International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 08 | Aug 2020 www.irjet.net p-ISSN: 2395-0072

FEASIBILITY STUDY OF CONTINUOUS FLOW THROUGH VERMICOMPOSTING UNIT FOR GOVERNMENT COLLEGE OF ENGINEERING AMRAVATI

Pratik R. Deshmukh[1], Dr. M. L. Gulhane[2]

[1]Post Graduate Student, Civil Engineering Department, Government College of Engineering Amravati, 444604, India
[2]Associate Professor, Civil Engineering Department, Government College of Engineering Amravati, 444604, India

---

Abstract - *In the 21st century tremendous amount of solid waste is being generated which is creating a huge challenge in front of town planners. It is estimated that solid waste generation will be doubled by 2025. Out of the total solid waste generated in the world approximately 48% is organic in nature. There are several technologies and methodologies available for effective management and treatment of solid waste like a waste to energy conversion, incineration, gasification, pyrolysis, landfill, composting, vermicomposting etc. Among these vermicomposting is best option for the conversion of organic matter into nutrient rich compost. The term vermicomposting means the use of earthworms for composting organic residues. Traditional vermicomposting is batch process which requires two to three months for the production of the vermicompost. Harvesting of the traditional vermicomposting is done only after conversion of organic matter of complete batch into vermicompost, this conversion takes long period. To overcome this problem eating habit of earthworm (species: Eisenia Foetida) is observed and it is found that earthworms can consume practically all kinds of organic matter and they can eat their own body weight per day, e.g. 1 kg of worms can consume 1 kg of residues every day. This eating habit of Eisenia Foetida earthworms is used in the Continuous Flow through Vermicomposting (CFTV) Unit to get yield of vermicompost on regular basis. To achieve this objective a modular CFTV Unit is designed and fabricated. This CFTV unit allows the addition of organic residue from the top of the unit and vermicompost is harvested from the bottom of the unit. This unit facilitates simultaneous addition of organic waste and harvesting of vermicompost at regular interval of 10-12 days. The vermicompost harvested from CFTV unit is found to be rich in Nitrogen, Phosphorus and Potassium.*

***Key Words*: Continuous Flow through Vermicomposting Unit, Vermicomposting, Eisenia Foetida, Earthworm, Solid Waste Management, Garden Waste Treatment.**

1. INTRODUCTION

Worldwide, approximately 1.3 billion metric tons of solid waste is being generated now-a-days. This amount is nearly twice of that were being generated a decade before. It is estimated that solid waste generation will be doubled by 2025. Out of the total solid waste generated in the world approximately 48% is organic in nature. Developed countries produce more solid waste due to their high living standards, on other hand they spend more money for the treatment of the generated waste. Because of that the net waste generation and disposal of developed countries get decreased. But in case of developing countries due to their weaker economy they didn't afford the installation of updated technologies for safe disposal of waste generated by them.

In 21st century there are several technologies and methodologies available for effective management and treatment of solid waste like a waste to energy conversion, incineration, gasification, pyrolysis, landfill and composting, etc. but problem is that some of these methods affect the surrounding environment adversely. For example seepage of leachate in landfills pollute soil and ground water, incineration process emits a high amount of carbon dioxide and other harmful gases, also incineration process require fuel to burn the waste which also affect the environment.

Composting and vermicomposting are one of the best waste management methods to treat and reuse organic waste. In the composting process, decomposable microorganisms degrade the biodegradable organic pollutants and convert that to carbon dioxide and water. When in normal composting process earthworms are added to speed up the degradation activity, it is called as vermicomposting process. Composting process is cheaper than vermicomposting, but vermicomposting gives more nutrient rich vermicompost as compare to compost obtained by normal composting.

Traditional vermicomposting is batch process. Traditional vermicomposting require two to three months for the production of the vermicompost. Harvesting of the traditional vermicomposting is done only after conversion of organic matter of complete batch into vermicompost. Due to this waiting period the production of the vermicompost is obtain on irregular basis. Therefore to get the vermicompost

on regular interval continuous flow-through vermicomposting unit is needed.

This study is to check the feasibility of continuous flow through vermicomposting (CFTV) unit for Government College of Engineering, Amravati and to get the vermicompost yield on regular basis.

2. Material and Method

2.1. Raw waste

The garden waste mainly consisting of fallen leaves and trimming of plants collected from the garden area of Government College of Engineering, Amravati was used as raw material for composting. To reduce the volume of the collected garden waste it is shredded in to small size using garden waste shredder machine.

During the vermicomposting process, temperature, pH and moisture was measured at an interval of 3 days. Temperature was monitored using a digital thermometer (Probe type, Naitik Creations, India). Moisture content was measured by using on field moisture meter. pH is measured by using on field pH meter.

2.2. Design and fabrication of CFTV unit

A CFTV unit is designed and fabricated so that to reduce the labor work and user friendly operation of the unit. A rectangular CFTV unit of size 1.2m X 0.7m X 0.6m having sloping base is designed so as to reduce the efforts required for the harvesting of vermicompost. Sloping base of the CFTV unit has a 0.15m slit which is used for the harvesting of the vermicompost. Fig. no. 2.1 shows the drawing of the CFTV unit. Fig.no. 2.2 shows actual image of the CFTV unit.

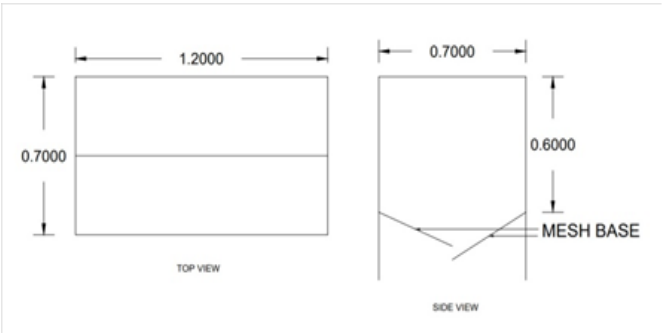


Fig. 2.1 Drawing of CFTV unit

Fig. 2.2 CFTV unit

2.2. Earthworms used in CFTV unit

There are different species of earthworms viz. Eisenia foetida (Red earthworm), Eudrilus eugeniae (night crawler), Perionyx excavatus etc. Lumbricus rubellus and Eisenia foetida (Red earthworm) are thermo-tolerant and so particularly useful. In Indian weather red earthworms are preferred because of their high multiplication rate and thermo-tolerant, thereby they converts the organic matter into vermicompost within 45-50 days. Red earthworms can consume practically all kinds of organic matter and they can eat their own body weight per day, e.g. 1 kg of worms can consume 1 kg of residues every day. This eating habit of Eisenia Foetida earthworms is used in the CFTV Unit to get yield of vermicompost on regular basis.

2.3. Bulking agent used in CFTV unit

Vermicompost can be produced from organic waste with the addition of a suitable bulking agent. Growth and reproduction of earthworms depend on the quality of their feeding materials in terms of their potential to increase microbial activity. The various bulking agent used for vermicomposting process is cow dung, sheep manure, cattle dung, sewage sludge, biogas plant slurry, poultry droppings, etc. Bulking agent used to condition the waste. It acts as an initial source of microbes that help in the biodegradation process. Microbes present in bulking agent invade the waste substance slowly and earthworm also adapted to the waste through bulking agent. Various reports say that cow dung is the frequently used bulking agent in vermicomposting process. In this CFTV unit cow dung is used as a bulking agent. Cow dung is mixed with water and slurry is made to remove heat from cow dung. This cow dung slurry is then mixed with garden waste.

2.4. Layering in CFTV unit

To start the vermicomposting process proper bedding is very important to get the maximum yield in less duration. In case of CFTV unit unlike traditional

vermicomposting different bedding is used. Following layers are used in the CFTV unit

First layer

This is the bottom most layer in the unit. This layer consists of newspapers. A thin sheet of newspapers is placed at the bottom. This layer is to prevent above layers of unit from falling down through the mesh, provided at the bottom of unit.

Second Layer

In this layer mixture of garden waste and cow dung slurry is spread. Equal amount of garden waste and cow dung is mixed together i.e. in 50:50 proportion. 10-12 days old cow dung is used in this layer, this cow dung is then mixed with water and slurry made of it so that the cow dung loose its heat. Cow dung will work as bulking agent.

Third Layer

Third layer is of Eisenia Fetida worms. For this unit 1 kg full grown Eisenia Fetida worms are used. These earthworms are evenly spread above the second layer.

Fourth Layer

In this layer garden waste mixed with some amount of food waste will be added. Addition of food waste will be done only to provide earthworm food which they like most. Due to the favorite food they will acclimatize in the new environment easily. After these initial layers, garden waste will be added in the unit on regular interval till the unit gets filled.

3. Results and discussion

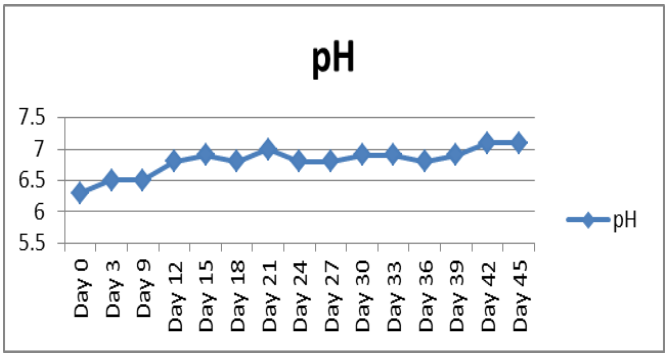
3.1. Raw waste characterization

At initial stage it is found that the total carbon and total nitrogen is 45.2% and 8.3 gm/kg respectively. Initial C/N ratio of the garden waste is 54.4. MC was found to be 59% (optimum range of 40-60% for start of the vermicompost process). The average pH is 6.3. The bulk density of raw shredded waste was found to be 0.68 g/cm^3, which is calculated by using pycnometer method and calculated using following formula.

$$\text{Bulk density (g/cm}^3\text{)} = \frac{\text{Weight of sample in gram}}{\text{Volume of sample in cm3}}$$

3.3 pH levels in CFTV unit during vermicomposting

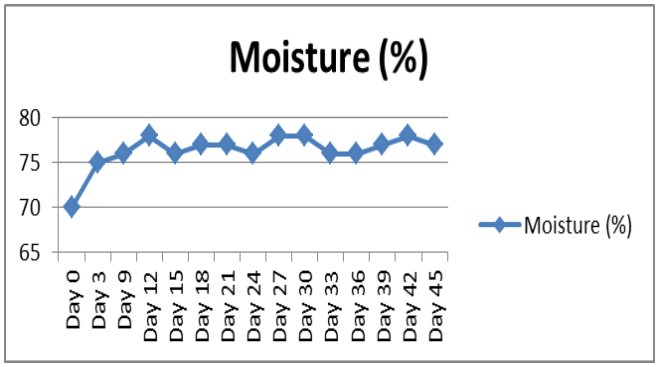
pH level in the CFTV unit is monitored by using on field pH meter on regular interval of 3 days. pH levels play important role in vermicomposting process therefore it is necessary to keep it between the permissible limit i.e. 6 to 7. It is found that pH remain within the limit during the 30 days of testing.



Graph 3.1- pH levels in CFTV unit

3.4 Moisture levels in CFTV unit during vermicomposting

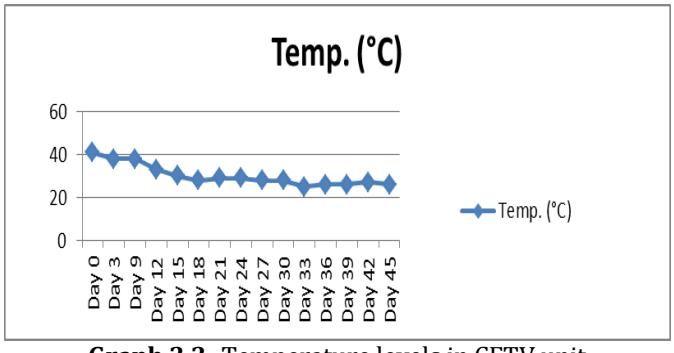
Moisture level in the CFTV unit is monitored by using on field moisture meter on regular interval of 3 days. Optimum moisture is important for the proper working of the earthworms. Earthworms work well in the moist condition. To maintain the moisture content daily water is sprinkled in the CFTV unit.



Graph 3.2- Moisture levels in CFTV unit

3.5 Temperature levels in CFTV unit during vermicomposting

Temperature level in the CFTV unit is monitored by using on digital thermometer on regular interval of 3 days. Earthworms work efficiently in cool environment. As we add cow dung slurry in the garden waste it raise the temperature of the garden waste. Sprinkling of water helps to decrease temperature in the CFTV unit. Daily sprinkling of water helps to maintain temperature in the CFTV unit.



Graph 3.3- Temperature levels in CFTV unit

3.3. Harvesting of vermicompost from CFTV unit

After the completion of initial detention time of 20 days, 1st harvesting is done from the bottom slit of the CFTV unit. After removal of some untreated waste nutrient rich vermicompost is obtained, 880gm. vermicompost is harvested in 1st harvesting. After completion of 10 days 2nd harvesting is done, in 2nd harvesting 1320gm. vermicompost is harvested. 1260gm. of vermicompost is harvested in 3rd harvest after 10 days. Similarly 4th harvesting is done and 1380gm. vermicompost is harvested.

4. Conclusion

It is found that designed CFTV unit is feasible to use for the treatment of garden waste generated in Government College of Engineering, Amravati. It gives vermicompost on regular interval of 10 days. Approximately 1200gm. to 1400gm. of vermicompost is obtained after the interval of 10 days. The vermicompost harvested from CFTV unit is found to be rich in Nitrogen, Phosphorus, and Potassium. Average values of Nitrogen, Phosphorus, Potassium found are 12.56 g/kg, 7.02gm/kg and 18.2gm/kg respectively.

ACKNOWLEDGEMENT

The first author is grateful to the authorities of Government College of Engineering, Amravati for providing the infrastructure, testing laboratories, manpower and funds for performing the field scale experimental study.

REFERENCES

[1] M. M. Manyuchi, T. Chitambwe, P. Muredzi and Q. Kanhukamwe, Continuous Flow-through Vermireactor for Medium Scale Vermicomposting.

[2] Omufisi O. Mildred, Design of a vermireactor for tana kitchen in uon upper kabete campus.

[3] S. Gajalakshmi, P. Sankar Ganesh, S.A. Abbasi, Biochemical Engineering Journal 22 (2005) 111–116, A highly cost-effective simplification in the design of fast-paced vermireactors based on epigeic earthworms.

[4] Chaichi Devi, Meena Khwairakpam, Bioresource Technology (2019), Bioconversion of Lantana camara by vermicomposting with two different earthworm species in monoculture.

[5] T. Djerdja , D. K. Hackenbergerb , D. K. Hackenbergera , B. K. Hackenbergera, Geoderma 358 (2020) Observing earthworm behavior using deep learning

[6] O. Taeporamaysamai, C. Ratanatamskul, Co-composting of various organic substrates from municipal solid waste using an on-site prototype vermicomposting reactor, International Biodeterioration & Biodegradation (2016) 1-10.