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Stimulus of Silkworm Excreta on quality and quantity of cocoon production

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Abstract

Field experiments were conducted for two years to determine the effect of silkworm rearing waste on growth and yield of mulberry plants and silkworm growth and economic traits. Methodology: this study consisted 11 treatments including absolute control with 3 replications. Results of this study: silkworm excreta alone 400 gm per plant recorded the longest shoot, greater number of branches, more number of leaves, highest 100 leaf weight and highest leaf yield. The silkworm excreta alone 400 gm per plant had a significant and positive influence on larval and cocoon parameters which recorded the highest values of larval weight, single cocoon weight, shell ratio, single cocoon filament length and denier.

Keywords: Silkworm excreta, Mulberry, leaf yield, silkworm larva, cocoon production

I INTRODUCTION

Sericulture is a commercially sustainable farm based economic enterprise favouring rural poor in the unorganized sector, because of its relatively low requirement of fixed capital and high return. Moreover, it involves four major phases of activities *viz.*, mulberry cultivation, silkworm rearing, silk reeling and silkworm egg production. During these different phases, various by-products are produced.

The major by-products of silkworm rearing are the unfed mulberry leaves and faeces, which together constitute silkworm litter. This litter can be used as excellent organic manure. Quantifying the silkworm litter, it is estimated that 45 per cent of the total leaves fed to the silkworm goes as waste in the form of unfed leaves and shoots. The silkworm ingests only 40 per cent of the leaf spread in the trays, of which only about 55 per cent is digested and the rest is converted as silkworm faeces. By rearing silkworm, it is expected to obtain 2,416 kg of litter / acre under irrigated condition and 440 kg /acre under rainfed condition (Hanumappa and Prabhakar, 1985). Silkworm larval litter contains 3.47 per cent nitrogen, 0.03 per cent phosphorus and 1.50 per cent potash. Application of compost manure produced out of sericulture waste including silkworm litter is highly beneficial for mulberry cultivation and is much effective than conventional use of farm yard manure (Bhogesha et al., 1997). Hence, this study was taken up to recycle the silkworm excreta as an organic manure to increase the mulberry and silkworm economic traits.

II RESEARCH METHODOLOGY

The field experiments were conducted during 2017-18 and 2018-19 at the Department of Sericulture, Forest College and Research Institute, TNAU, Mettupalayam. Method of composting: the seriwaste composting technique as formulated by Department of Sericulture, TNAU was followed. (http://agritech.tnau.ac.in/sericulture/seri_waste%20proct.html):

As a part of the experiment, the solid wastes produced *viz.*, silkworm litter, mulberry leaf litter and mulberry shoot wastes were collected daily and quantity of manure produced was worked out.

Composting with microorganisms: Rearing waste and mulberry farm residues were collected and put in a pit of convenient size with 1 m depth. The left-over stems/shoots were crushed before putting them in pit, which makes their decomposition faster. The thin layer of cattle dung and water or spent slurry of biogas plant was spread into the pit regularly after every collection of one-foot thick compacted layer of the wastes. When the pit was filled, it was also plastered with a layer of mud and cattle dung. The pit was protected from rain and direct sunlight by providing a thatched shed over it. As decomposition process usually takes about 4-5 months, the pit was left undisturbed and opened only after 5 months.

The decomposition of organic waste is a complex process involving various biochemical activities of microorganisms, especially the *Bacillus*, *Trichoderma*, *Aspergillus*, *Belaromyces*, etc. Therefore, to speed up the process of decomposition, the culture of these microbes were added along with sericultural wastes. As the species *of Bacillus*, *Trichoderma* and *Verticillium* are also known to be the potential biocontrol agent of plant diseases, the compost enriched with these microbes were effective in controlling the soil borne diseases of mulberry.

Field experiments were conducted with 11 treatments and 3 replications. Manures were applied in five equal splits after pruning of mulberry as per recommendations below.

Treatment details:

T1: Silkworm Excreta (SE) @ 300 g / plant
T2: Silkworm Excreta (SE) @ 400 g / plant
T3: Silkworm Excreta (SE) @ 500 g / plant
T4: Mulberry Shoot Waste (MSW) @ 300 g / plant
T5: Mulberry Shoot Waste (MSW) @ 400 g / plant
T6: Mulberry Shoot Waste (MSW) @ 500 g / plant
T7: Mulberry Leaf Waste (MLW) @ 300 g / plant
T8: Mulberry Leaf Waste (MLW) @ 400 g / plant
T9: Mulberry Leaf Waste (MLW) @ 500 g / plant
T10: Vermicompost @ 400 g / plant
T11: Absolute control

Observations were taken on both mulberry and silkworm economic traits. On mulberry: Shoot length (cm), No. of branches per plant, No. of leaves per branch, intermodal length, leaf weight (100 leaf weight in g) and leaf yield (kg/ha/harvest). On Silkworm: 5th instar larval weight (g), Cocoon weight (g), Shell weight (g), Shell ratio (%), Filament length (m) and Denier.

III RESULTS AND DISCUSSION

Table 1. Nutrient analysis of silkworm rearing wastes

Content	Major nutrients			Secondary nutrients		
	N (%)	P (%)	K (%)	Ca (ppm)	Mg (ppm)	S (ppm)
Mulberry Silkworm excreta	2.05	0.60	2.20	1.66	0.71	0.29
Mulberry shoot waste	1.20	0.09	1.32	0.93	0.22	0.14
Mulberry leaf waste	1.44	0.17	1.89	1.02	0.41	0.31

Among the three wastes tried, Silkworm excreta (SE) showed higher percentage of N: 2.05%, P: 0.60%, K: 2.20%, calcium: 1.66, magnesium: 0.71% and Sulphur: 0.29%, when compared with mulberry shoot and leaf waste. Mishra and dash (1992) reported that dried silkworm larval litter contains 8.08 per cent moisture, crude protein (14.78 %), crude fat (2.14 %), crude fibre (19.70 %). An experiment conducted by Rajanna *et al.,* (2000) using sericultural by-products *viz.*, pupal powder (PP), silkworm excreta (SWE), sheep manure (SM), Swine waste (SW), pongamia cake (PC) and also in combination with recommended NPK showed higher total soluble carbohydrates and crude protein in leaves under silkworm excreta and recommended NPK application compared to leaves grown with organic manures only

Table 2. Effect of application of Sericulture waste on mulberry growth parameters

Treatment	Shoot length (cm)	No. of branches/ plant	No. of leaves/ branch	Internodal length (cm)
T1 – Silkworm Excreta (SE) 300 g/plant	97.50	9.50	26.40	3.97
T2 – Silkworm Excreta (SE) 400 g/plant	99.00	9.50	28.15	3.85
T3 – Silkworm Excreta (SE) 500 g/plant	96.70	9.40	26.00	3.88
T4 – Mulberry Shoot Waste (MSW) 300 g/plant	90.06	8.81	22.06	3.77
T5 – Mulberry Shoot Waste (MSW) 400 g/plant	91.00	9.00	23.10	3.79
T6 – Mulberry Shoot Waste (MSW) 500 g/plant	90.74	8.09	22.01	3.68
T7 – Mulberry Leaf Waste (MLW) 300 g/plant	91.60	9.30	24.00	3.73
T8 – Mulberry Leaf Waste (MLW) 400 g/plant	92.34	9.10	24.15	3.78
T9 - Mulberry Leaf Waste (MLW) 500 g/plant	90.80	8.97	22.16	3.71
T10 – Vermicompost 400 g/plant	92.40	9.30	24.69	3.79
T11 - Absolute Control	87.15	8.40	22.15	3.76
S. Ed	**1.68**	**0.22**	**0.54**	**0.14**
C. D at 5 %	**3.71**	**0.50**	**1.21**	**NS**

Effect of application of Sericulture waste on mulberry

Mulberry growth parameters

Shoot length (cm): All the treatments were found to be effective in increasing the shoot length. The longest shoot length of 99.00 cm was recorded in treatment 2. The treatments T1 (97.50 cm) and T3 (96.70 cm) were on par with treatment 2. The absolute control recorded a shoot length of 87.15 cm. **Number of branches per plant:** All the treatments were equally effective in terms of number of branches per plant. Among the treatments, the values ranged from 9.50 (T2) to 9.00 (T10) while the control plot recorded a value of 8.40. **Number of leaves per branch:** All the treatments were effective in producing more number of leaves per branch than control. The treatment 2 was found to be superior to in terms leaves per branch (28.15). This was followed by the treatment T1 and T3 and the latter two were on par. The control plot recorded 22.15 leaves per branch. **Internodal length (cm):** Internodal length was not influenced by the treatments. The internodal length ranged from 3.97 to 3.73 cm. Similar effect was noticed by Faruque Ahmed *et al.,* 2017 in Mulberry with highest production in the combined application of recommended

basal dose of NPK and seriwaste compost treatment. Seriwaste compost practiced only in mulberry to produce high yielding and healthy leaves to improve the silk yield and also sericulture waste serves as good source of organic nutrients. It contains more amounts of plant nutrients like macro and micro nutrients which contribute to increased production. For the new trend to using the seriwaste to the field crops to increase their yield and quality of the agricultural crops and products. The success of future agriculture depends upon sustainability of agricultural production system as observed by Kalaiyarasan *et. al.* 2015.

Table 3. Effect of application of Sericulture waste on mulberry yield

Treatment	100 leaf weight (g)	Leaf yield (kg /ha/harvest)
T1 – Silkworm Excreta (SE) 300 g/plant	415.22	12322.0
T2 – Silkworm Excreta (SE) 400 g/plant	450.35	12935.4
T3 – Silkworm Excreta (SE) 500 g/plant	409.13	12272.6
T4 – Mulberry Shoot Waste (MSW) 300 g/plant	278.15	9351.8
T5 – Mulberry Shoot Waste (MSW) 400 g/plant	301.52	10474.7
T6 – Mulberry Shoot Waste (MSW) 500 g/plant	287.65	9911.4
T7 – Mulberry Leaf Waste (MLW) 300 g/plant	334.64	10573.0
T8 – Mulberry Leaf Waste (MLW) 400 g/plant	368.15	10767.7
T9 - Mulberry Leaf Waste (MLW) 500 g/plant	298.31	10312.3
T10 – Vermicompost 400 g/plant	372.14	10862.3
T11 - Absolute Control	265.27	8791.5
S. Ed	**15.61**	**49.2**
C. D at 5 %	**33.15**	**104.1**

Mulberry yield parameters:

The data related to mulberry yield parameters like 100 leaf weight and leaf yield are given in Table 3. **100 leaf weight (g):** Application of Sericulture waste had a positive and significant effect on leaf weight in all the treatments. The 100 leaf weight was the highest in treatment 2 (450.35 g), the other sets of treatments which were on par were T1 (415.22 g) and T3 (409.13 g), T10 (372.14 g), T7 (334.64 g) and T5 (301.52 g). The lowest weight of 265.27 g per 100 leaves was recorded in absolute control plot. **Leaf yield (kg/ha/harvest):** All the treatments were significantly superior to control in terms of leaf yield in kg per hectare per harvest. Treatment 2 recorded the highest leaf yield of 12935.4 kg/ha/harvest. This was followed by T1 (12322.0) and T3 (12272.6) and the latter two were on par. The lowest leaf yield of 8791.5 kg per hectare per harvest was produced in control. Same impact on that application of 100% RDF (150:75:75 kg NPK ha-1) + 75% organic manure (Seriwaste) and 50% RDF + 50% organic manure increased the productivity of maize as well as succeeding sunflower with enhanced net return and B:C ratio in Maize-Sunflower sequential cropping system without any harmful residual effect was reported by Shanmugam and Ramamoorthy, 2014. Seriwaste compost practiced only in mulberry to produce high yielding and healthy leaves to improve the silk yield and also sericulture waste serves as good source of organic nutrients. The seriwaste to the field crops to increase their yield and quality of the agricultural crops and products. The success of future agriculture depends upon sustainability of agricultural production system as detected by Kalaiyarasan *et. al.* 2015.

Table 4. Effect of application of Sericulture waste on silkworm growth parameters

Treatment	Larval weight (g)	Cocoon weight (g)	Shell weight (g)
T1 – Silkworm Excreta (SE) 300 g/plant	2.48	1.22	0.19
T2 – Silkworm Excreta (SE) 400 g/plant	2.82	1.26	0.20
T3 – Silkworm Excreta (SE) 500 g/plant	2.45	1.20	0.19
T4 – Mulberry Shoot Waste (MSW) 300 g/plant	2.04	1.12	0.16
T5 – Mulberry Shoot Waste (MSW) 400 g/plant	2.10	1.11	0.18
T6 – Mulberry Shoot Waste (MSW) 500 g/plant	2.08	1.15	0.16
T7 – Mulberry Leaf Waste (MLW) 300 g/plant	2.25	1.15	0.18
T8 – Mulberry Leaf Waste (MLW) 400 g/plant	2.29	1.17	0.19
T9 - Mulberry Leaf Waste (MLW) 500 g/plant	2.09	1.18	0.17
T10 – Vermicompost 400 g/plant	2.31	1.16	0.19
T11 - Absolute Control	2.02	1.11	0.15
S. Ed	**0.03**	**0.01**	**0.01**
C. D at 5 %	**0.07**	**0.03**	**0.02**

Silkworm growth parameters

Larval weight (g): The fifth instar larval weight was significantly and positively influenced by application of sericulture waste practices. The highest larval weight of 2.82 g was recorded in treatment 2. This was followed by T1 (2.48 g) and T3 (2.45 g) and were on par with each other. The lowest value of 2.02 g per larva was recorded in absolute control. **Cocoon weight (g):** Single cocoon weight of 1.26 g was the best which was recorded in treatment 2. As in the case of larval weight, the treatments T1 (1.22 g) and T3 (1.20 g) were the next best treatments. All the sericulture wastes practices were significantly superior to absolute control (1.11 g). **Shell weight (g):** All the treatments except absolute control were on par in terms of shell weight which ranged between 0.18 g to 0.20 g while the control treatment recorded the lowest value of 0.15 g. Sudhakar *et. al.* 2018 reported that to avoid this, rearing residue can be recycled properly by adopting above described technologies for generating good quality nutrient rich compost and applying the same to mulberry field it will improve the fertility and health status of the soil and the impact on silkworm growth and cocoon yield. Further, it is economical and also eco-friendly. Seriwaste compost practiced only in mulberry to produce high yielding and healthy leaves to improve the silk yield and also sericulture waste serves as good source of organic nutrients. It contains more amounts of plant nutrients like macro and micro nutrients which contribute to increased production was reported by Kalaiyarasan *et. al.* 2015.

Table 5. Effect of application of Sericulture waste on silkworm economic traits

Treatment	Shell ratio (%)	Filament length (m)	Denier
T1 – Silkworm Excreta (SE) 300 g/plant	16.98	781.5	2.48
T2 – Silkworm Excreta (SE) 400 g/plant	17.05	872.9	2.48
T3 – Silkworm Excreta (SE) 500 g/plant	16.70	772.9	2.33
T4 – Mulberry Shoot Waste (MSW) 300 g/plant	16.10	701.5	2.21
T5 – Mulberry Shoot Waste (MSW) 400 g/plant	16.98	714.6	2.23
T6 – Mulberry Shoot Waste (MSW) 500 g/plant	16.31	710.5	2.22
T7 – Mulberry Leaf Waste (MLW) 300 g/plant	16.38	738.9	2.24
T8 – Mulberry Leaf Waste (MLW) 400 g/plant	16.46	773.3	2.31
T9 - Mulberry Leaf Waste (MLW) 500 g/plant	16.54	711.3	2.22
T10 – Vermicompost 400 g/plant	16.68	777.4	2.35
T11 - Absolute Control	15.84	635.4	2.20
S. Ed	**0.13**	**35.8**	**0.01**
C. D at 5 %	**0.27**	**76.1**	**0.03**

Silkworm economic traits

Shell ratio (%): The silk content in terms of shell ratio was 17.05, 16.98 and 16.70 % in T2, T1 and T3 respectively which were superior to other treatments and were on par among them. The lowest value of 15.84 % was recorded in absolute control plots. **Filament length (m):** Single cocoon filament length was positively and significantly influenced by the sericulture waste treatments. The longest filament length of 872.90 meter was reeled in treatment 2. The other sericulture waste treatments viz., T1, T2, T10, T8 were on par. The shortest length of silk filament was recorded in absolute control treatment (635.4 m). **Denier:** The silk filament thickness in terms of denier was also influenced significantly by the treatments. The highest denier of 2.48 was recorded in treatment 2 and 1. This was followed by T3 (2.33), T10 (2.35) and T8 (2.31) and were on par with each other. The least denier of 2.20 was recorded in absolute control. Seriwaste compost accomplished only in mulberry to produce high yielding and healthy leaves to improve the silk yield and also sericulture waste serves as good source of organic nutrients and also It contains more amounts of plant nutrients like macro and micro nutrients which contribute to increased production as noticed by Kalaiyarasan *et. al.* 2015. The silkworm rearing residue can be recycled properly by adopting above described technologies for generating good quality nutrient rich compost and applying the same to mulberry field it will improve the fertility and health status of the soil and the impact on silkworm growth and cocoon yield was reported by Sudhakar *et. al.* 2018.

Effect of seriwaste compost on nutrients uptake by mulberry plants

Table 6. Effect of seriwaste compost on macro nutrients uptake by mulberry (kg ha^{-1} $harvest^{-1}$)

Treatments	Macro nutrients		
	N	P_2O_5	K_2O
T1	19.26	4.84	9.86
T2	20.94	5.21	11.05
T3	19.22	3.92	8.98
T4	14.75	3.09	6.72
T5	16.06	2.83	6.16
T6	14.05	2.85	6.21
T7	17.81	3.62	7.33
T8	17.30	2.65	7.77
T9	17.29	2.34	6.15
T10	19.12	3.01	8.21
T11	11.90	2.68	5.86
SEd	**0.80**	**0.16**	**0.50**
CD(P=0.05)	**1.67**	**0.33**	**1.06**

Among the different treatments, treatment 2 showed highest value in macro nutrients uptake by mulberry plants. These beneficial synergetic effects improved production of plant growth substances and enzyme activity within mulberry plant which in turns improved the nutritional status of mulberry leaf treated by the recommended basal dose of seriwaste compost treatment reported by Faruque Ahmed *et al.,* 2017. Sudhakar *et. al.* 2018 reported that to avoid this, rearing residue can be recycled properly by adopting above described technologies for generating good quality nutrient rich compost and applying the same to mulberry field it will improve the fertility and health status of the soil. Seriwaste compost practiced only in mulberry to produce high yielding and healthy leaves to improve the silk yield and also sericulture waste serves as good source of organic nutrients. It contains more amounts of plant nutrients like macro and micro nutrients which contribute to increased production as perceived by Kalaiyarasan *et. al.* 2015. Similarly, a study was conducted by Chakraborty and Kundu, 2015 got the same results with mulberry plants. Likewise An experiment conducted by Rajanna *et al.,* (2000) using sericultural by-products *viz.*, pupal powder (PP), silkworm excreta (SWE), sheep manure (SM), Swine waste (SW), pongamia cake (PC) and also in combination with recommended NPK showed higher total soluble carbohydrates and crude protein in leaves under silkworm excreta and recommended NPK application compared to leaves grown with organic manures only

IV CONCLUSION

Effective utilization of seriwaste compost was found to be a good source of organic manure moreover application of silkworm excreta alone @ 400 g per plant is the best dosage for mulberry. It showed better impact on silkworm economic traits also.

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