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

www.agronomyjournals.com
2024; SP-7(9): 643-646
Received: 06-07-2024
Accepted: 13-08-2024

Ranjitha Bai H
Department of Sericulture, College of Agriculture, UAS, GKVK, Bengaluru, Karnataka, India

Tejaswini EH
Department of Sericulture, College of Agriculture, UAS, GKVK, Bengaluru, Karnataka, India

Sandhya N
Department of Sericulture, College of Agriculture, UAS, GKVK, Bengaluru, Karnataka, India

Kenchappa NM
Department of Sericulture, College of Agriculture, UAS, GKVK, Bengaluru, Karnataka, India

Naveen Chandra Reddy
Department of Sericulture, College of Agriculture, UAS, GKVK, Bengaluru, Karnataka, India

Raje Gowda
ICAR-Krishi Vigyan Kendra, Kandli, Hassan, Karnataka, India

Corresponding Author:
Ranjitha Bai H
Department of Sericulture, College of Agriculture, UAS, GKVK, Bengaluru, Karnataka, India

Effect of levels of mulberry shoots biochar, farm yard manure and NPK fertilizer application on mulberry shoots biochar to tree mulberry on cocoon parameters of silkworm, *Bombyx mori* L

Ranjitha Bai H, Tejaswini EH, Sandhya N, Kenchappa NM, Naveen Chandra Reddy and Raje Gowda

DOI: https://doi.org/10.33545/2618060X.2024.v7.i9Si.1567

Abstract
An experiment was conducted during summer 2022 to study the effect of mulberry shoots biochar application to tree mulberry on cocoon parameters of silkworm. Tree mulberry grown with the application of 100% NPK+ FYM@ 10 t ha^{-1} + Biochar @ 15 t $ha^{-1}y^{-1}$ significantly enhanced the shorter fifth instar larval durations (7.76 days), higher larval weight (9.18 g/10) at fourth instar, higher larval weight (53.21 g/10) at fifth instar and cocoon parameters *viz*., single cocoon weight (2.63 g), pupal weight(2.04 g), shell weight (0.59 g), shell ratio (22.85%), average cocoon filament length (1499.06 m) and cocoon filament weight (0.59 g) followed by 100% NPK+ FYM@ 10 t ha^{-1} + Biochar @ 10 t $ha^{-1}y^{-1}$ with larval weight (2.52 g), pupal weight (2.00 g), shell ratio (22.62%), average filament length (1418.91 m) and cocoon filament weight (0.47 g). The study revealed that, application of mulberry shoots biochar along with FYM and RDF increased the rearing, cocoon and reeling parameters providing all the essential nutrients for mulberry growth compared to application of package of practice and absolute control and in turn it contributed for quality cocoon production. Utilization of sericulture waste generated during mulberry cultivation and silkworm rearing leads to generate additional income, entrepreneurship development in sericulture and value addition in turn contributing to achieve sustainability in sericulture.

Keywords: Tree mulberry, mulberry shoots biochar, silkworm, rearing performance

1. Introduction
Mulberry is one of the most important commercial crop grown extensively as a food plant for silkworm. It is a perennial and high biomass producing plant. The mulberry leaf quality plays a vital role in healthy growth of silkworm and the economic traits such as larval, cocoon and grainage parameters which are influenced largely by the nutritional status of the leaves fed to silkworm (Krishnaswami *et al*., 1971) [2]. When foliage has been used as food for silkworm, shoots is left wasted. These shoots often take a long time to decompose in soil. Keeping in this view mulberry shoots can be used as a feedstock for biochar production.
Biochar is a carbon-rich substance, produced by thermal decomposition of organic compounds at a relatively low temperature (<700 ℃) under limited supply of oxygen called pyrolysis. It contains more than 60% carbon and is rich in various nutrients essential for crop growth. Retuning biochar to the field can quickly improve soil carbon storage and improve crop yields. Biochar has a great, stable, and a long term potential in carbon sequestration.

2. Materials and Methods
An experiment was conducted during summer season of 2022 to study the effect of mulberry shoots biochar application to tree mulberry on cocoon parameters of silkworm. After imposition of 10 treatments (Table 1 & 2) to mulberry garden. To know the effects of feeding leaves from V-1 tree mulberry raised through the application of mulberry shoots biochar on silkworm growth and yield, Krishnaraja (FC_2 × FC_1) silkworm hybrid was reared on these leaves by following standard silkworm rearing practices outlined by (Dandin and Giridhar, 2014) [1].

The mulberry leaves harvested from different treatments were fed to the respective batch of silkworms. The silkworms were feeding thrice a day with mulberry leaves of V1 variety. Observations were recorded on rearing performance of silkworm (Table 1), cocoon and also reeling parameters (Table 2).

2.1 Experiment details

Crop	Tree mulberry
Variety	Victory^{-1}
Spacing	10 x 10 feet
Design	RCBD
No. of treatment	10
No. of replications	3
RDF	350:140:140 kg NPK ha^{-1}y^{-1}

RDF: Recommended dose of fertilizer

2.2 Treatment details

Treatments	Description
T_1	Absolute Control
T_2	100% NPK
T_3	FYM @ 20 t ha^{-1}y^{-1}
T_4	100% NPK + FYM@ 20 t ha^{-1} (Package of practice)
T_5	100% NPK+ FYM@ 10 t ha^{-1} + Biochar @ 5 t ha^{-1}y^{-1}
T_6	100% NPK+ FYM@ 10 t ha^{-1} + Biochar @ 10 t ha^{-1}y^{-1}
T_7	100%NPK+ FYM@ 10 t ha^{-1} + Biochar @ 15 t ha^{-1}y^{-1}
T_8	75% NPK+ FYM@ 10 t ha^{-1} + Biochar @ 5 t ha^{-1}y^{-1}
T_9	75% NPK+ FYM@ 10 t ha^{-1} + Biochar @ 10 t ha^{-1}y^{-1}
T_{10}	75% NPK+ FYM@ 10 t ha^{-1} +Biochar @ 15 t ha^{-1}y^{-1}

Note:
1. FYM and mulberry shoots biochar were applied as basal application on the day of pruning.
2. Split quantity of NPK fertilizers was applied 15 days after pruning.
3. All other practices of mulberry cultivation were followed as per standard package of practices (Dandin and Giridhar 2014) [1]

2.3 Experimental details for silkworm rearing

To know the effects of feeding leaves from V-1 tree mulberry raised through the application of mulberry shoots biochar on silkworm growth and yield, Krishnaraja ($FC_2 \times FC_1$) silkworm hybrid was reared on these leaves by following standard silkworm rearing practices outlined by (Dandin and Giridhar, 2014) [1]. The experimental details are as follows:

Silkworm Hybrid	$FC_2 \times FC_1$ (Krishnaraja)
Number of treatments	10
Number of replications	3
Number of worms/treatments	30

Disinfection of rearing room and equipment's

Before the commencement of rearing, the rearing room and rearing appliances were thoroughly cleaned, washed and disinfected with 2% bleaching powder in 0.3% slaked lime at the rate of 0.4 ml per m^2 (Dandin and Giridhar, 2014) [1] using gator sprayer. The room was made air tight for 48 hours for effective disinfection by sealing cracks and crevices, doors, windows and ventilators with newspaper to avoid diffusion of formaldehyde gas. Afterwards, the rearing room was kept open for 24 hours.

Procurement of Chawki

The commercial bivoltine double hybrid, Krishnaraja {FC_2 (CSR_2 x CSR_{27}) x FC_1 (CSR_6 x CSR_{26})} was used in the study. The disease-free worms were procured from the registered Chawki Rearing Centre, Channarayapattana for the experiment.

Silkworm feeding and bed cleaning

The late age silkworms were reared in shelves seperatively as per treatments by feeding three times a day with chopped tender mulberry leaves of V-1 variety raised under different treatments. Bed cleaning was done twice during IV and V instars by lifting unfed leaves and excreta of the silkworm. Optimum spacing was provided according to the age of the silkworms. After each bed cleaning and when all the silkworms settled for moulting, lime powder was dusted on silkworms following standard rearing practices (Dandin and Giridhar, 2014) [1].

Mounting and harvesting

Plastic collapsible mountages were used in the experiment. The ripe worms were hand-picked from each treatment and replication, mounted separately and distributed uniformly on the plastic collapsible mountages. Later on, the cocoons were harvested manually after sixth day of complete spinning.

Observations recorded during rearing

Fifth instar larval duration (days)

A total number of days taken from the first day of Vth instar (after IVth moult) till the time when 50% of the worms ripe was recorded in all the treatments and replication separately and the mean duration was worked out.

Fourth instar larval weight (g/10 larvae)

Weight of ten IVth instar silkworms was recorded by randomly picking ten silkworms from each replication of respective treatments, just before they settle for moult.

Fifth instar larval weight (g/10 larvae)

Weight of ten Vth instar silkworms was recorded by randomly picking silkworms from each replication of respective treatments on the fifth day of the fifth instar.

Cocoon weight (g)

The average single cocoon weight in grams from 10 cocoons chosen randomly was recorded on the sixth day after spinning from all the replications in each treatment and single cocoon weight was arrived at.

Pupal weight (g)

After obtaining the cocoon weight, same cocoon was cut open and pupal weight was recorded.

Cocoon shell weight (g)

The average cocoon shell weight was determined in grams from 10 cocoon shells chosen randomly. The shells used were from the same cocoons used for determining the cocoon weight.

Cocoon shell ratio (%)

Cocoon shell ratio indicates the total quantity of silk available from the single cocoon and is expressed as a percentage. It was calculated by using the following formula.

$$\text{Cocoon shell ratio (\%)} = \frac{\text{Weight of the single cocoon shell}}{\text{Weight of the single whole cocoon}} \times 100$$

Average cocoon filament length (m)

It is the total length of silk filament, unwound from the single cocoon and measured in meters. A sample of five cocoons per replication was randomly drawn and stifled in a hot air oven at 70 ºC for three hours.

The cocoons were kept in open for three hours to remove the moisture content and were dried under shade. The cocoons were cooked individually in boiling water to soften the sericin layer. These cooked cocoons were reeled on an epprouvette with a wheel circumference of 1.125 m. The length of the silk filament was determined by the number of revolutions recorded and converted into meters by the formula,

$L = R \times 1.125$ m

Where in,
L = Length of the silk filament (m)
R = Number of revolutions
1.125 = Circumference of the epprouvette wheel

Cocoon filament weight (g)
It is the weight of reeled silk filament from the epprouvette with a wheel circumference of 1.125 m and is expressed in grams.

3. Results and Discussion

Silkworm groups which were reared on mulberry leaves applied with combination of mulberry shoots biochar, FYM and RDF showed significantly improved Shorter fifth instar larval durations (7.76 days), maximum larval weight (9.18 g/10 larvae) at fourth instar and maximum larval weight (53.21 g/10 larvae) at fifth instar was observed when silkworms were raised on mulberry leaves grown with the application 100% NPK+ FYM@ 10 t ha^{-1} + Biochar @ 15 t $ha^{-1}y^{-1}$ (T_7) compared to package of practice (T_4) treatments (Table 1). Longest fifth instar larval duration (8.68 days), The lowest fourth instar larval weight (7.78 g /10 larvae) and lowest fifth instar larval weight (43.16 g /10 larvae) was noticed in absolute control (T_1). Increase in larval weight might be due to the resultant superior leaf quality. Shankar (1990) [6] too observed that, application of nutrients in different forms of organic sources to mulberry resulted in superior maximum larval weight than applying inorganic fertilizers alone. Potala Harshita.

Table 1: Rearing parameters of mulberry silkworm (FC_2× FC_1) as influenced by feeding leaves from tree mulberry applied with mulberry shoots biochar

Treatments	Larval duration (days) Vth Instar	Larval weight (g/10 larvae) IVth Instar	Larval weight (g/10 larvae) Vth Instar
T_1: Absolute Control	8.68	7.78	43.16
T_2: 100% NPK	8.36	8.05	45.36
T_3: FYM @ 20 t $ha^{-1}y^{-1}$	8.18	8.21	45.99
T_4: 100% NPK + FYM@ 20 t ha^{-1} (Package of practice)	8.08	8.33	46.50
T_5: 100% NPK+ FYM@ 10 t ha^{-1} + Biochar @ 5 t $ha^{-1}y^{-1}$	7.95	9.07	49.53
T_6: 100% NPK+ FYM@ 10 t ha^{-1} + Biochar @ 10 t $ha^{-1}y^{-1}$	7.90	9.08	52.35
T_7: 100%NPK+ FYM@ 10 t ha^{-1} + Biochar @ 15 t $ha^{-1}y^{-1}$	7.76	9.18	53.21
T_8: 75% NPK+ FYM@ 10 t ha^{-1} + Biochar @ 5 t $ha^{-1}y^{-1}$	8.27	8.55	47.42
T_9: 75% NPK+ FYM@ 10 t ha^{-1} + Biochar @ 10 t $ha^{-1}y^{-1}$	8.18	8.69	48.35
T_{10}: 75% NPK+ FYM@ 10 t ha^{-1} +Biochar @ 15 t $ha^{-1}y^{-1}$	8.09	8.77	48.37
F- Test	*	*	*
S.Em ±	0.11	0.16	1.03
CD @ 5%	0.34	0.47	3.07

* - Significant at 5%

Table 2: Cocoon and reeling parameters of mulberry silkworm (FC_2× FC_1) as influenced by feeding leaves from tree mulberry applied with mulberry shoots biochar

Treatments	Single Cocoon weight (g)	Single Cocoon shell weight (g)	Single Pupal weight (g)	Cocoon shell ratio (%)	Filament length (m)	Filament weight (g)
T_1: Absolute Control	2.16	0.49	1.68	20.77	1163.81	0.35
T_2: 100% NPK	2.18	0.47	1.72	21.10	1279.41	0.42
T_3: FYM @ 20 t $ha^{-1}y^{-1}$	2.20	0.50	1.70	20.99	1177.03	0.39
T_4: 100% NPK + FYM@ 20 t ha^{-1} (Package of practice)	2.25	0.51	1.75	21.32	1289.81	0.43
T_5: 100% NPK+ FYM@ 10 t ha^{-1} + Biochar @ 5 t $ha^{-1}y^{-1}$	2.50	0.54	1.96	22.54	1338.19	0.42
T_6: 100% NPK+ FYM@ 10 t ha^{-1} + Biochar @ 10 t $ha^{-1}y^{-1}$	2.52	0.52	2.00	22.62	1418.91	0.47
T_7: 100%NPK+ FYM@ 10 t ha^{-1} + Biochar @ 15 t $ha^{-1}y^{-1}$	2.63	0.59	2.04	22.85	1499.06	0.48
T_8: 75% NPK+ FYM@ 10 t ha^{-1} + Biochar @ 5 t $ha^{-1}y^{-1}$	2.30	0.48	1.82	21.52	1345.78	0.43
T_9: 75% NPK+ FYM@ 10 t ha^{-1} + Biochar @ 10 t $ha^{-1}y^{-1}$	2.42	0.54	1.87	22.45	1267.88	0.43
T_{10}: 75% NPK+ FYM@ 10 t ha^{-1} +Biochar @ 15 t $ha^{-1}y^{-1}$	2.44	0.51	1.94	22.47	1410.47	0.44
F- Test	*	*	*	NS	*	*
S.Em ±	0.04	0.01	0.03	0.70	30.91	0.00
CD @ 5%	0.12	0.03	0.10		91.84	0.02

* - significant at 5%, NS – Non-Significant

Mala and Chandrashekhar (2020) [5] reported that application of seri waste bio-digester effluent to mulberry along with other organic manures and inorganic fertilizers increased the maximum larval weight (38.63g/10 larvae) compared to

application of sole inorganic fertilizers (34.32 g/10 larvae).

Application of combination of mulberry shoots biochar along with FYM and RDF registered marked influence on cocoon traits (Table 2). Cocoon weight (2.63 g), pupal weight (2.04 g), shell weight (0.59 g), shell ratio (22.85%), average cocoon filament length (1499.06 m) and cocoon filament weight (0.48 g) were maximum in worms fed with mulberry leaf raised with 100% NPK+ FYM@ 10 t ha^{-1} + Biochar @ 15 t $ha^{-1}y^{-1}$ followed by 100% NPK+ FYM@ 10 t ha^{-1} + Biochar @ 15 t $ha^{-1}y^{-1}$ (2.52 g of cocoon weight, 2.00 g of pupal weight, 22.62% of shell ratio, 1418.91 m of average cocoon filament length and 0.48 g cocoon filament weight. The lower cocoon traits were noticed in absolute control (T_1) cocoon weight (2.16 g), pupal weight (1.68 g), shell weight (0.49 g), shell ratio (20.77%), average cocoon filament length (1163.81 m) and cocoon filament weight (0.35 g). Increase in cocoon parameters might be due to high organic matter in soil, good water holding capacity and adequate nutrient availability leading to better soil characteristics which in turn supported for quality mulberry leaves and thereby quality cocoons.

The combination of mulberry shoots biochar along with FYM and RDF might have supplied all the essential components required for the plant which helped in better performance of silkworms and cocoon quantitative traits. The mulberry shoots biochar along with FYM and RDF might have supplied all the essential components required for the plant which helps in better performance of silkworms and cocoon quality. Potala Harshita Mala and Chandrashekhar (2020) [5] who reported that application of seri waste bio-digester effluent to mulberry along with other organic manures and inorganic fertilizers increased the cocoon parameters *viz.*, single cocoon weight (1.86 g), pupal weight (1.53 g), shell weight (0.30 g), shell ratio (16.60%) compared to application of sole inorganic fertilizer.

4. Conclusion

The present study showed that, the highest cocoon parameters *viz*., cocoon weight, pupal weight, shell weight, shell ratio and average cocoon filament length were recorded in worms fed with V1 mulberry leaf obtained through application of 100% NPK+ FYM@ 10 t ha^{-1} + Biochar @ 15 t $ha^{-1}y^{-1}$.

5. References

1. Dandin SB, Giridhar K. Handbook of sericulture technologies. Bangalore: Central Silk Board; c2014. p. 427.
2. Krishnaswami S, Kumararaj S, Vijayaraghavan K, Kasiviswanathan K. Silkworm feeding trials for evaluating the quality of mulberry leaves as influenced by variety, spacing and nitrogen fertilizers. Indian J Seric. 1971;10:79-89.
3. Narayanaswamy TK, Rajegowda S, Shankar MA, Sreeramulu KR. Effect of different organic manures on growth and yield parameters of M5 and S36 mulberry varieties in relation to silkworm growth. Res Crops. 2006;7(2):541-543.
4. Philomena KL, Subramanyam MR, Jagadeesh N, Kamble CK. Qualitative and quantitative analysis of varieties as influenced by using organic manure (compost) and inorganic fertilizers for production of quality seed cocoons. In: Proc Natl Sem Silkworm Seed Prodn. SSTL, Bangalore; 2003. p. 69-74.
5. Potala Harshita Mala, Chandrashekhar S. Influence of application of seri-waste bio-digester liquid to mulberry on cocoon parameters of silkworm, Bombyx mori L. Int J Curr Microbiol App Sci. 2020;9(4):116-120.
6. Shankar MA. Nutritional management of mulberry and its effect on silkworm growth, development and silk quality. PhD thesis, University of Agricultural Sciences, Bangalore, Karnataka, India; c1990. p. 410.