompost station of 2 units is 92000 INR. With half annual production of 50 tones (from 2 units) the total can be calculated as --1 kg x 10 INR, 1 ton =1000 INR.

*Compost field trial on bhendi growth parameters*:

The ANOVA analysis shows that the effects of soil amendments was significant for all roots and shoot vegetative growth parameters and crop yield at the three growth stages. In general, plant growth was better in farmyard manure than in control where the soil not receiving the compost and also the bhendi yield has increased 50% as compared to control plants. All of these Growth morphology parameters and product yield as shown in Table 2 and Figure 4. The vermicomposting of dry grass clippings, rice straw and cow manure using *Eudrilus eugeniae* was successful. The produced vermicompost had a dark color, a mull-like soil odor and was

Table 2: Showing growth parameters of Bhendi for vermicompost analysis

| S. No. | Parameters | 30 DAYS | 60 DAYS | 120 DAYS | Quality |
|---|---|---|---|---|---|
| Control | Shoot | + | ++ | ++ | Normal |
| | Root | + | ++ | ++ | Normal |
| | Flower | + | ++ | +++ | Normal |
| | Fruit | 00 | 00 | 5kg | Normal |
| | | | | | |
| Vermicompost | Shoot | + | ++ | ++ | Excellent |
| | Root | + | ++ | +++ | Excellent |
| | Flower | + | ++ | +++ | Excellent |
| | Fruit | 00 | 00 | 25kg | Excellent |
| | | | | | |

+: Good Growth, ++: Very Good Growth, +++: Excellent Growth

Fig. 4: Plants after 2 months of plantation.

homogeneous. It had all the essential macro- and micro-plant nutrients like N, P, K, Ca, Mg, Mn, Cu, Zn and Fe, indicating the achievement of getting an environment friendly nutrient-rich vermicompost for the agriculture sector. The enhancement of nutrients and beneficial microbial population in the vermicompost is yet another important evolving trend where the vermicompost is value added with nutrients and or microorganisms resulting in improved growth and yield of crop plants. The economic analysis revealed that this method is low cost investment and high yield of more profit. This compost has subjected to field trial analysis on some selected vegetable plants which has shown promising enhancement in growth permeates and product yield, so from this research we can conclude that Biofertilizer production can be started as small business and it proved that it can improve soil fertility and vegetable crop yield.

## Conclusion

The concentrations of macro-elements (N, K, Ca, Mg, and S) were higher in leaves than in roots. Antagonistic relationships were recorded between K, Ca Mg, and S concentrations. A positive dependence was observed between the carrot root yield and the N, P, and K concentrations in leaves

and roots. With the rising quantity of vermicompost in the soil substrate, the weight of Bhendi roots and leaves also increased. As the dose of VC in the treatments increased, the differences in phytomass percentage increases got smaller. Surprisingly, the high proportion of VC in the soil substrate did not have a negative effect on the formation of both Bhendi roots and leaves. VC increased the weight of roots more than leaves.

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