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# Management of rice straw (*Oryza sativa*) by vermicomposting using epigeic earthworm, *Eisenia fetida*

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**Abstract**
Rice straw (*Oryza sativa*) is the most abundant and nutrition efficient crop residue and it is the major by-product of rice fields in India. Burning or dumping of rice straw is a great loss to nutrient economy in agriculture sector as it affects the physical, chemical and biological properties of soil. The present investigation was initiated to study, 'Management of Rice straw (*Oryza sativa*) by vermicomposting using epigeic earthworm, *Eisenia fetida'* at Department of Zoology, CT University Ludhiana. Rice straw and cow dung was used as substrate for the preparation of vermicompost. Based on the finding of present investigation, the waste got converted into vermicompost in 45 days at an average temperature, pH and humidity *i.e.* 25°C, 6-7.8 and 85% respectively. The end product was black colored with granular texture. It could be concluded that vermicomposting is done in order to decrease the need for chemical fertilizers and improve the microbial activity in soil. Vermicompost is eco friendly, nutrient rich fertilizer for agriculture sector.

**Keywords:** Compost; earthworm; epigeic; microorganisms; rice straw; vermicast; vermicompost

## Introduction
Agriculture provides plenty of waste consisting of crop straw, husk, sugarcane molasses, ground nut shells and generation of these wastes in India have been estimated to be 363 million tonnes annually [1]. Rice – straw is the most important crop residue in India with annual production reaching more than 95.76 MT in 2014-2015(ICAR 2015), and it has a variety of uses such as cattle feed and bedding, thatch mulch, as fuel in mills and paper industries etc. In States like Punjab and Haryana, a huge amount of rice-straw is burnt and dumped leading to loss of enormous amount of plant nutrients and causing air pollution, soil pollution and water pollution. These crop residues or wastes, if not properly handled, will cause many problems to farmers as well as to the environment. If rice straw is left in the field without proper management, it can cause pollution which can lead to the spreading of disease, and can also encourage the breeding of pests such as rats. Crop residues can be effectively composted to produce bio fertilizer therefore abundance of rice straw as an organic waste can be converted to fertilizer throughout the process of composting using earthworms [2].

Soil with vermicasts has roughly 1000 times more beneficial bacteria than soil without worms [3, 4]. It enhances germination, plant growth and crop yield; improves soil texture and structure, nutrient retention, water-holding capacity, and aeration [5]. The vermicompost promotes plant growth from 50-100% over conventional compost and 30-40% over chemical fertilizers [6, 7]. Vermicompost provides soil organic carbon and NPK, and also provides enzymes and hormones which stimulate plant growth. It enhances soil biodiversity by promoting the beneficial microbes which, in turn, enhances plant growth, plant health and crop yield by producing growth regulating hormones and enzymes, controlling plant pathogens, nematodes and other pests [3].

Vermicomposting potential of *Eisenia fetida* had been reported by many workers using a variety of organic waste such as cattle dung [8], industrial waste [9], household waste, sewage sludge etc. [10], but there is inadequate literature on utilization of rice straw as substrate in vermicomposting using earthworm *E.fetida*. Therefore, exploration of composting potential of this species have vast opportunities for the workers and it can also aid in eco friendly management of crop residues and other agricultural wastes [11]. In comparison to other species *E. fetida* have a rapid growth rate, good temperature tolerance (up to 35°C) and accepts a large range of moisture 60-90% [10]. Under optimal conditions, the life cycle of *E. fetida* ranges from 45 to 51 days [13]. *E. fetida* can be handled easily and it is tolerant to other species [14, 15, 16].

The vermicomposting with *E.fetida* in different organic residues *i.e.* sugarcane trash, weeds, vegetable market waste and paddy straw mixed with cattle dung was studied by Lakshmi (2013) [17]. Vermicomposting resulted in significant reduction in C:N ratio and increase in total nitrogen, phosphorus, potassium, zinc and iron content. Organic residues were reported to be the highest in rice straw compost [18]. Vermicompost increases the porosity of soil and contains most nutrients in plant available forms such as nitrates, phosphates, exchangeable calcium, soluble potassium etc. [19]. Basically, this microbial solution was developed for natural or organic farming systems; however, with further research its uses have been expanded to resolve some environmental issues, through which it facilitates the reuse of most waste [12]. Organic farming system is gaining increased attention for its emphasis on food quality and soil health. Vermicomposting can be a source of extra income for the farmers due to its useful products. Keeping the above facts in view the present study has been designed with the objective of management of rice straw waste by converting the material into vermicompost in the shortest time as possible and also to study the increasing number and weight of worms.

## Materials and methods

The present study was carried out during the month December, 2019 to month March, 2020 at CT University, Ludhiana, Punjab. The crop residue or organic waste used was rice straw. The waste was imported from nearby fields after the harvesting of rice crop. Rice-straw was chopped to approximately 5 cm size and 1kg of such chopped straw was moistened for a week by sprinkling water, and mixing frequently. 0.5kg earthworms (*Eisenia fetida*) were exported from nearby vermicomposting farm. 5kg cow dung was exported from nearby dairy farms.

a) Construction of the vermicompost beds: Kachcha floor beds or compost pits of $75 \times 50 \times 30$ cm$^3$ were built for further processes. The floor bed should be in a cool, moist and shady site.
b) The culture bed was prepared in layers as follows, a basal layer of vermibed comprising pebbles then a layer of sand to the thickness of 6cm was set up to ensure proper drainage.
c) This was then covered with a layer of loamy soil up to the height of 15 cm, after it was moistened.
d) Into this soil, 25 earthworms, *Eisenia fetida*, were inoculated.
e) Small lumps of fresh or dry cattle dung was then scattered over the soil.
f) The soil was then covered with agro waste (Rice straw).
g) The entire unit was covered with banana leaves or jute bag to protect the earthworms from sunlight and birds. It was kept moistened by sprinkling of water twice a week and turned once a week, up to the harvest of the vermicompost.
h) Bed was turned once after 15 days for maintaining aeration and for proper decomposition.
i) Harvesting was done when raw material was completely decomposed and it appeared black and granular.
j) Watering was stopped as compost got ready.

In every 5 days during the process of vermicomposting the temperature, humidity and pH were determined in each vermicompost unit. The temperature was measured with a field compost thermometer (REOTEMP FG20P Backyard Pro Compost Thermometer). The humidity was measured with a compost moisture meter (REOTEMP Garden and Compost Moisture Meter). The humidity ranges were as follows: 10–40% (dry); 40–80% (moist); 80–100% (wet). The pH was measured with a soil pH meter (The Squirm Firm pH meter). After 45 days, the total earthworm population and the total production of vermicompost was determined. The total population of earthworms was estimated using a hand-sorting method. Productivity of vermicompost was calculated in percentage using the formula:

Productivity of vermicompost (%)

$$= \frac{\text{Harvested vermicompost (kg)}}{\text{Total mass of feed(kg)}} \text{ x } 100\%$$

## Results and discussion

To promote the growth of worms as a way to increase the decomposition of rice straw during composting favorable conditions should be provided. The presence of favorable conditions, adequate amount of microbial nutrient and absence of toxic substances are essential to reach high composting activity of worms.

The pH of rice straw was also in a similar range to as obtained in previous studies [20, 21]. The pH recorded between 6.50 and 7.50 was in the range of 5–9 for vermicomposting [22]. The pH was slightly acidic in the vermicompost *i.e.* 6.4 on day1; on day15 it was highest and started to decrease till last day *i.e.* 6.65 on day45 (Fig. 1). The pH fluctuated to 6-7.8 until it was almost neutral on day 45 when the vermicompost was ready to harvest. This was in line with the findings of Dominguez and Edwards CA, 2011 [22], who reported a pH range of 5–9 during the process, the values reaching near neutrality.

The temperature observed during the process of vermicomposting in the vermicomposting pit during day5 was recorded to be 25°C, 15°C on day 15, 27°C on day30 and 28°C on day 45 (Fig. 2). The fluctuation of the temperature in °C was restricted to±0.25. The temperature in the vermicompost unit was measured in every 5 days and recorded was 25 °C (average), *i.e.*, within the range of 0–35 °C as per the classification given by Dominguez and Edwards, 2011 [22].

The humidity recorded in the vermicomposting pit during the first 2 weeks was 85.50%. During the second 2 weeks, the humidity was 90.50%. In both these periods, the humidity was 80–100%, which indicated a wet environment, slightly above the range (80–90%) given by Dominguez and Edwards, 2011 [22] for a rapid growth of *E. fetida* during the process of vermicomposting. The results for humidity indicated that the unit was moist to wet (85%), which was in the range of 80–90% for rapid growth (fig. 3).

A total of 1kg of rice straw and 5kg cow dung with 25 worms was used which produced 1.5 kg of vermicompost. The productivity of vermicompost measured was 25%. The vermicomposting of moistened rice straw and cow manure using *Eisenia fetida* was successful. The produced vermicompost had a dark color, a mull-like soil odor, was homogeneous and had granular texture (Table1, Fig. 4). According to Munroe, 2004 [4], number of earthworms of the three age groups, juvenile, non-clitellate and clitellate, were counted using the hand count method. At the 45th day, the total number of earthworms was estimated to be 350 respectively. A satisfactory population of earthworms, as defined by Edwards and Arancon, 2004 [23], is at least 9–18 kg of earthworms per $m^2$. The increase in temperature is caused by the respiration and decomposition of organic matter by microorganisms. The increment in temperature is a good indicator that there is microbial activity in the compost pile, as a higher temperature denotes greater microbial activity [24]. The darkening of soil mould is a slow process which involves microbial activities and may be accelerated by earthworms that prepare soil and rice straw mixture and fine soil particles for microbial attack. In India earthworms have been successfully utilized for vermicomposting of rice straw. According to literature possibilities of production of vermicompost using other types of waste material should also be explore in the future studies.

**Table1:** Harvest data of vermicompost during the study period.

| Harvest data of vermicompost | Observation |
|---|---|
| Average pH | 6.80 |
| Average temperature | 25°C |
| Average humidity | 85% |
| Productivity | 25% |
| Preparation days | 45 days |
| Total feed introduced | 6.0 kg |
| Vermicompost produced | 1.5 kg |
| Initial number of worm introduced | 25 |
| Number of worms at the time of harvest | 350 |

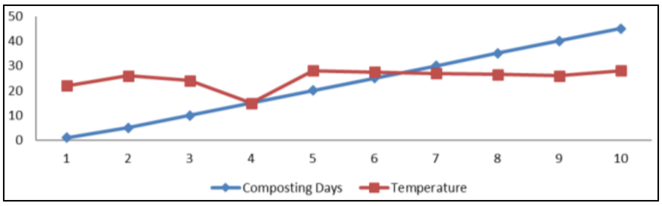


**Fig 1:** pH of compost on different composting days

## Conclusion

It can be concluded from the present investigation that the vermicomposting of rice straw and cow manure using *Eisenia fetida* was successful. Vermicompost is eco friendly, nutrient rich fertilizer for agriculture sector. Possibilities of the production of vermicompost using other types of waste material (vegetable waste, sugarcane molasses etc.) should be explored in the future studies.

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