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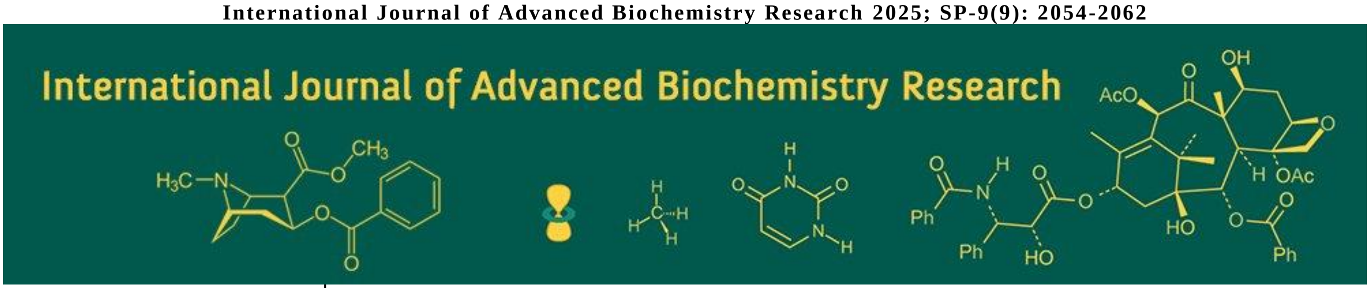

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Effect of liquid bioinoculants, organic and chemical additives on rate of decomposition and quality of sugarcane trash compost

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Abstract
Sugarcane trash is a major agricultural residue generated in large quantities after harvest. Due to its high lignocellulosic content, low nitrogen availability and wide C: N ratio, its natural decomposition is extremely slow. The present investigation was undertaken during 2024-25 at the Department of Plant Pathology and Agricultural Microbiology, College of Agriculture, Pune. The experiment was laid out in a completely randomized design with seven treatments and three replications. The main objective of this study was to evaluate the impact of liquid bioinoculants (*Trichoderma* spp. including *T. asperellum, T. harzianum, and T. hamatum*), organic additives such as cow dung slurry and chemical fertilizers (Urea, DAP, MAP, SSP) on the rate of decomposition, microbial population dynamics, and overall compost quality of sugarcane trash. The study recorded observations on key decomposition parameters such as temperature fluctuations, moisture content and *Trichoderma* population. Physical characteristics of compost, such as colour, particle size, texture, and weight loss during composting, were also assessed periodically at 0, 5, 10, 15, 30, 45, 60, 75, 90, and 120 days. Among the treatments, spray of 10 kg Urea + 5 kg Di-ammonium Phosphate (DAP) (18:46:0) + Spray of filtered cow dung slurry @ 5 lit. + liquid bioinoculant *Trichoderma* spp. (*T. asperellum, T. harzianum and T. hamatum*) @ 1 lit. per ton of sugarcane trash, emerged as the most effective strategy for efficient and rapid composting of sugarcane trash, achieving the highest microbial activity, as indicated by highest *Trichoderma* population (38.33×10^5 cfu/g compost), maximum temperature (50.24 °C) and superior compost quality with very dark gray colour, superior particle size through 4mm sieve (89.55 g) and maximum reduction in weight at maturity (7.11 kg). This approach not only addresses the issue of trash management but also recycles nutrients back into the soil, improving soil health, reducing dependency on synthetic fertilizers, and supporting sustainable agriculture.

Keywords: Sugarcane trash, composting, *Trichoderma*, bioinoculants, cow dung slurry

Introduction
In India, approximately 6.5 million tons of sugarcane trash are produced annually, with most residues typically burned in the field due to a lack of proper composting techniques (Mohan and Ponnusamy 2011) [23]. Hence, there is substantial economic interest in advancing technologies and processes for the efficient utilization of these wastes (Zhang *et al.*, 2000) [31]. The focus has shifted towards aerobic composting, which transforms wastes into organic manure enriched with plant nutrients and humus (Singh and Sharma, 2002), as well as the biodegradation of lignocellulosic wastes through integrated composting systems with bioinoculants. To rejuvenate soil productivity, adopting practices such as recycling crop biomass such as sugarcane residues and left over crop material, presents a promising alternative (Gaind and Nain 2007) [11]. Utilizing these plant residues, whether composted or otherwise, can serve as a cost-effective alternative to inorganic fertilizers, able it they may yield early compost with limited nutrient content. Enriching compost with mineral additives can effectively boost the growth and efficacy of indigenous fungi, accelerating the decomposition process of sugarcane trash. For decomposition of 1 ton sugarcane crop residues added 8 kg Urea + 10 kg SSP + 1 kg decomposing culture (Ghodke *et al.*, 2020) [13]. The cellulose-decomposing microbes play a vital role in preserving the carbon equilibrium in nature, particularly evident in the decomposition of sugarcane trash, which ultimately fosters

humus formation and enhances soil fertility.

Composting is a thermophilic process that can be aerobic or anaerobic, requiring aeration to stabilize organic wastes and maintaining optimal moisture levels for microbial activity. Compost is the result of composting, characterized as a stabilized and sanitized product that undergoes an initial rapid decomposition stage. It is advantageous for plant growth, making the quality of compost crucial in waste composting for sustainable agriculture and resource management (Gajalakshmi and Abbasi, 2008) [12]. The composting process progresses through four distinct phases: 1. In the initial mesophilic phase (10-42 °C), temperatures rise swiftly, triggering decomposition of organic matter. During the thermophilic phase (45-70 °C), 3 sustained high temperatures result from intense metabolic activity by indigenous microorganisms. The middle mesophilic phase (50-65 °C) follows, during which temperatures decrease, allowing heat- resistant microbes to thrive once more. Finally, the finishing phase (23-50 °C) stabilizes both organic matter and biological heat production (Chen *et al.*, 2011) [6].

Adding cow dung slurry to trash during composting significantly enhances the decomposition process and improves compost quality. Cow dung is rich in microbial populations and nutrients, particularly nitrogen and carbon which stimulate microbial activity and accelerate the breakdown of organic matter. It is possible to accelerate decomposition of cane trash by using cellulolytic or lignolytic microorganisms like *Trichoderma*, *Trichurus* and *Aspergillus* spp. (Saravanan and Mahendran, 2003) [27]. *Trichoderma* spp., common inhabitants of the rhizosphere, besides accelerating decomposition of organic residues can act as biocontrol agents of soilborne plant pathogens (Chet, 1987; Chet *et al.*, 1997; Harman and Lumsden 1990; Harman, 2000) [7, 8, 17, 18]. *Trichoderma* act as a biocontrol agent that can reduce disease and enhance plant growth under green house or field conditions (Harman and Bjorkman 1998; Ousley *et al.*,1994) [16, 24]. The inoculation of *Trichoderma* also enhanced iron transport mechanisms from roots to shoots (Yedidia *et al.*, 2001). Production or control of plant hormones is responsible for improving root development, such as auxin, harzionic acids and harzionalide by *Trichoderma spp.* (Cai *et al.*, 2013, Contreras-Cornejo *et al.*, 2009) [9].

Therefore, instead of relying on environmentally harmful practices like trash burning, it becomes imperative to adopt sustainable alternatives such as composting with the aid of bioinoculants, organic and chemical additives. These approaches not only ensure efficient recycling of sugarcane residues but also enhance soil fertility, reduce dependence on chemical fertilizers and mitigate adverse environmental impacts. Emphasizing such eco-friendly practices will be crucial in improving crop productivity, lowering production costs and safeguarding natural resources for future generations.

Methods

A pot trial experiment was conducted at the farm of Department of Plant Pathology and Agricultural Microbiology, College of Agriculture, Pune during 2024-25 in completely randomized design with seven treatments and three replications. The plastic pots were fixed by digging small pit at experimental site. In each treatment of pot, 10-15 layers of chopped sugarcane trash was filled with chemical additives *viz.*, Mono ammonium phosphate (MAP) @ 5 kg, Diammonium phosphate (DAP) @ 5 kg and Urea @ 10 kg urea mixed in 100 lit. water for per ton of sugarcane trash. These layers are then moistened with filtered 5 litres of slurry made up of cow dung (i.e., 50 g soil + 50 g cow dung for every 1 litre of water). Liquid bioinoculant of *Trichoderma spp.* (*T. asperellum, T. harzianum and T. hamatum*) @ 1 lit. each per ton of sugarcane trash was applied in each layer of sugarcane trash. Over the final trash layer, a layer of soil will be spread to a thickness of 15cm and the head is covered. The heap will be moistened once in a week from above and allowed to decompose up to 4 months. The compost material was turned once at 30 days after composting to allow more aeration inside the material. Allowing bottom layer to top and top layer at bottom for uniform composting. The observations on changes in microbial population was estimated at monthly interval through serial dilution technique and pour plate method (Aneja, 2007). Periodical monitoring of decomposition at (0, 5, 10, 15, 30, 45, 60, 75, 90 and 120 days) by measuring temperature with compost temperature probe (Bajiko *et al.*, 2018) [2] and the moisture percent by gravimetric method (Hati, 2021) [19] during composting stages. Effect of liquid bioinoculants, organic and chemical additives on the quality of compost of sugarcane trash including physical properties such as, dark coloration, fine texture, weight at maturity, per cent weight loss at regular intervals were recorded and summarized. The data obtained from different observations were computed statistically by using the standard statistical methods as described by Panse and Sukhatme (1967) [25] for its statistical significance. The data were presented in tabular form with suitable graphical illustrations and figures at appropriate places.

Results and discussion

Periodical CO_2 evolution as influenced by use of liquid bio-inoculants, organic and chemical additives for decomposition of sugarcane trash

The data pertaining to the periodical CO_2 evolution under aerobic conditions are presented in Table 1 and depicted graphically in Figure 1. The highest CO_2 evolution which peaked at 62.33 mg kg^{-1} d^{-1} dry matter on the 60th day**,** recorded in T_5- Spray of 10 kg Urea + 5 kg Di-ammonium Phosphate (DAP) (18:46:0) + Spray of filtered cow dung slurry @ 5 lit. + liquid bioinoculant *Trichoderma spp.* (*T. asperellum, T. harzianum and T. hamatum*) @ 1 lit. each per ton of sugarcane trash there after the respiration rate was decreased at 90 and 120 days of composting in respect of various treatments. It was found statistically at par with treatment T_6-Application of 8 kg Urea + 10 kg SSP and 1 kg decomposing culture and T_4- Spray of 10 kg Urea + 5 kg Mono-ammonium Phosphate (MAP) (12:61:0) + Spray of filtered cow dung slurry @ 5 lit + liquid bioinoculant *Trichoderma spp.* (*T. asperellum, T. harzianum and T. hamatum*) @ 1 lit. each per ton of sugarcane trash with total CO_2 evolution of 61.63 mg kg^{-1} d^{-1} and 60.90 mg kg^{-1} d^{-1}, respectively and the lowest CO_2 evolution 34.30 mg kg^{-1} d^{-1} in the absolute control (T_7). By the end of the composting period (120th day) CO_2 evolution in all treatments had significantly decreased, with values ranging from 44.07 mg kg^{-1} d^{-1} (T_5) to 30.87 mg kg^{-1} d^{-1} indicating compost stabilization. These observations are supported by Bharadwaj and Gaur (1970)**,** who suggested that greater carbon loss during composting results from intensified microbial activity, influenced by substrate fineness and oxygen availability. during decomposition. Furthermore, Laharia *et al.*, (2019) [20] reported that the respiration rate increased during the initial composting phase up to 60 days due to high microbial mineralization of organic matter, but gradually declined at 90 and 120 days signaling a reduction in microbial activity as compost reached maturity.

Table 1: Periodical CO_2 evolution as influenced by use of liquid bio-inoculants, organic and chemical additives for decomposition of sugarcane trash.

Treatments	Periodical CO_2 evolution (mg kg^{-1} d^{-1})									
	1st d	5th d	10th d	15th d	30th d	45th d	60th d	75th d	90th d	120th d
T_1	13.03	13.43	14.13	16.13	23.67	38.33	51.60	49.70	41.63	32.50
T_2	12.93	13.20	14.43	16.17	24.45	39.13	52.07	50.03	43.10	35.73
T_3	13.07	13.63	15.63	17.63	25.37	32.63	42.20	41.63	37.63	31.33
T_4	13.87	13.97	15.07	18.30	26.90	40.43	60.90	52.67	43.27	38.73
T_5	12.73	13.33	15.57	18.33	27.33	42.43	62.33	54.53	47.73	44.07
T_6	13.63	13.97	15.27	18.20	27.17	41.33	61.63	53.27	46.33	43.17
T_7	12.60	12.93	13.93	14.37	19.40	26.53	34.30	39.17	36.83	30.87
S.E. (m) ±	1.57	1.20	1.37	1.13	0.82	0.89	0.77	0.93	0.72	0.69
CD 5%	NS	NS	NS	NS	2.47	2.71	2.34	2.81	2.19	2.08

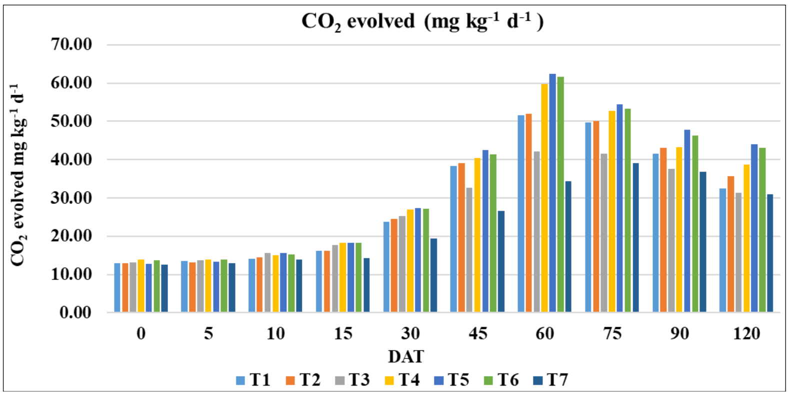

Fig 1: Effect of liquid bio-inoculants, organic and chemical additives on CO_2 evolved during composting of sugarcane trash

Periodical C:N ratio as influenced by use of liquid bio-inoculants, organic and chemical additives for decomposition of sugarcane trash.

The perusal of the data presented in Table 2 and graphically depicted in Figure 2 on periodical C:N ratio indicated that, all the treatments were significantly superior in reducing C:N ratio of sugarcane trash as compared to untreated control. Among them T_5 - Spray of 10 kg Urea + 5 kg Di-ammonium Phosphate (DAP) (18:46:0) + Spray of filtered cow dung slurry @ 5 lit. + liquid bioinoculant *Trichoderma spp.* (*T. asperellum, T. harzianum and T. hamatum*) @ 1 lit. each per ton of sugarcane trash was found significantly superior and the most effective for the reducing C:N ratio of sugarcane trash. It decreased from 118.8 at initiation to 17.77 by the end of the composting period (120 days). However, it was found statistically at par with treatment T_6- Application of 8 kg Urea + 10 kg SSP and 1 kg decomposing culture and T_4- Spray of 10 kg Urea + 5 kg Monoammonium Phosphate (MAP) (12:61:0) + Spray of filtered cow dung slurry @ 5 lit + liquid bioinoculant *Trichoderma spp.* (*T. asperellum, T. harzianum and T. hamatum*) @ 1 lit. each per ton of sugarcane trash with values reaching 119.47 and 118.80 at initiation to 17.99 and 20.72 at 120 days, respectively. The highest C:N ratio of sugarcane trash was found in the control treatment which received no amendments, showed the least reduction, ending at 65.62, suggesting incomplete composting within the given time frame. These results are in agreement with the findings of Zhengyu *et al.*, (2023) [32], who recommended a final C:N ratio of 20-30 especially when combined with microbial inoculation. Similar results were also observed by Goyal *et al.*, (2005) [15] at maturity (90 days of composting), the C:N ratio of the final composted products ranged from 11.7 to 28.3, with the lowest in pressmud and the highest in sugarcane trash plus cattle dung. The study confirms that balanced nutrients and microbial consortia improve composting efficiency, evidenced by a consistent C:N ratio decline.

Table 2: Periodical C:N ratio as influenced by use of liquid bio-inoculants, organic and chemical additives for decomposition of sugarcane trash.

Treatments	Periodical C:N ratio									
	1st d	5th d	10th d	15th d	30th d	45th d	60th d	75th d	90th d	120th d
T_1	118.47	118.07	117.17	115.93	107.73	87.93	64.43	38.53	29.67	25.10
T_2	118.67	118.20	117.45	114.80	107.13	86.97	60.87	37.47	27.17	21.68
T_3	117.93	117.23	116.50	114.10	106.93	98.07	85.33	77.53	64.77	56.92
T_4	118.13	117.53	116.70	114.27	101.83	82.27	59.63	35.07	25.93	20.72
T_5	118.80	117.70	116.93	113.73	100.63	80.90	53.83	32.30	23.53	17.77
T_6	119.47	118.50	117.70	114.33	101.13	81.23	55.90	33.13	24.37	17.99
T_7	117.47	117.13	116.97	115.83	111.50	107.23	96.70	86.37	78.13	65.62
S.E. (m) ±	1.84	0.88	0.91	0.86	1.21	1.35	0.82	1.02	1.14	0.98
CD 5%	NS	NS	NS	NS	3.68	4.09	2.49	3.09	3.47	2.97

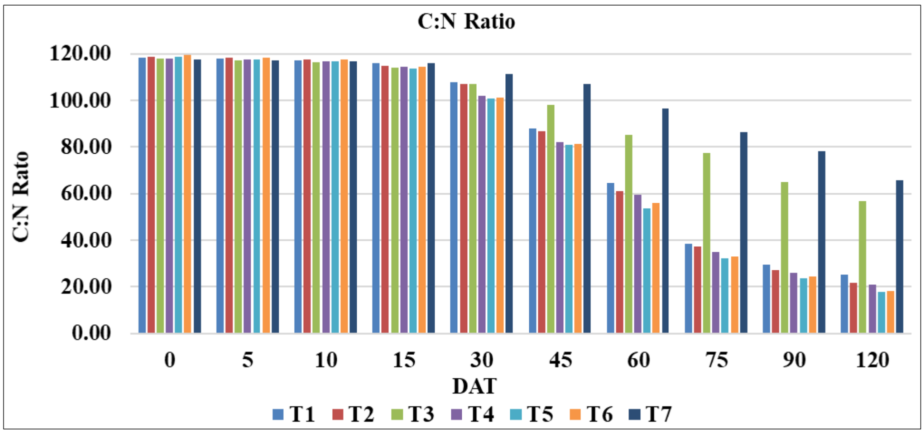

Fig 2: Effect of liquid bio-inoculants, organic and chemical additives on C:N ratio during composting of sugarcane trash

Periodical temperature (ºC) as influenced by use of liquid bio-inoculants, organic and chemical additives for decomposition of sugarcane trash

The data depicting on the periodical variation in temperature were recorded at regular intervals from the onset of composting up to 120 days and are presented in Table 3 and Fig. 3. All treatments showed a significantly increasing temperature trend during the early phase of composting (up to 60 days) followed by a gradual decline towards stabilization. The maximum temperature i.e., 50.24 °C was recorded in spray of 10 kg Urea + 5 kg Di-ammonium Phosphate (DAP) (18:46:0) + Spray of filtered cow dung slurry @ 5 lit. + liquid bioinoculant *Trichoderma* spp. (*T. asperellum, T. harzianum and T. hamatum*) @ 1 lit. each per ton of sugarcane trash. It was found statistically at par with treatment Application of 8 kg Urea + 10 kg SSP and 1 kg decomposing culture (T_6) and Spray of 10 kg Urea + 5 kg Monoammonium Phosphate (MAP) (12:61:0) + Spray of filtered cow dung slurry @ 5lit + liquid bioinoculant *Trichoderma* spp. (*T. asperellum, T. harzianum and T. hamatum*) @ 1 lit. each per ton sugarcane trash (T_4) reaching temperature 49.63 °C and 47.71 °C, respectively. Whereas, least temperature was recorded in absolute control (T_7) i.e. 38.28 °C. In the 120th days of composting, no significant differences were observed among all treatments and was ranged between 35.67 °C to 30.81 °C. This uniformity in final temperatures suggests that all treatments, regardless of their initial thermophilic intensity, approached ambient stabilization levels by day 120. These findings align with Gowda (1996) [14], who observed that microbial respiration raises compost temperature through oxygen use and heat release, favoring rapid growth of thermophilic microbes (40-70 °C) and faster decomposition. Similarly, Dhapate *et al.* (2018) [10] reported higher temperatures in sugarcane trash inoculated with cellulolytic fungi compared to uninoculated controls which then gradually decreased up to 120 days. The present study confirms that nutrient supplementation with microbial inoculants sustained elevated thermophilic conditions promoting efficient organic matter decomposition.

Table 3: Periodical temperature (^{0}C) as influenced by use of liquid bio-inoculants, organic and chemical additives for decomposition of sugarcane trash

Treat.	Periodical Temperature (^{0}C)									
	1st d	5th d	10th d	15th d	30th d	45th d	60th d	75th d	90th d	120th d
T_1	28.84	28.97	29.43	31.33	35.83	42.87	45.71	43.01	36.09	31.59
T_2	28.32	29.07	30.30	32.57	35.27	43.54	46.27	44.58	37.63	32.05
T_3	27.70	28.70	29.33	32.43	34.87	37.77	39.20	37.52	34.03	32.90
T_4	28.37	29.23	31.00	33.07	36.70	43.67	47.71	42.37	38.29	33.89
T_5	29.74	28.77	30.83	33.40	38.13	44.87	50.24	45.71	39.58	35.67
T_6	27.95	28.93	31.20	33.83	37.27	44.47	49.63	46.74	38.74	34.95
T_7	29.53	28.43	29.93	31.27	33.47	35.29	38.28	35.85	32.86	30.81
S.E. (m) ±	0.65	1.23	0.78	1.34	0.76	0.86	0.85	0.75	0.74	1.15
CD 5%	NS	NS	NS	NS	2.30	2.62	2.59	2.29	2.25	NS

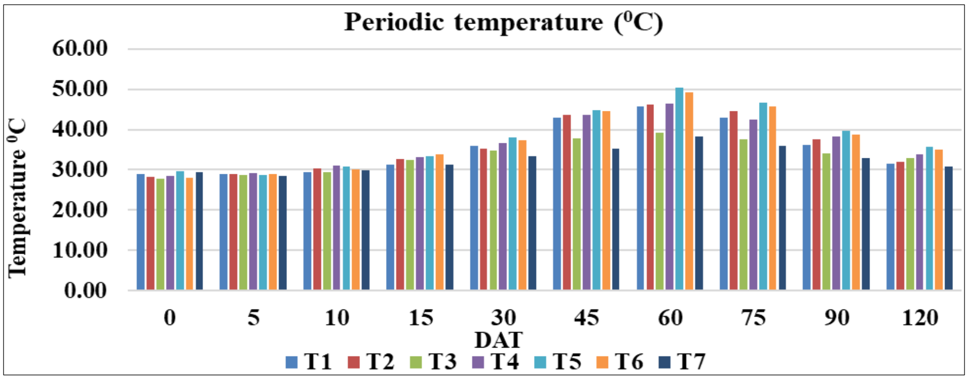

Fig 3: Effect of liquid bio-inoculants, organic and chemical additives on temperature (°C) during composting of sugarcane trash

Periodical moisture content (%) as influenced by use of liquid bio-inoculants, organic and chemical additives for decomposition of sugarcane trash

Moisture content was regularly monitored throughout the composting period across all treatments and the observations are enumerated in Table 4 and depicted graphically in Figure 4. Most treatments maintaining levels between 43 to 55% during the composting. Among all treatments T_5 - Spray of 10 kg Urea + 5 kg Di-ammonium Phosphate (DAP) (18:46:0) + Spray of filtered cow dung slurry @ 5 lit. + liquid bioinoculant *Trichoderma* spp. (*T. asperellum*, *T. harzianum* and *T. hamatum*) @ 1 lit. each per ton of sugarcane trash, T4 - Spray of 10 kg Urea + 5 kg Monoammonium Phosphate (MAP) (12:61:0) + Spray of filtered cow dung slurry @ 5lit + liquid bioinoculant *Trichoderma* spp.(*T. asperellum*, *T. harzianum* and *T. hamatum*) @ 1 lit. each per ton sugarcane trash and T6 - Application of 8 kg Urea + 10 kg SSP and 1 kg decomposing culture were significantly retained higher moisture levels ending at 48.00%, 48.20% and 49.50%, respectively. These treatments benefited from the presence of nutrient-rich additives and microbial inoculants, which enhanced organic matter decomposition and helped retain moisture through the release of metabolic water during microbial respiration. These results align with the findings of Misra *et al.*, (2003) [22] who noted that the optimal moisture content for composting ranges between 40% and 65%, with moisture levels above 65% reduce porosity and promote anaerobic conditions leading to unpleasant odours, while levels below 30% can inhibit bacterial activity. Further support comes from Razmjoo *et al.*, (2015) [26] and Bazrafshan *et al.* (2016) [3], who reported that a moisture range of 45-50% is ideal for microbial activity and effective composting under aerobic conditions.

Table 4: Periodical moisture content (%) as influenced by use of liquid bio-inoculants, organic and chemical additives for decomposition of sugarcane trash

Treatments	Periodical moisture content (%)									
	1st d	5th d	10th d	15th d	30th d	45th d	60th d	75th d	90th d	120th d
T_1	61.43	53.10	48.57	50.30	51.40	47.43	52.90	47.20	49.67	47.57
T_2	64.03	54.60	49.37	51.33	52.10	48.40	54.37	49.87	50.20	47.97
T_3	65.70	55.93	49.40	48.57	49.50	47.83	53.47	49.37	52.10	47.40
T_4	66.13	54.67	51.00	46.93	53.57	49.40	52.50	50.40	47.80	48.20
T_5	62.73	54.47	49.10	50.00	53.80	52.67	54.90	50.60	49.40	48.00
T_6	63.63	53.90	51.13	49.63	53.90	51.50	53.93	51.10	48.00	49.50
T_7	68.20	56.77	48.87	46.13	50.27	48.80	48.93	47.57	54.50	43.37
S.E. (m) ±	1.66	1.45	1.20	0.74	1.03	0.74	1.00	0.89	0.92	0.90
CD 5%	NS	NS	NS	2.26	3.11	2.26	3.04	2.70	2.78	2.72

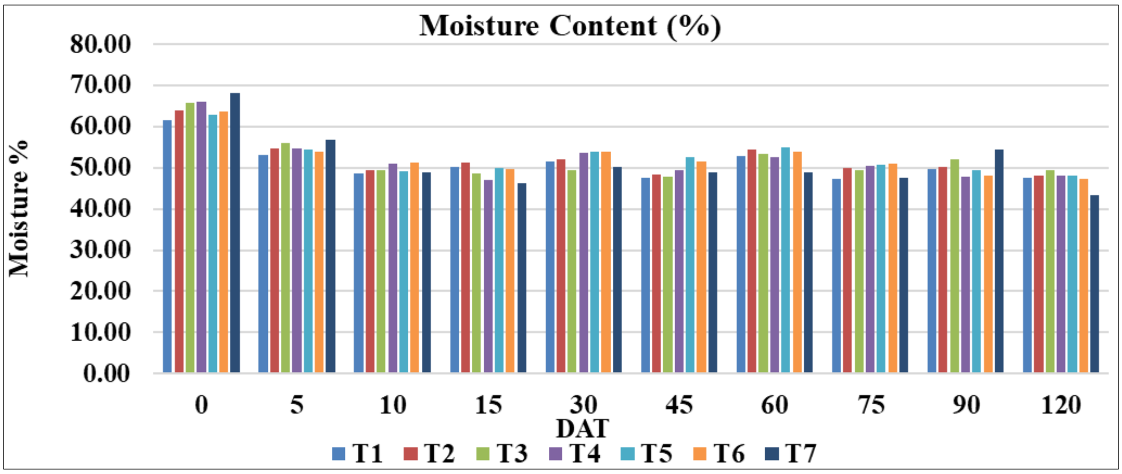

Fig 4: Effect of liquid bio-inoculants, organic and chemical additives on moisture content (%) during composting of sugarcane trash

Periodical population of *Trichoderma spp.* (1x 10^5 cfu/g compost) as influenced by use of liquid bio-inoculants, organic and chemical additives during decomposition of sugarcane trash

The population dynamics highlight the influence of nutrient sources and microbial inoculants on fungal proliferation during sugarcane trash decomposition are enumerated in Table 5 and depicted graphically in Figure 5. The fungal population was significantly increased up to 60 days after inoculation of liquid bio-inoculants and decreased gradually thereafter**.** The numbers of *Trichoderma spp.* at initial for all treatment were ranged between (0.70 and 2.6x10^5 cfu/g of compost). The *Trichoderma* spp. population were observed significantly increased from 26.00 × 10^5 cfu/g compost and recorded maximum 38.33 × 10^5 cfu/g of composting T_5 - Spray of 10 kg Urea + 5 kg Di-ammonium Phosphate (DAP) (18:46:0) + Spray of filtered cow dung slurry @ 5lit. + liquid bioinoculant *Trichoderma spp.* (*T. asperellum*, *T. harzianum and T. hamatum*) @ 1 lit. each per ton of sugarcane trash at 60th day of composting. However, it was found statistically at par with treatment T_4- Spray of 10 kg Urea + 5 kg Monoammonium Phosphate (MAP) (12:61:0) + Spray of filtered cow dung slurry @ 5 lit + liquid bioinoculant *Trichoderma spp.*(*T. asperellum*, *T. harzianum and T. hamatum*) @ 1 lit. each per ton sugarcane trash which recorded 36.67 × 10^5 cfu/g of compost, respectively. Whereas, minimum *Trichoderma spp.* population 15 × 10^5 cfu/g of compost was observed in absolute control (T_7) at 60 days after inoculation. Gradual decline in *Trichoderma spp.* populations was observed across all treatments at 90th and 120th day of composting, as substrate availability reduced and composting progressed toward the stabilization phase and approached maturity. These observations are supported by Dhapate *et al.*, (2018) [10], who reported that fungal populations in sugarcane trash compost peaked around 60 days due to thermophilic fungi, then declined as compost stabilized. Furthermore, Mahanta *et al.*, (2014) [21] confirmed that *Trichoderma harzianum* possesses strong lignocellulolytic potential and can effectively break down complex plant residues by producing key enzymes like cellulases and hemicellulases. This explains the high fungal population and efficient decomposition observed in treatments inoculated with *Trichoderma*.

Table 5: Periodical population of *Trichoderma spp.* (1x 10^5 cfu/g of compost) as influenced by use of liquid bio-inoculants, organic and chemical additives during decomposition of sugarcane trash

S.N.	Treatments	10^5 CFU/g of compost			
		30th d	60th d	90th d	120th d
T_1	Spray of 10 kg Urea + 5 kg Mono-ammonium Phosphate (MAP) (12:61:0) per ton of sugarcane trash	14.67	20.0	16.67	15.33
T_2	Spray of 10 kg Urea + 5 kg Di-ammonium Phosphate (DAP) (18:46:0) per ton of sugarcane trash	16.00	23.3	18.67	17.00
T_3	Spray of filtered cow dung slurry @ 5 lit + liquid bio-inoculant *Trichoderma spp. (T. asperellum, T. harzianum and T. hamatum)* @ 1 lit. each per ton of sugarcane trash	22.67	27.0	22.33	21.00
T_4	$T_1 + T_3$	24.67	36.7	28.00	23.67
T_5	$T_2 + T_3$	26.00	38.3	29.00	24.33
T_6	Application of 8 kg Urea + 10 kg SSP and 1 kg decomposing culture per ton sugarcane trash	19.20	29.0	21.00	20.67
T_7	Absolute control	11.67	15.0	13.00	12.33
S.E. (m) ±		1.18	1.46	1.35	1.47
CD 5%		3.59	4.44	4.08	4.47

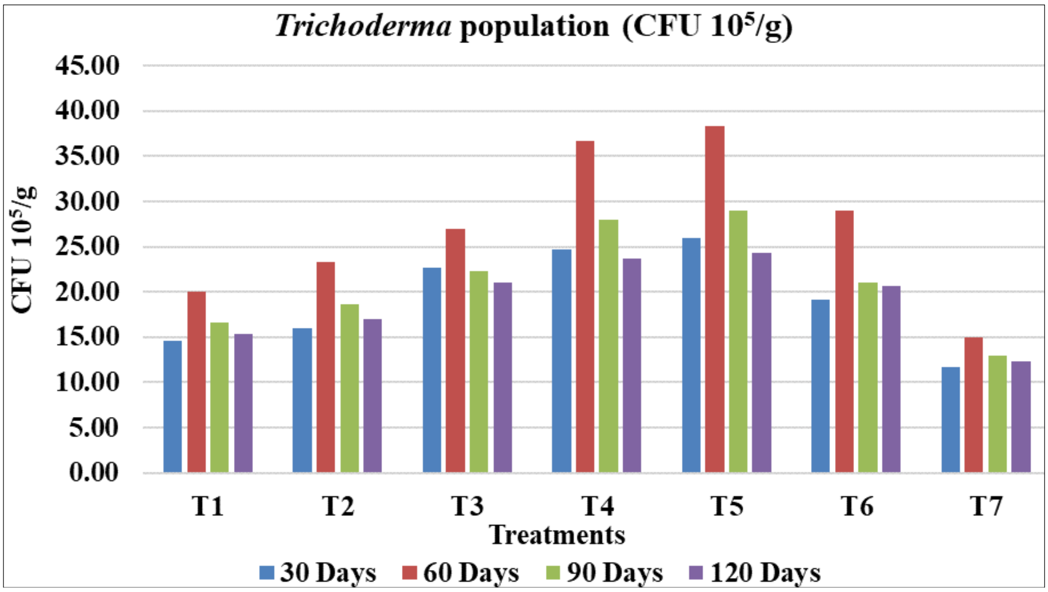

Fig 5: Effect of liquid bio-inoculants, organic and chemical additives on *Trichoderma* population during composting of sugarcane trash

Effect of liquid bioinoculants, organic and chemical additives on quality of compost

Physical properties *viz.*, colour at maturity, particle size, final compost weight and percentage weight loss of matured compost produced by the decomposition of sugarcane trash using different combinations of liquid bio-inoculants, organic, and chemical additives are summarized in Table 6 and depicted graphically in Figure 6.

Colour at maturity

Colour change is a qualitative indicator of compost maturity. Most treatments (T_1 to T_6) resulted in compost with a "Very dark grayish brown" to "Very dark gray" colour, typical of well-decomposed and stabilized organic matter. Notably, "Very dark gray" colour, was observed in T_5 - Spray of 10 kg Urea + 5 kg Di-ammonium Phosphate (DAP) (18:46:0) + Spray of filtered cow dung slurry @ 5lit. + liquid bioinoculant *Trichoderma spp.* (*T. asperellum, T. harzianum and T. hamatum*) @ 1 lit. each per ton of sugarcane and T_6-Application of 8 kg Urea + 10 kg SSP and 1 kg decomposing culture suggesting complete humification and maturity. In contrast, the absolute control (T_7) showed a "Light Olive Brown", indicating poor or incomplete decomposition shown below.

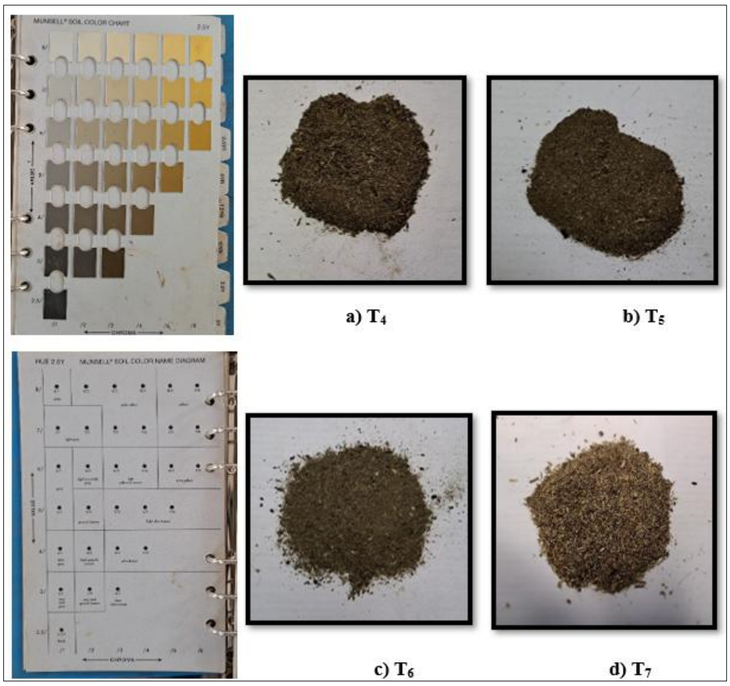

Fig 6: Colour of compost observed at maturity in munsel colour chart

Particle Size (4 mm sieve fraction)

The results in respect of particle Size (4 mm sieve fraction) of compost was significantly influenced by different treatments shown in Table 6. Among all treatments, the treatment T_5 - Spray of 10 kg Urea + 5 kg Di-ammonium Phosphate (DAP) (18:46:0) + Spray of filtered cow dung slurry @ 5lit. + liquid bioinoculant *Trichoderma spp.* (*T. asperellum, T. harzianum and T. hamatum*) @ 1 lit. each per ton of sugarcane resulted superior 89.55 g particle size. However, it was found statistically at par with treatment T_6 - Application of 8 kg Urea + 10 kg SSP and 1 kg decomposing culture. The lowest particle size was observed in the absolute control T_7 (65.79 g), indicating poor decomposition and coarse compost texture due to the lack of external inputs.

Weight at maturity and per cent loss in weight

Among all the treatment, the treatment T_5 - Spray of 10 kg Urea + 5 kg Di-ammonium Phosphate (DAP) (18:46:0) + Spray of filtered cow dung slurry @ 5lit. + liquid bioinoculant *Trichoderma spp.* (*T. asperellum, T. harzianum and T. hamatum*) @ 1 lit. each per ton of sugarcane recorded maximum weight at maturity 7.11 kg and total loss in weight i.e. 28.9% and it was statistically at par with treatment T_6 - Application of 8 kg Urea + 10 kg SSP and 1 kg decomposing culture showed 7.17 kg weight at maturity and weight loss value 28.3%. While the absolute control T_7 showed the 8.95 kg weight at maturity and least weight loss of 10.5%, indicating poor composting efficiency due to the absence of both nutrient and microbial inputs. Similar results were proposed by Dhapate *et al.*, (2018) [10] and Shinde *et al.*, (2024) [28] who reported loss in weight of sugarcane trash during composting.

Treatments integrating with chemical fertilizers, organic additives, and microbial inoculants (especially T_5 and T_6) significantly improved compost physical quality. These treatments produced darker and finer compost with higher mass reduction, indicating better microbial breakdown and humification.

Table 6: Physical properties of matured sugarcane trash compost after 120 days of composting as influenced by liquid bio-inoculants, organic and chemical additives

Tr. No.	Treatment details	Colour at maturity	Particle size (4mm) (g)	Weight at maturity (Kg)	Per cent loss in weight (%)
T_1	Spray of 10 kg Urea + 5 kg Monoammonium Phosphate (MAP) (12:61:0) per ton of sugarcane trash	Very dark grayish brown	81.12	7.67	23.3
T_2	Spray of 10 kg Urea + 5 kg Di-ammonium Phosphate (DAP) (18:46:0) per ton of sugarcane trash	Very dark grayish brown	84.32	7.54	24.6
T_3	Spray of filtered cow dung slurry @ 5 lit + liquid bioinoculant *Trichoderma spp. (T. asperellum, T. harzianum and T. hamatum)* @ 1 lit. each per ton of sugarcane trash	Dark grayish brown	78.41	8.45	15.5
T_4	$T_1 + T_3$	Very dark grayish brown	82.31	7.41	25.9
T_5	$T_2 + T_3$	Very dark gray	89.55	7.11	28.9
T_6	Application of 8 kg Urea + 10 kg SSP and 1 kg decomposing culture per ton sugarcane trash	Very dark gray	88.57	7.17	28.3
T_7	Absolute control	Light olive brown	65.79	8.95	10.5
S.E. (m) ±			1.73	0.11	
CD 5%			5.26	0.32	

Conclusion

Among the various composting techniques combined application of 10 kg Urea + 5 kg Di-ammonium Phosphate (DAP) (18:46:0) + Spray of filtered cow dung slurry @ 5lit. + liquid bioinoculant *Trichoderma spp.* (*T. asperellum, T. harzianum and T. hamatum*) @ 1 lit. each per ton of sugarcane trash proved most effective. Integrating liquid bioinoculants with organic and chemical additives provides a sustainable, eco-friendly method can transform sugarcane trash into high quality compost. However these results are based on one season experimentation and needs further investigation by conducting long term research trials.

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