



ISSN Print: 2664-6781
 ISSN Online: 2664-679X
 NAAS Rating (2026): 4.77
 IJACR 2026; 8(9): 58-61
www.chemistryjournals.net
 Received: 13-07-2026
 Accepted: 14-08-2026
 Published: 25-09-2026

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Studies on the rate of decomposition of *Parthenium* grass (*Parthenium hysterophorus* L.) along with partially decomposed cow dung during vermicompost production

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DOI: <https://www.doi.org/10.33545/26646781.2026.v8.i9.a.749>

ABSTRACT

The present investigation was undertaken to study the rate of decomposition of parthenium grass (*Parthenium hysterophorus* L.) along with partially decomposed cow dung during vermicompost production. The experiment was conducted during 2025–26 (25th March to 24th June, 2026) at the Department of Animal Husbandry and Dairy Science, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, using the HDPE raised bed method. Four treatments were evaluated: T₁ (30% cattle shed waste + 70% partially decomposed cow dung), T₂ (30% parthenium grass + 70% partially decomposed cow dung), T₃ (40% parthenium grass + 60% partially decomposed cow dung), and T₄ (50% parthenium grass + 50% partially decomposed cow dung), arranged in a Randomized Block Design with five replications. Beds measuring 1.22 m × 0.91 m × 0.61 m were pre-decomposed for 21 days, after which *Eisenia foetida* was released at ~50 earthworms per 10 kg of raw material and moisture was maintained at 65–70% of maximum water-holding capacity. Temperature peaked at 15 days after filling (DAF) in all treatments (highest in T₁ at 46.2 °C and lowest in T₄ at 43.7 °C) and declined steadily to 20.1–22.2 °C at 90 DAF. Final vermicompost weight ranged from 42.6 kg (T₂) to 47.4 kg (T₁), averaging 45.0 kg. The highest weight reduction occurred in T₂ (39.87%), while T₃ gave the highest yield recovery (67.07%). Maturity period decreased significantly as parthenium proportion increased: T₄ matured earliest at 68 DAF, followed by T₃ (73 DAF), T₂ (76 DAF), and T₁ (87 DAF). Weed seed germination remained minimal in parthenium treatments (1.50 to 3.30 seeds/kg) and absent in T₁. Total organic carbon declined steadily across all treatments, and C:N ratios at 90 DAF ranged from 12.10 (T₂) to 17.20 (T₃), with all treatments achieving maturity (< 20 C:N). Increasing parthenium grass up to 50% accelerated decomposition and shortened maturity, proving its efficacy as a viable bedding substrate.

Keywords: *Parthenium hysterophorus* L., Vermicomposting, *Eisenia foetida*, C:N ratio, Organic waste management

1. Introduction

Decades of intensive chemical fertilizer and pesticide application since the Green Revolution have degraded soil health, leading to erosion, reduced organic matter content, and chemical residue accumulation. Regenerating soil organic matter is critical for sustainable agriculture. Vermicomposting—an eco-biotechnological process utilizing earthworms to transform organic waste into nutrient-rich humic castings—offers an efficient, low-cost solution (Ghatnekar *et al.*, 1998; Benitez *et al.*, 2000) [2, 1].

Earthworms act as mechanical blenders and biological drivers in soil systems (Norbu, 2002; Hansen, 2007) [4, 3]. While conventional composting takes 6–8 months and often yields nutrient-depleted product, vermicomposting rapidly converts biomass into high-quality bio-fertilizer. India generates 600–700 million tonnes of agricultural waste annually (Khobragade *et al.*, 2017) [5], representing a immense potential source of plant nutrients (Anonymous, 2014) [6].

Parthenium (*Parthenium hysterophorus* L.) is an aggressive, invasive weed posing significant ecological and agricultural threats. Traditional control methods like mechanical weeding and herbicide sprays are costly and environment-hazardous. Because *parthenium* seeds lack dormancy and germinate readily under moist conditions (Aneja, 1999; Kaur *et al.*, 2022) [7, 8], converting parthenium biomass into vermicompost offers a dual benefit: effective weed management and organic manure production. This study evaluates the rate of decomposition of parthenium grass blended in varying proportions with partially decomposed cow dung.

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2. Materials and Methods

2.1 Experimental site & layout

The experiment was conducted from March 25 to June 24, 2026, at the Vermicomposting Unit, Department of Animal Husbandry and Dairy Science, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra (22°42' N, 77°02' E, 307.41 m AMSL). Analytical testing was performed at the Department of Soil Science, Post Graduate Institute, Dr. PDKV, Akola. The region experiences a semi-arid climate with a mean annual rainfall of 740 mm.

2.2 Experimental treatments

The experiment was laid out in a Randomized Block Design (RBD) with four treatments and five replications across 20 HDPE raised beds (1.22 m × 0.91 m × 0.61 m):

- **T₁**: Cattle shed waste (30%) + Partially decomposed cow dung (70%) [Control]
- **T₂**: *Parthenium* grass (30%) + Partially decomposed cow dung (70%)
- **T₃**: *Parthenium* grass (40%) + Partially decomposed cow dung (60%)
- **T₄**: *Parthenium* grass (50%) + Partially decomposed cow dung (50%)

2.3 Substrate preparation and inoculation

Parthenium grass was harvested fresh, chopped to < 2 cm pieces, and layered into HDPE beds with cow dung. Beds underwent pre-decomposition for 21 days to dissipate initial heat. *Eisenia foetida* red worms were released at a rate of 50 earthworms per 10 kg of substrate (at 21 DAF). Moisture content was maintained at 65–70% water-holding capacity via periodic sprinkling.

2.5 Analytical methods and observations

Temperature was measured in the center of beds at a 15 cm depth using a digital thermometer. Total organic carbon (TOC) was measured by dry combustion at 600 °C for 2 hours (Anonymous, 1985) [9]. Total Nitrogen was evaluated using the Kjeldahl method to determine C:N ratios (Jackson, 1973) [10]. Weed seed germination was evaluated by a grow-out test using 2 kg finished compost per tray over 10 days. Statistical analysis was performed using Analysis of Variance (Panse *et al.*, 1967) [11] with CD evaluated at $p = 0.05$.

3. Results and Discussion

3.1 Temperature dynamics

Temperature profiles peaked at 15 DAF in all treatments due to rapid microbial heat generation, reaching 46.2 °C in T₁ and 43.7 °C in T₄. Temperatures declined smoothly as organic matter stabilized, settling at ambient ranges (20.1–22.2 °C) at 90 DAF (Table 2). This decline aligns with findings by Patnaik *et al.* (2010) [12], Hait *et al.* (2011) [13], and Rynk *et al.* (1992) [14].

Table 1. Periodical Changes in Temperature (°C) During Vermicomposting

Tr. No.	15 DAF	30 DAF	45 DAF	60 DAF	75 DAF	90 DAF
T ₁	46.2	35.9	29.4	24.4	23.0	22.2
T ₂	45.0	35.1	28.8	23.8	22.2	21.6
T ₃	44.5	34.4	28.2	23.1	21.6	21.0
T ₄	43.7	33.7	27.0	22.1	20.8	20.1
SE(m) ±	0.43	0.27	0.30	0.29	0.19	0.24
CD (5%)	1.32	0.84	0.93	0.85	0.60	0.75
Mean	44.85	34.78	28.35	23.35	21.90	21.23

3.2 Weight loss and yield recovery

The highest final vermicompost weight was recorded in T₁ (47.4 kg) and T₃ (47.2 kg). Maximum percentage weight reduction occurred in T₂ (39.87%), followed by T₄ (38.77%), T₁ (34.26%), and T₃

(32.93%). T₃ gave the highest yield recovery at 67.07% (Table 3). Similar mass reductions and recovery rates have been reported by Mahala *et al.* (2019) [15], Mayadevi (2016) [16], and Attayee (2015) [17].

Table 2. Biomass Weight Changes and Yield Recovery

Tr. No.	Initial Wt (kg)	Final Wt (kg)	Wt Reduction (kg)	Wt Reduction (%)	Yield Recovery (%)
T ₁	72.10	47.40	24.70	34.26	65.74
T ₂	70.85	42.60	28.25	39.87	60.13
T ₃	70.45	47.20	23.25	32.93	67.07
T ₄	69.90	42.80	27.10	38.77	61.23
SE(m) ±	—	0.50	—	—	—
CD (5%)	—	1.54	—	—	—
Mean	—	45.00	—	—	—

3.3 Maturity period and weed seed germination

Maturity time decreased significantly with higher *parthenium* proportions (Table 4). T₄ matured fastest at 68 DAF, followed by T₃ (73 DAF), T₂ (76 DAF), and T₁ (87 DAF). The soft leaf structure of *parthenium* accelerates decomposition compared to fibrous cattle shed waste (Savant, 2016; Pawar *et al.*, 2017) [19, 18]. Germinated weed seeds per kg of finished compost were zero in T₁ and extremely low in *parthenium* treatments (1.50 to 3.30 seeds/kg), confirming that

earthworm activity effectively neutralizes *parthenium* seed viability (Babu *et al.*, 2008) [20].

3.4 Total organic carbon (TOC) and C:N ratio

Total Organic Carbon declined steadily across all treatments from 30 DAF to 90 DAF (Table 5). T₁ recorded the lowest final TOC (23.90%), reflecting complete carbon loss via respiration (Suthar, 2007; Garg *et al.*, 2006) [22, 21]. At 90 DAF, C:N ratios ranged between 12.10 (T₂) and 17.20 (T₃). Since a C:N ratio below 20 indicates mature, humified compost (Garg *et al.*, 2006; Shailaja, 2005; Mistry

et al., 2015) [21, 23, 24], all formulations achieved full agronomic maturity.

Table 3. Maturity Period and Weed Seed Germination Rate

Tr. No.	Maturity Time (DAF)	Germinated Seeds (No./kg)
T ₁	87.0	0.00
T ₂	76.0	1.50
T ₃	73.0	2.40
T ₄	68.0	3.30
SE(m) ±	0.768	0.30
CD (5%)	2.303	0.90
Mean	76.0	1.80

Table 4. Total Organic Carbon (%) and Final C:N Ratio

Tr. No.	TOC 30 DAF (%)	TOC 60 DAF (%)	TOC 90 DAF (%)	C:N Ratio (90 DAF)
T ₁	34.20	28.20	23.90	13.60
T ₂	36.25	31.25	27.10	12.10
T ₃	38.10	33.35	29.10	17.20
T ₄	39.05	34.30	30.05	13.90
SE(m) ±	0.91	0.97	0.86	0.48
CD (5%)	2.81	2.98	2.65	1.47
Mean	36.90	31.77	27.53	14.20

4. Conclusion

Parthenium hysterophorus grass is a highly suitable organic substrate for vermicomposting when combined with partially decomposed cow dung. Increasing *parthenium* inclusion from 30% to 50% accelerated decomposition and reduced compost maturity time from 87 days (control) down to 68 days (T₄). Weed seed viability was effectively suppressed during the process, and all *parthenium* treatments achieved ideal final C:N ratios (< 20). Treatment T₄ (50% *parthenium* + 50% cow dung) is recommended for rapid vermicompost production, whereas T₃ (40% *parthenium* + 60% cow dung) provides the highest total yield recovery (67.07%).

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How to cite this article: Chirade T, Bidwe K, Shelke R, Shegokar S, Kankal D, Pawar V, et al. Studies on the rate of decomposition of *Parthenium* grass (*Parthenium hysterophorus* L.) along with partially decomposed cow dung during vermicompost production. *International Journal of Advanced Chemistry Research*. 2026;8(9):58-61. doi: <https://www.doi.org/10.33545/26646781.2026.v8.i9.a.749>

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