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RESEARCH ARTICLE

Seri waste - A boon to enhance yield, quality of mulberry leaf and rearing parameters of silkworm, *Bombyx mori* L. with integrated nutrient management approach

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Abstract

An experiment was conducted at the Forest College and Research Institute, Mettupalayam and a farmer's field at Annur, Coimbatore district, to assess the impact of organic manures and chemical fertilizers on mulberry (*Morus* spp.) leaf yield, quality and cocoon production. Mulberry is the primary food source for *Bombyx mori* L. and its nutritional status plays a vital role in sericulture productivity. Excessive reliance on chemical fertilizers can impair soil health and silkworm performance, while organic amendments offer a more sustainable alternative. The objective of this study was to evaluate the effectiveness of Integrated Nutrient Management (INM) using sericulture waste compost, vermicompost and varying levels of Recommended Dose of Fertilizer (RDF) on soil fertility, nutrient uptake, plant growth and leaf yield in two mulberry cultivars, G4 and S36. The experiment involved treatments combining RDF with organic manures, including seri-waste compost and vermicompost, applied individually and in combination. Results showed that treatments integrating 75 % RDF with either vermicompost or seri-waste compost significantly improved plant growth, leaf yield and nutrient uptake compared to control and full RDF alone. Compost-based treatments also enhanced soil organic carbon and macronutrient content. In conclusion, integrating organic manures with reduced levels of chemical fertilizers is a promising strategy to improve mulberry productivity, enhance soil health and promote sustainable sericulture. These findings support the use of enriched seri-wastes as effective nutrient sources in INM programs for mulberry cultivation.

Keywords: cocoon production; mulberry leaf yield; nutrient uptake; organic manures; soil organic carbon; vermicompost

Introduction

India is the world's second-largest silk producer and the leading consumer of raw silk (1). It possesses a rich diversity of wild silk moths, classified primarily by their host plants into mulberry (*Morus* spp.), tropical and oak tasar (*Terminalia* spp.), eri (*Ricinus* spp. and others) and muga (*Litsea* spp.) (2, 3). Commercial silk production is dominated by mulberry silk, contributing about 90 % of total output, while the remainder comprises non-mulberry or Vanya silks (1). Sericulture, practiced in approximately 59000 Indian villages, supports nearly six million families and plays a vital role in rural employment, especially for women (4). The production chain involves silkworm seed generation, host plant cultivation (mainly mulberry), silkworm rearing and cocoon processing, each generating significant organic residues (5).

These residues include mulberry cultivation waste, silkworm excreta and pupae left after cocoon processing. Silkworm pupae are nutrient-rich with pharmaceutical, cosmetic, biofuel and feed applications, although their use in India remains limited (6,7). India, along with China, contributes about 98 % of global silk production, with India producing 35261 metric tonnes in 2018-19 across all four commercial silk types: mulberry, tasar, eri and muga (8,9). Mulberry is the exclusive food source for the domesticated silkworm *Bombyx mori* L. and its nutritional quality significantly affects silkworm growth and cocoon quality (10).

Excessive use of chemical fertilizers in mulberry cultivation can reduce leaf quality and cause toxicity in silkworms, whereas integrating organic manures enhances leaf nutrition and cocoon traits (11). Sericulture-generated organic wastes, such as seri-waste compost, offer a sustainable alternative to chemical inputs, improving soil health and nutrient availability (12). Although chemical fertilizers boost leaf yield, their long-term use leads to soil degradation and nutrient depletion (13). Consequently, there is growing interest in organic and INM strategies that recycle animaland plant-derived residues to restore soil fertility and sustainability (11, 12).

Sericulture generates significant by-products rearing 100 Disease-Free Layings (DFLs) requires 1000 kg of mulberry leaves, producing 300 kg of litter and 500 kg of biomass residues (14). Additionally, processing 1 kg of silk yields about 8.014 kg of wet pupae and 2 kg of dry pupae, which are increasingly explored for nutraceutical applications (15). Another major by-product, sericin protein from cocoon degumming, is largely discarded but holds potential for cosmetic and biomedical uses, with an estimated 250-300 tonnes of waste generated annually from India's 1600-tonne silk production (16).

Annually, 1 ha of mulberry cultivation can generate around 15 tonnes of sericultural waste, containing approximately 280-300 kg N, 90-100 kg P and 150-200 kg K (17). Vermicomposting has emerged as an efficient method to convert these wastes into nutrient-rich composts, enhancing soil structure, fertility and microbial activity (12). Vermicompost derived from sericultural residues using earthworm consortia such as *Eudrilus eugeniae*, *Eisenia foetida* and *Perionyx excavatus* contains 1.8–2.0 % N, 0.6-0.9 % P and 1.0-1.5 % K, with high micronutrient and microbial content (18, 19).

Despite their rich organic matter content, many sericultural residues remain underutilized (11). However, composts derived from silkworm litter and other seri-wastes have shown better nutrient profiles and agronomic efficiency than conventional farmyard manure (12, 17, 20). In this context, the present study evaluates the impact of INM strategies involving organic manures and chemical fertilizers on mulberry yield, leaf quality and silkworm performance, with the aim of promoting sustainable sericulture through improved soil health and nutrient recycling.

Materials and Methods

A field experiment was conducted at farmer's field, Annur, Coimbatore district in order to analyze the effect of organic and inorganic fertilizers on yield and quality of mulberry leaves along with silkworm rearing traits, cocoon yield and quality. Organic manures were produced using two methods from seriwaste. They are discussed below in detail.

Production of organic manures like seri-compost and vermicompost from seri-waste

Sericulture waste was collected from one of the silkworms rearing farm of Annur block, homogenized and around 1 kg of sample was taken, shade dried, processed and stored for further macro and micronutrient analysis.

Method of compost for seri-waste using microbes

Sericultural residues, including silkworm litter and leftover mulberry foliage, were systematically collected and initially spread in uniform thin layers (Fig. 1). These layers were then supplemented with a mixture comprising fresh cow dung, ash and water, which was evenly applied and compacted to facilitate microbial activity. To enhance the nutrient content of the compost, superphosphate was incorporated at a rate of 10 kg per metric ton of organic material. Once the composting pit was filled and the biomass accumulated to a height of approximately 30-40 cm above the ground, the entire surface was sealed with a 2.5 cm-thick plaster consisting of a mud and cow dung mixture, serving as a natural cover to retain moisture and regulate temperature.

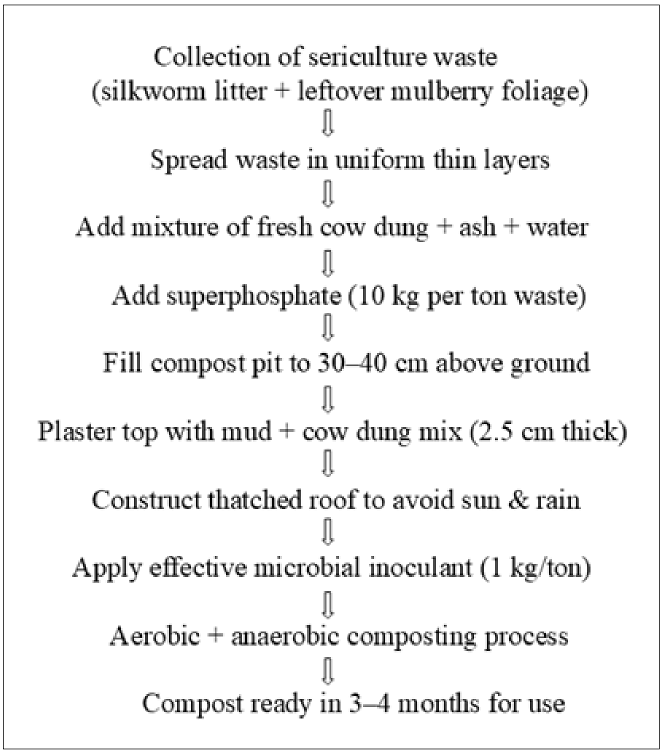

Fig. 1. Flowchart depicting the microbial composting method for seri-waste into seri-compost.

To shield the composting site from environmental exposure such as rainfall and direct sunlight, a thatched roof structure was constructed. To accelerate the decomposition process and ensure efficient organic matter breakdown, a microbial inoculant in the form of an Effective Microbial consortium (EM) was applied at a dosage of 1 kg per metric ton of organic substrate. By integrating both aerobic and anaerobic composting techniques, sericulture farms with one hectare of operational area can generate approximately 10 to 15 metric tonnes of well-decomposed, nutrient-rich compost annually.

Vermicompost preparation using sericulture waste

To produce vermicompost, sericulture-derived organic materials such as silkworm litter and residual mulberry leaves were used as feedstock. These wastes were initially blended with cow dung slurry and diluted with approximately 100 L of water per metric ton of waste to achieve the desired moisture content. The mixture was then left in open composting pits for a preliminary decomposition period of 7-10 days. During this phase, the moisture level was maintained at 30-40 %, which is essential for microbial activity. As decomposition progressed, the temperature of the biomass rose to 50-60 °C. To prevent thermal stress and microbial death, the composting material was manually turned once or twice to facilitate aeration and reduce the internal temperature to optimal levels.

Subsequently, semi-decomposed biomass with a maintained moisture content of 30-40 % was transferred into composting trenches, each receiving approximately 200-300 kg of material. A mixed culture of juvenile-stage earthworms-*Eudrilus eugeniae*, *Eisenia foetida* and *Perionyx excavates*-was inoculated at a rate of 1.5 kg per metric ton of organic material. It was critical to ensure that, at the time of worm introduction, the feed had stabilized to a suitable temperature and moisture range to avoid thermal mortality. Excessive heat generated during the decomposition process (>50 °C) necessitated further cooling before worm inoculation.

Two to three days post-inoculation, water was sprinkled regularly to maintain optimal moisture levels, ensuring a conducive environment for vermicomposting. Protective covers, such as coconut fronds or green foliage, were placed over the trenches to minimize water loss due to evaporation and to maintain ambient conditions. The composting material was manually turned on a weekly basis to ensure uniform decomposition and aeration.

After a composting period of approximately 6-7 weeks, the substrate transformed into a dark brown to black, granular substance-indicating the formation of vermicompost. The mature compost was harvested and sieved through a mesh to recover the earthworms and cocoons, which were then reused in subsequent composting cycles. Prior to harvesting, the material was allowed to air-dry slightly to facilitate handling and separation.

The final product was characterized by its humus-like texture -coarse, granular, light in weight and devoid of offensive odours. The vermicompost was rich in organic matter and contained electrically charged colloidal particles that enhance the adsorption and availability of plant nutrients in the soil. It was directly applied to agricultural fields to improve crop productivity and soil health without the need for extended storage. The final product was analysed for macronutrient and micronutrient content and in comparison, with two different seri-compost.

Details of field experiment

The field experiment was conducted with G4 and S36 cultivars to assess leaf yield, quality traits and cocoon yield and quality. The initial soil of G4 was alkaline (pH- 7.4), EC- 0.32 dsm^{-1}(non-saline), organic carbon- 0.40 % (low), nitrogen - 292 kg ha^{-1} (medium), phosphorus- 15 kg ha^{-1}(medium) and potassium- 381 kg ha^{-1} (high). The initial soil sample of S36 was alkaline (pH- 8.1), EC-0.41 dsm^{-1}, organic carbon - 0.45 %, nitrogen - 230 kg ha^{-1}, phosphorus - 13 kg ha^{-1} and potassium- 281 kg ha^{-1}. The treatments listed below were imposed on mulberry varieties - G4, S36 with three replications using Randomized Block Design (RBD) and the data were subjected to Analysis of Variance (ANOVA) using AGRES software.

Treatments were,

T1 - 100 % of RDF

T2 - 75 % of RDF + 25 % Seriwaste compost

T3 - 50 % of RDF + 50 % Seriwaste compost

T4 - Seriwaste compost 100 %

T5 - Vermicompost 100 %

T6 - Seriwaste compost 50 % + Vermicompost 50 %

T7 - 75 % of RDF + 25 % Vermicompost

T8- 50 % of RDF + 50 % Vermicompost

T9 - Absolute control

Results and Discussion

Nutrient composition of organic amendments

The macro- and micronutrient contents of different composts are presented in Table 1 & 2. Compost prepared through EM (T3) recorded the highest levels of nitrogen, phosphorus and potassium, followed by vermicompost (T2), indicating enhanced mineralization and microbial activity due to effective microbial inoculants. Iron and manganese contents were comparatively higher in vermicompost-treated sericompost (T2), while copper and zinc concentrations peaked in EM-treated compost (T3). These results align with findings from earlier studies (17), suggesting that composting methods significantly influence the availability of micronutrients due to differential microbial transformations and humification processes.

Postharvest soil properties

Application of composts led to a notable increase in organic carbon across treatments for both G4 and S36 cultivars (Table 3 & 4). In G4, enriched seri-waste compost (T4) achieved the highest soil organic carbon (SOC), on par with enriched vermicompost (T5) and their 50:50 blend (T6), suggesting that organic inputs are effective in restoring carbon pools. The trend was similarly observed in S36. These results demonstrate the composts' capacity to enhance carbon sequestration and soil health through the addition of stable organic matter (21).

Soil nutrient availability (N, P, K) followed a similar trend. Treatments combining reduced fertilizer rates with composts (T2, T3, T7, T8) matched or exceeded the performance of full RDF (T1). Notably, T2 (75 % RDF + 25 % seri-waste compost) consistently resulted in elevated nutrient levels across both cultivars, indicating a potential synergistic effect between mineral fertilizers and organic matter that may enhance nutrient retention and availability.

Table 1. Comparison of macronutrient content in seri-waste and two different seri-compost

S.No.	Treatments	N (%)	P (%)	K (%)
1.	T1 - Seriwaste (Control)	0.97	0.6	0.8
2.	T2 - Sericompost (Earthworms)	2.41	0.8	1.1
3.	T3 - Sericompost (EM)	2.78	1.3	1.7
	S.Ed.	0.74	0.31	0.44
	CD (0.05)	1.62	0.68	0.96

Table 2. Comparison of micronutrient content in seri-waste and two different seri-compost

S.No.	Treatments	Fe (ppm)	Mn (ppm)	Cu (ppm)	Zn (ppm)
1.	T1 - Seriwaste (Control)	931.2	61.0	1.5	12.8
2.	T2 - Sericompost (earthworms)	1298.0	479.3	55.8	90.3
3.	T3 - Sericompost (EM)	1190.2	463.1	61.3	95.2
	S.Ed.	114.09	115.36	13.10	22.87
	CD (0.05)	248.6	251.37	28.55	49.81

Table 3. Effect of fertilizers along with manures on post-harvest soil available nutrient status of G4 cultivar

Treatments	Organic carbon (%)	Available Nitrogen (kg ha^{-1})	Available Phosphorus (kg ha^{-1})	Available Potassium (kg ha^{-1})
T1	0.41	177.6	12.9	278.9
T2	0.46	181.0	13.3	286.1
T3	0.55	167.5	11.9	251.3
T4	0.61	162.4	10.9	234.9
T5	0.59	161.5	10.6	231.6
T6	0.58	158.3	10.5	229.8
T7	0.44	178.8	13.1	282.5
T8	0.52	165.9	11.6	248.6
T9	0.39	152.4	9.8	215.4
S.Ed.	**0.03**	**2.80**	**0.24**	**6.37**
CD(0.05)	**0.06**	**5.93**	**0.51**	**13.51**

Table 4. Effect of fertilizers along with manures on post-harvest soil available nutrient status of S36 cultivar

Treatments	Organic carbon (%)	Available Nitrogen (kg ha^{-1})	Available Phosphorus (kg ha^{-1})	Available Pottassium (kg ha^{-1})
T1	0.42	204.4	11.3	254.3
T2	0.51	210.5	11.6	267.7
T3	0.61	187.6	10.6	230.8
T4	0.68	175.8	9.8	209.7
T5	0.67	172.3	9.7	205.8
T6	0.67	169.5	9.5	203.1
T7	0.49	208.2	11.5	261.6
T8	0.59	182.3	10.5	225.6
T9	0.40	159.7	9.1	190.8
S.Ed.	**0.03**	**3.79**	**0.17**	**7.03**
CD(0.05)	**0.06**	**8.03**	**0.35**	**14.91**

Biometric parameters and leaf yield

Biometric observations (Table 5 & 6) indicated that T2 significantly enhanced shoot length, number of shoots, leaf count, internodal length and leaf yield. This enhancement is likely due to improved soil structure, moisture retention and nutrient availability induced by organic amendments. Organic inputs may also influence hormonal signalling and microbial symbiosis, leading to improved vegetative growth.

In both cultivars, the highest leaf yield during first and second prunings was achieved in T2, closely followed by T7 (vermicompost-based) and T1 (100 % RDF). Treatments T3 and T8 also performed well. These findings underscore that partial replacement of inorganic fertilizers with seri-waste-based composts can sustain or even boost biomass production (22), offering a viable strategy for reducing chemical inputs.

Table 5. Effect of fertilizers along with manures on biometric parameters and leaf yield of G4 cultivar

Treatments	Shoot length (cm)	No. of shoots per plant	No. of leaves per shoot	Total no. of leaves	Leaf yield (kg ha^{-1} harvest^{-1})	Leaf yield (kg ha^{-1} harvest^{-1})
					Ist cutting	IInd cutting
T1	136.2	12.53	26.1	186	7461	7492
T2	141.6	12.9	26.8	192	7562	7628
T3	123.1	10.4	20.1	169	6415	6521
T4	106.2	7.4	17.6	153	6221	6376
T5	105.1	7.3	16.9	151	6201	6305
T6	102.1	7.1	16.8	148	6120	6218
T7	139.2	12.6	26.3	189	7523	7511
T8	121.6	10.2	19.6	162	6316	6418
T9	87.4	6.9	15.2	143	5623	5581
S.Ed.	**3.01**	**0.22**	**0.39**	**3.40**	**33.1**	**46.5**
CD(0.05)	**6.36**	**0.47**	**0.83**	**7.61**	**107.6**	**110.6**

Table 6. Effect of fertilizers along with manures on biometric parameters and leaf yield of S36 cultivar

Treatments	Shoot length (cm)	No. of shoots per plant	No. of leaves per shoot	Total no. of leaves	Leaf yield (kg ha^{-1} harvest^{-1})	Leaf yield (kg ha^{-1} harvest^{-1})
					Ist cutting	IInd cutting
T1	127.6	11.62	15.4	116.4	4492	4629
T2	132.1	11.9	15.9	119.6	4623	4871
T3	121.2	9.9	13.9	105.4	4310	4386
T4	113.0	7.1	11.9	94.6	3970	3912
T5	111.5	6.9	11.5	91.9	3826	3844
T6	108.4	6.8	11.4	91.2	3798	3785
T7	130.1	11.7	15.7	117.9	4619	4805
T8	119.1	9.8	13.6	104.9	4290	4327
T9	95.4	5.0	8.0	80.4	3380	3410
S.Ed.	**2.53**	**0.16**	**0.26**	**2.18**	**75.2**	**94.5**
CD (0.05)	**5.37**	**0.35**	**0.56**	**4.62**	**176.2**	**200.3**

Nutrient uptake by mulberry plants

Macro- and micronutrient uptake (Table 7 & 8) was significantly enhanced by T2 in both cultivars. For G4, uptake of N, P and K reached 20.84, 5.25 and 11.20 kg ha^{-1} harvest^{-1} respectively, while Fe, Mn, Zn and Cu uptake peaked at 2201.1, 593.6, 243.5 and 105.2 g ha^{-1} harvest^{-1}, similar trends were observed in S36. These results highlight the compost's ability to enhance root absorption due to better cation exchange capacity and microbial mobilization of nutrients. The lowest uptake values were recorded in control plots (T9), confirming the positive impact of compost amendments (23).

Leaf quality attributes

Chlorophyll a, b, total chlorophyll, carotenoids and leaf moisture content were all significantly higher in T2, followed closely by T7 and T1 (Table 9 & 10). These parameters are vital for photosynthetic efficiency and directly impact silkworm nutrition. The composts likely contributed to better chloroplast development and osmotic balance in the leaves, enhancing pigment synthesis and moisture retention (24). The lowest quality parameters were observed in T9, underscoring the role of organic inputs in leaf physiological quality.

Silkworm rearing performance

The effects of treatments on silkworm rearing parameters are summarized in Table 11 & 12. Larval weight, cocoon weight, shell weight, shell ratio and cocoon yield were significantly enhanced in T2, with values statistically similar to T7 and T1. T3 and T8 also showed good performance. For example, larval weights were highest in T2 across both cultivars, while the lowest values were found in the control (T9). These results suggest improved nutritional quality of mulberry leaves under compost treatments, which directly translates to superior cocoon production and quality (25,26).

Interpretation and broader implications

The superior performance of compost-amended treatments, particularly T2, may be attributed to the sustained release of nutrients, improved microbial activity and enhanced soil physical conditions. Enriched composts provide both macro and micro nutrients and help mitigate nutrient leaching and volatilization losses common with chemical fertilizers. Moreover, improved chlorophyll content and moisture retention in leaves enhance their palatability and nutritive value for silkworms, positively influencing rearing success.

Table 7. Effect of fertilizers along with manures on macro and micro nutrient uptake of G4 cultivar

Treatments	Macro nutrient uptake (kg ha^{-1} harvest^{-1})			Micro nutrient uptake (g ha^{-1} harvest^{-1})			
	N uptake	P uptake	K uptake	Fe uptake	Mn uptake	Zn uptake	Cu uptake
T1	20.10	5.10	10.72	2131.3	572.9	236.9	101.8
T2	20.84	5.25	11.20	2201.1	593.6	243.5	105.2
T3	19.14	3.65	8.23	1852.5	510.2	181.7	96.2
T4	15.39	2.95	6.62	1458.2	413.6	113.6	90.1
T5	15.01	2.88	6.54	1421.6	401.7	110.2	88.2
T6	14.73	2.81	6.23	1392.0	390.6	108.8	87.9
T7	20.13	5.12	10.90	2150.0	581.0	238.2	102.5
T8	18.51	3.52	7.92	1786.9	493.2	176.9	94.5
T9	11.90	2.63	5.16	1076.2	301.9	98.9	79.2
S.Ed.	**0.37**	**0.07**	**0.19**	**33.70**	**10.85**	**2.84**	**2.10**
CD(0.05)	**0.78**	**0.16**	**0.40**	**71.43**	**23.01**	**6.02**	**4.43**

Table 8. Effect of fertilizers along with manures on macro and micro nutrient uptake of S36 cultivar

Treatments	Macro nutrient uptake (kg ha^{-1} harvest^{-1})			Micro nutrient uptake (g ha^{-1} harvest^{-1})			
	N uptake	P uptake	K uptake	Fe uptake	Mn uptake	Zn uptake	Cu uptake
T1	18.01	4.55	9.89	2070.6	558.1	228.3	91.3
T2	18.73	4.69	10.18	2137.4	577.7	232.8	94.7
T3	16.50	3.09	8.92	1811.8	494.3	202.9	81.9
T4	13.97	2.61	6.73	1672.9	384.5	187.4	72.9
T5	13.87	2.54	6.52	1652.9	379.2	185.1	71.5
T6	13.25	2.48	6.51	1616.2	374.7	182.5	68.9
T7	18.16	4.58	10.12	2112.3	562.7	229.4	92.7
T8	16.16	3.01	8.87	1762.3	474.3	198.4	80.9
T9	9.79	2.07	4.79	1063.5	286.7	167.9	62.4
S.Ed.	**0.37**	**0.07**	**0.19**	**33.70**	**10.85**	**2.85**	**2.08**
CD(0.05)	**0.78**	**0.16**	**0.40**	**71.43**	**23.00**	**6.04**	**4.41**

Table 9. Effect of fertilizers along with manures on leaf quality parameters of G4 cultivar

Treatments	Chl 'a' (mg g^{-1})	Chl 'b' (mg g^{-1})	Total Chl (mg g^{-1})	Carotenoids (mg g^{-1})	Crude protein(%)	Moisture content (%)
T1	1.82	0.51	2.35	0.49	23.10	83.70
T2	1.85	0.56	2.41	0.53	24.21	87.90
T3	1.57	0.37	1.94	0.46	21.72	76.45
T4	1.54	0.34	1.85	0.39	19.09	67.51
T5	1.52	0.31	1.85	0.36	18.63	70.84
T6	1.51	0.30	1.82	0.35	17.90	69.10
T7	1.83	0.53	2.38	0.50	23.70	86.31
T8	1.56	0.35	1.91	0.42	21.53	72.03
T9	1.35	0.27	1.62	0.22	15.78	62.20
S.Ed.	**0.03**	**0.03**	**0.04**	**0.03**	**0.58**	**2.11**
CD(0.05)	**0.06**	**0.05**	**0.08**	**0.05**	**1.22**	**4.48**

Table 10. Effect of fertilizers along with manures on leaf quality parameters of S36 cultivar

Treatments	Chl 'a' (mg g^{-1})	Chl 'b' (mg g^{-1})	Total Chl (mg g^{-1})	Carotenoids (mg g^{-1})	Crude Protein(%)	Moisture content (%)
T1	1.58	0.50	2.09	0.36	23.25	86.41
T2	1.61	0.53	2.14	0.41	24.31	89.10
T3	1.33	0.44	1.67	0.30	21.62	81.51
T4	1.26	0.36	1.61	0.24	18.99	75.01
T5	1.23	0.33	1.58	0.22	18.53	74.11
T6	1.21	0.33	1.55	0.23	18.09	74.05
T7	1.59	0.51	2.10	0.39	23.60	88.25
T8	1.32	0.42	1.64	0.29	21.13	79.42
T9	1.04	0.20	1.35	0.12	15.68	69.71
S.Ed.	**0.02**	**0.02**	**0.03**	**0.03**	**0.33**	**1.33**
CD(0.05)	**0.05**	**0.04**	**0.07**	**0.06**	**1.08**	**2.81**

Table 11. Effect of fertilizers along with manures on silkworm rearing parameters from G4 cultivar

Treatments	Larval weight (g)	Cocoon weight (g)	Shell weight (g)	Shell ratio (%)	Cocoon yield (kg ha^{-1} $harvest^{-1}$) for 100 dfl
T1	4.72	2.27	0.46	23.80	93.95
T2	4.91	2.36	0.58	24.58	97.83
T3	4.48	2.13	0.45	21.13	81.96
T4	4.19	1.90	0.29	18.97	74.23
T5	4.15	1.86	0.35	18.42	73.74
T6	4.10	1.82	0.33	18.24	70.62
T7	4.80	2.30	0.52	24.01	94.17
T8	4.31	2.05	0.38	20.85	78.35
T9	3.75	1.45	0.25	17.34	65.40
S.Ed.	**0.13**	**0.05**	**0.01**	**0.40**	**2.30**
CD(0.05)	**0.27**	**0.10**	**0.02**	**0.84**	**4.87**

Table 12. Effect of fertilizers along with manures on silkworm rearing parameters from S36 cultivar

Treatments	Larval weight (g)	Cocoon weight (g)	Shell weight (g)	Shell ratio (%)	Cocoon yield (kg ha^{-1} $harvest^{-1}$) for 100 dfl
T1	4.71	2.25	0.51	21.69	93.61
T2	4.88	2.30	0.52	21.61	95.56
T3	4.49	2.07	0.41	19.81	83.40
T4	4.25	1.84	0.30	17.26	73.43
T5	4.22	1.81	0.29	16.84	71.79
T6	4.20	1.78	0.28	16.45	70.93
T7	4.80	2.28	0.51	21.98	94.73
T8	4.34	2.01	0.40	19.10	80.49
T9	3.91	1.38	0.21	15.22	62.10
S.Ed.	**0.10**	**0.04**	**0.01**	**0.45**	**1.66**
CD(0.05)	**0.21**	**0.08**	**0.02**	**0.95**	**3.52**

However, the efficacy of composts may vary with soil type, compost maturity and microbial composition. Clayey soils, for instance, may exhibit different nutrient dynamics than sandy loams. Additionally, while enriched composts offer great potential, their field-scale production, standardization and cost-effectiveness remain challenges that warrant further research.

Conclusion

This study investigates the utilization potential of annual sericulture agro-industrial residues in India for enhancing soil health and quality. The findings indicate that the highest values for biometric traits and leaf yield in the G4 mulberry cultivar were observed in treatments T2 (75 % RDF + 25 % sericulture waste compost), T7 (75 % RDF + 25 % vermicompost) and T1 (100 % of the RDF), followed by T3 (50 % RDF + 50 % sericulture waste compost) and T8 (50 % RDF + 50 % vermicompost). A similar pattern was observed in the S36 cultivar. With respect to leaf quality, nutrient availability, uptake and silkworm rearing performance, T2 consistently showed superior results, closely followed by T7 and T1 and to a lesser extent by T3 and T8 in both cultivars. Overall, the results suggest that applying T2, T7, or T1 can effectively enhance mulberry leaf yield and quality without compromising soil fertility and sustainability.

Further long-term field trials across varied agro-climatic regions are essential to validate the scalability and consistency of these findings. Investigating economic feasibility, microbial dynamics and residual effects of seri-waste compost on soil health and subsequent crop cycles will help optimize INM strategies. Additionally, exploring bio-enhanced versions of seri-waste compost (e.g., fortified with beneficial microbes or biochar) could offer improved nutrient efficiency and environmental benefits in sustainable sericulture systems.

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Authors' contributions

RR contributed to conceptualization, drafting and review of the manuscript. MM was responsible for editing. BC contributed to conceptualization and editing, while RS handled editing. UM, MP, MS and LMR were involved in review drafting and editing. SV and VS contributed to editing. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interest to declare.

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