E-ISSN: 2618-0618
P-ISSN: 2618-060X

www.agronomyjournals.com
2024; 7(4): 641-644
Received: 02-01-2024
Accepted: 06-02-2024

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Composting of sugarcane trash by using a microbial consortium

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DOI: https://doi.org/10.33545/2618060X.2024.v7.i4i.615

Abstract
In sugarcane farms, sugarcane trash has been a potential source of raw materials that can be processed into organic fertilizer. The present study aims to examine the ability of fungal and bacterial decomposers to decompose sugarcane trash. Further, our study is to examine the composting rate and compost quality of sugarcane trash. Three fungal species and three bacterial species were used for the evaluation of the decomposition of sugarcane trash. The combination of fungal decomposers consists of *Aspergillus awamori*, *Penicillium chrysogenum* and *Trichoderma viride*. The combination of bacterial decomposers consists of *Pseudomonas fluorescence*, *Bacillus subtilis*, and *Bacillus polymixa*. Four treatments are prepared: the first is fungal decomposers, the second is bacterial decomposers, the third is a combination of fungal and bacterial species, and the fourth is control (void decomposers). Two turnings of compostable material were done at 15 and 30 days. The decomposer dose used was 10 ml of each bacteria (concentration: 2.2×10^9 CFU/ml) or fungus (2×10^6 CFU/ml) per 10 kg of sugarcane trash for each treatment. Composting was conducted for 70 days. The samples were drawn after 70 days for analysis of different parameters. In this study, decomposition rate, decomposing percentage, weight loss, C:N ratio, pH, total nitrogen, phosphorous, potassium, *etc.* were analyzed after the completion of the decomposition process. This experiment proved that the third treatment, a combination of fungal and bacterial species was more effective in terms of composting rate and compost quality.

Keywords: Compost, sugarcane trash, decomposers

Introduction
In India, approximately 10-15 t/ha of sugarcane trash, constituting 10-12% of the weight of cane harvested, is produced by the crop and much of this residue is usually burned in the field. High C:N ratios, high fiber content and a lack of proper composting techniques prolong the decomposition of trash in the field. Generally, cane trash contains 68% organic matter, 0.42% N, 0.15% P, 0.57% K, 0.48% Ca and 0.12% Mg, besides 25.7, 2045, 236.4 and 16.8 ppm Zn, Fe, Mn and Ca, respectively (Shrivastava *et al.* 1992) [11]. It is estimated that 15 t/ha of dry cane trash breaks down over about one year to form 2.5 t of organic matter (Calcino *et al.* 2000) [4]. Besides the loss of organic matter and plant nutrients, burning of crop residues results in atmospheric pollution due to the emission of toxic gases like methane and carbon dioxide that pose a threat to humans and ecosystem. Decomposition of trash by microorganisms can be a good alternative option to mitigate these problems. Hence, the present study was conducted to examine the effect of fungus and bacteria on the decomposition of sugarcane trash.

Material and Methods
The present study was conducted at the "Agricultural Microbiology Laboratory" of "Bharti green tech" during the year 2023-24. All over laboratory work that is maintaining fungal cultures, sterilization of glassware's and culture medium, culture incubating and experimental method were conducted in the laboratories of company.

The ten kilograms of sugarcane trash were taken on a dry-weight basis and mixed with bacterial and fungal decomposers as per the treatment. The material was put in a gunny sack and allowed to decompose. Moisture was adjusted to about 60% of the water holding capacity. Two turnings of compostable material were done at 15 and 30 days.

The decomposer dose used was 10 ml of each bacteria (concentration: 2.2×10^9 CFU/ml) or fungus (2×10^6 CFU/ml) per 10 kg of sugarcane trash for each treatment. Composting was conducted for 70 days. The samples were drawn after 70 days for analysis of different parameters.

Table 1: Treatment details

Sr. No.	Treatments
T1	**Bacterial decomposers** (*Pseudomonas fluorescence, Bacillus subtilis, Bacillus polymixa*)
T2	**Fungal decomposers** (*Aspergillus awamori, Penicillium chrysogenum and Trichoderma viride*)
T3	**Bacterial + Fungal decomposers** (*Pseudomonas fluorescence, Bacillus subtilis, and Bacillus polymixa Aspergillus awamori, Penicillium chrysogenum and Trichoderma viride*)
T4	**Control** (Void decomposers)

The variables observed included compost temperature, decomposition rate, moisture content, C/N, pH, organic C, N, P, and K compost, compost weight, and weight loss of compost during composting. The rate of decomposition and decomposition percentage during composting is calculated using equations (Olson, 1963; Sari *et al*., 2016) [8, 10].

$$R = \frac{W0 - Wt}{T}$$

Reference

R = Decomposition rate (g/day)
T = Composting time (days)
W0 = Initial material weight
Wt = Weight after composting process at T-time

The weight of the compost and the weight loss of the compost are obtained at weighing the final weight and then looking for the difference between the initial weight and the final weight. The percentage of weight loss during the composting process is calculated according to the equation (Olson, 1963; Sari *et al*., 2016) [8, 10].

$$W = \frac{W0 - Wt}{T} \times 100$$

Reference

W = Decomposition percentage (%)
W0 = Initial material weight
Wt = Weight after composting process at T-time

Statistical analysis

All laboratory work was carried out in Completely Randomized Design, with three replications and four treatments.

Results and Discussion

The sugarcane trash decomposing efficiency of bacterial and fungal isolates was evaluated and compared in terms of decomposition rate, decomposition percentage, C:N ratio, percent loss in weight and increase in nitrogen, phosphorus and potassium content.

The highest C:N ratio of compost was found in the control, with values reaching 37.1. The maximum decrease in the C:N ratio of sugarcane trash during composting was observed by inoculation with a mixture of bacterial and fungal strains, which is 19.1. This means that the combination of decomposers added can accelerate the process of decomposition of organic matter, thus providing a lower C:N ratio than controls. The carbon is an energy source for microbes and nitrogen is needed for the synthesis of protoplasm. The use of metabolic carbon is much higher than that of nitrogen, which causes a decrease in the C:N ratio. Dhapate *et al*. (2018) [5] report that inoculating sugarcane waste with a combination of fungal strains caused the C:N ratio (16.3) to decrease as much as possible during the composting process. The inoculation of cellulolytic fungal cultures is responsible for the decrease in the C:N ratio of sugarcane waste during decomposition.

Highest pH, 7.8 was observed in the third treatment, followed by T2 (7.4), T1 (7.4) and control (7.1). Decreasing the pH to around 5.0 or lower as a result of organic acid production (Atalia *et al*., 2015). The production of organic acids lowers pH during the first phase of composting. The conversion of ammonium to ammonia during the thermophilic phase causes the pH to climb until it eventually stabilizes at values that are almost neutral. (Roman and others, 2015) [9].

The N, P and K content of compost with the addition of bacterial and fungal decomposers seems to have a higher than other treatments *i.e.* 0.97, 0.31 and 3.34 percent respectively. Phosphate can be dissolved by *Bacillus polymixa* and *Pseudomonas fluorescence* (Alemu, 2013) [1]. K can be solubilized by *Bacillus* and *Aspergillus* species.

Based on the results of the study, the highest composting rate was observed in the third treatment, which is 0.041 gm/day (4.12% per day) followed by T2 (3.84%), T1 (3.37%) and the control (0.88%). The composting rate in the control was lower or significantly different compared to the third treatment. This is assumed to happen because the additional decomposers can complement the material's natural decomposer in a way that makes them perform better together. In the control group, the composting rate was found to be 0.008 kg/day. The decomposers already present in the waste from sugarcane were assumed to play a part in the composting rate. This accusation is consistent with the findings of Strom & Finsstein (1994) [12], who reported that naturally occurring decomposer bacteria are capable of composting.

The addition of bacterial and fungal decomposers observed the highest decrease in weight *i.e.* 28.9 percent followed by T2 (26.9%), T1 (23.6%) and control (6.2%). This is presumably due to the fact that the addition of decomposers accelerates the decomposition process, therefore reducing the mass of the compost. Muliarta *et al.* (2019) [7] obtained similar results, demonstrating that the addition of comparators and local decomposers also led to a greater mass decrease in comparison to controls. A 29% weight loss was measured by Andrea *et al.* (1998) [2], and weight loss over a 45-day period was noted by Gautam *et al.* (2010) [6].

Table 2: Observations

Treat.	C:N ratio	pH	N (%)	P (%)	K (%)	Weight loss (%)	Decompost -ing rate (Gm/day)	Decompost-ing percentage (per day)
T1	21.9	7.4	0.89	0.29	2.89	23.6	0.033	3.37
T2	21.4	7.4	0.88	0.24	2.83	26.9	0.038	3.84
T3	19.1	7.8	0.97	0.31	3.34	28.9	0.041	4.12
T4	37.1	7.1	0.67	0.16	2.10	6.2	0.008	0.88
SEm±	-	0.11	0.04	0.03	0.19	0.91	0.00	0.16
CD at 1%	-	0.33	0.11	0.09	0.57	2.66	0.01	0.48

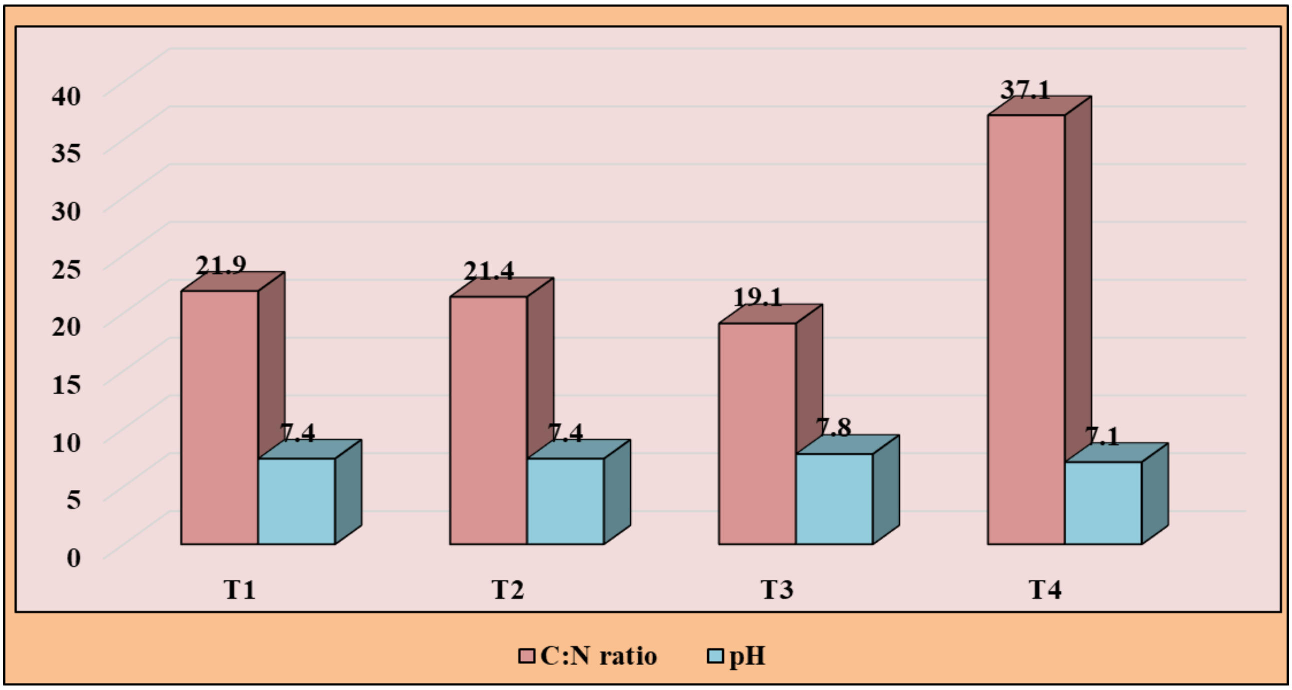

Fig 1: C:N ratio and pH of compost

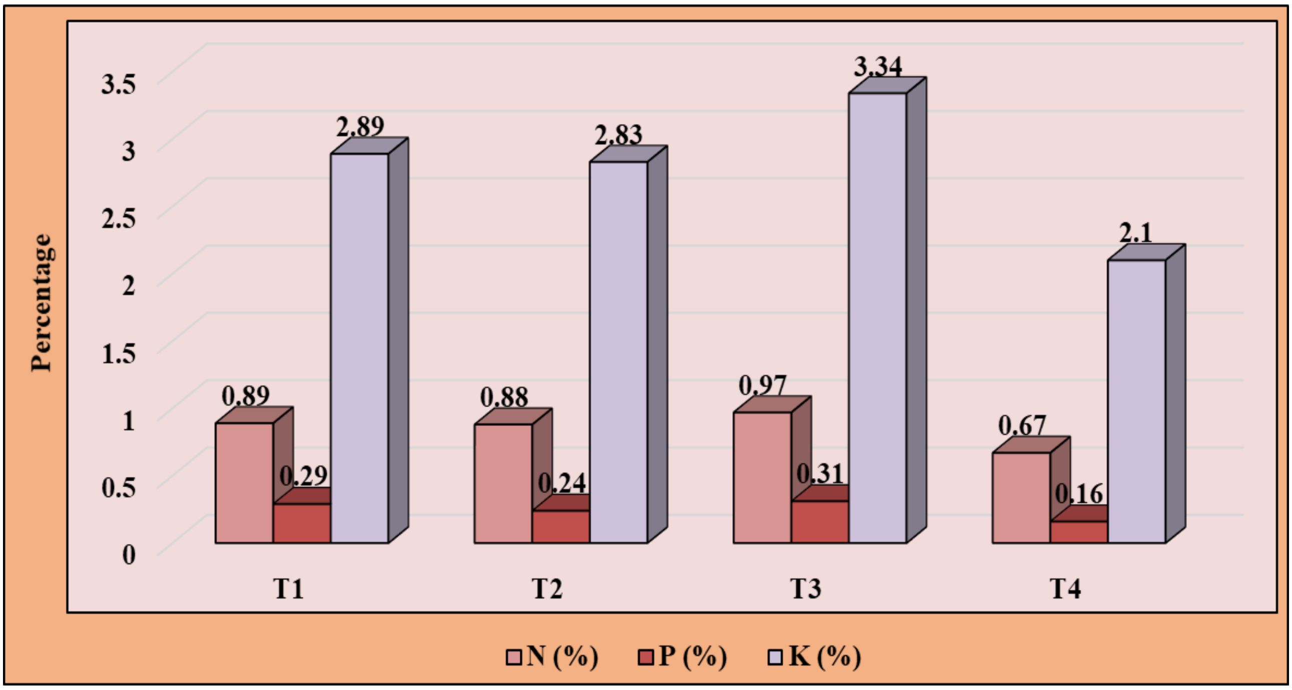

Fig 2: N, P and K content of compost

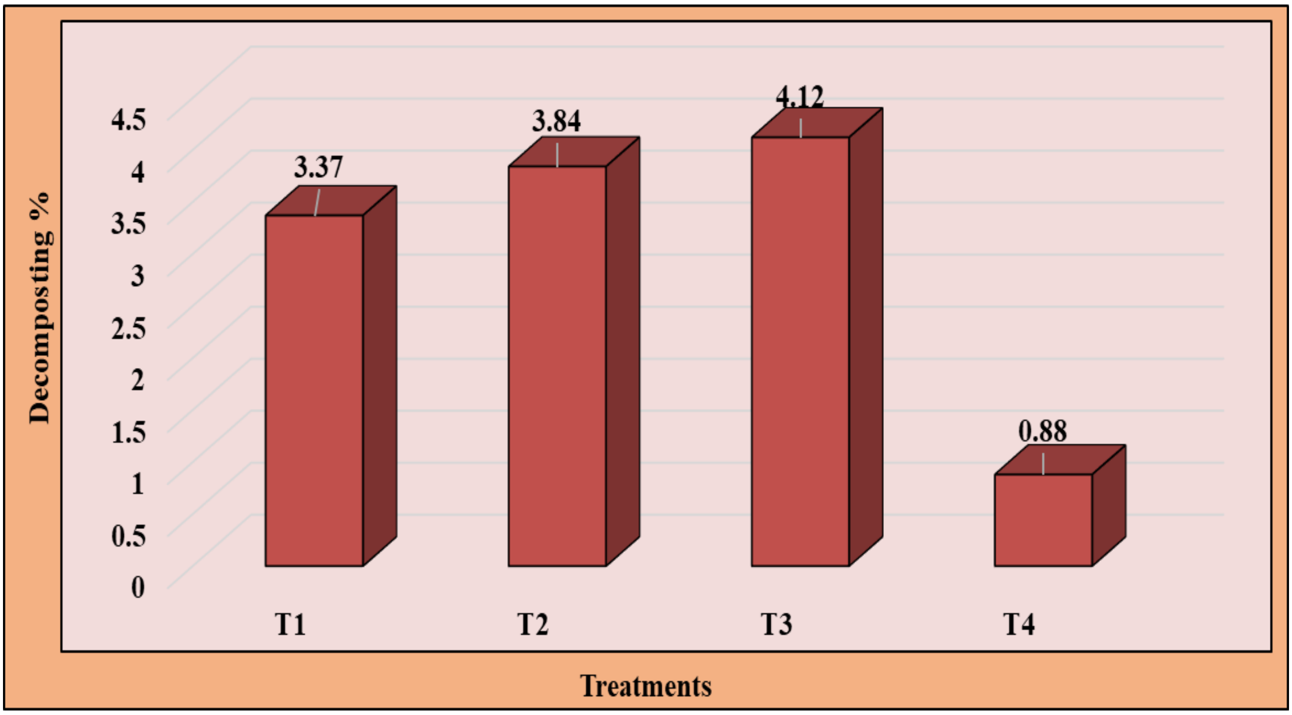

Fig 3: Decomposting percentage of compost

Conclusion

- The composting of the sugarcane trash, with the addition of bacterial and fungal decomposers, was able to provide a C:N ratio of up to 19.1.
- The use of a consortium of bacterial and fungal decomposers increases the composting rate, composting percentage and mass reduction compared higher than other treatments where bacterial and fungal cultures are used separately. In the control, no significant degradation of sugarcane crop residue was observed.
- This laboratory study provides evidence that the use of a microbial consortium for the decomposition of sugarcane trash helps accelerate the decomposition process of sugarcane crop residue.
- The analysis of the compost suggests that the use of a microbial consortium would be best for increasing the nutritional properties of sugarcane trash decompost.

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