

Influence of Bio and Organic Nutrients on Economic Traits of Mulberry Silkworm *Bombyx Mori L*

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ABSTRACT: The cocoons spun by NxYB races of silkworm exhibited promising results in larval growth and cocoon traits when developing worms were fed with mulberry leaves (S_{1635}) raised by applying the organic manures and other biofertilizers. Pooled data of two silkworms rearing revealed that, average weight of 10 mature larvae ranged from 31.7gm.to 38.1gm; single cocoon weight was on an of average 1.3gm., single shell weight varied from 0.214gm. to 0.220 gm., SR% fluctuated from 16.2% to 16.6%; filament length ranged from 673.6m to 680.6 m were recorded when silkworm fed with S_{1635} mulberry leaves. The cocoons also exhibited reelability having the recovery of silk in the tune of 88.1% to 88.2 % and denier 2.5 gm. This indicates that application of organic manures along with biofertilizers and reduction of recommended chemical fertilizer doses does not adversely affect larval growth and cocoon traits.

KEYWORDS: Organic manures, Biofertilizers, S_{1635} mulberry variety, NxYB silkworm hybrid.

I. INTRODUCTION

Mulberry (*Morus sp*) being a hardy perennial plant, possesses deep root system and grows in a wide range of soils and climatic conditions. This plant is endeared mainly for its echoing green leaves, being the staple food of silkworms (*Bombyx mori L.*). Owing to the continuous application of chemical fertilizers which brings about the depletion of the soil fertility, sustainable yield of cocoons could not be achieved. Balanced fertilizer application either organic or inorganic or in combination of both, obviously ensured the yield of profuse nutritious mulberry leaves which in turn resulted a better cocoon crop production.. Mulberry silkworm, (*Bombyx mori L.*) has been found to be very much sensitive with all those attributes and also for quality rating of leaves for consumption and utilization. The mulberry leaves having necessary ingredients (moisture, nutrients etc) should be fed to silkworm larvae in accordance with the biological demands of different stages of larvae for their steady growth and development. The present investigation was aimed at determining the effect of bio and organic nutrients on the quality of mulberry leaves which influences of larval body weight and ultimately the silk cocoon parameters.

II. RELATED WORK

In order to increase the leaf yield and to reduce the dependency on continuous use of chemical fertilizers, an experimental attempt have been made in order to understand how different organic residues like vermicompost and or poultry litter either singly or in combinations with bio fertilizers influence the mulberry leaf yield and quality. A good number of reports on the effect of fertilization and other agronomical practices on the yield and quality of mulberry leaves are available (Kasi Viswanathan and Iyengar, 1970; Ray et al., 1973). The plant productivity depends on the availability of the nutrients (mineral elements) in soil. The consumption of S_{1635} variety of mulberry by silk worm has been reported to be less because of more succulency and superior feeding value (Das and Prasad, 1974; Sarkar 2000). The effect of feeding on the leaves of the mulberry (*Morus alba.*) on the larval growth, cocoon yield and other economic characters of the cocoons have been reported by a number of investigators (Seki and Oshikanae, 1959, Yokoyama (1962) Krishnaswami et al; (1971), Narasimhanna (1988), Shafiq & Haq (1993) and Sudhakar et al; (2000)).

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 12, December 2016

According to Seki and Oshikanae (1959), cocoon weight was found to increase when fed with nutritionally enriched leaves of mulberry Thangamani and Vivekanandan (1984) noticed that silkworm when fed on leaves enriched with 70.6% moisture, 29.46% crude protein, 17.93% minerals and 9.78% total sugar produced better cocoon crops production. Srinivas et al; (2008) reported the beneficial effects of organic manures and biofertilizers and revealed that enhancement in larval weight might be due to the high sugar and carbohydrate contents in mulberry leaves grown under the treatment of vermicompost and Azospirillum biofertilizers. Application of organic fertilizers to mulberry had a significant influence on yield of cocoons and silk productivity (Raje Gowda 1996).

III. TEXT INPAINTING

The plantation was raised in lateritic soil of Vidyasagar University campus (22° 25' N latitude and 87° 17' longitude) of Paschim Midnapore, West Bengal, India with eight months old mulberry saplings of S₁₆₃₅ variety during the year of 2004-2006. The soil of the experimental plot was acidic (pH 5.6) in nature having 0.41% organic carbon. The experiment was laid in a randomised complete block design (RCBD) with five treatments and replicated three times for each treatment.

The treatments included were followed:

T1 = 20 MT/ha FYM + 336 kg N+180 kg P₂O₅+ 112 kg K₂O /ha /yr,

T2 = 10 MT/ha Vermicompost + Azotobacter +AMF + 50% N + 33% P₂O₅ and K₂O /ha /yr of T1,

T3 = 7 MT/ha Poultry-manure + Azotobacter +AMF + 50% N + 33% P₂O₅ and K₂O /ha /yr of T1,

T4 = 5 MT/ha Vermicompost + Azotobacter +AMF + 50% N + 33% P₂O₅ and K₂O /ha /yr of T1,

T5 = 3.5 MT/ha Poultry-manure + Azotobacter +AMF + 50% N + 33% P₂O₅ and K₂O /ha /yr of T1

The experiment was initiated with a ground level pruning and recommended cultural practices for irrigated mulberry were followed with the application of organic manures like Farm Yard Manures (FYM) @ 20MT/ha./year, vermicompost @ 10 MT/ha./year and poultry litter @ 7 MT/ha./year. Azotobacter biofertilizer was applied @ 20 kg./ha./year after two to three days of every pruning near mulberry rhizosphere by making small furrows and then covered with soil in four equal splits, whereas phosphofert biofertilizer i.e. *Arbuscular mycorrhizal* fungi was applied @100kg./ha./years for four consecutive years following the same process. Inorganic fertilizers were applied after 20 days of biofertilizer application. Harvests were done in four season's viz. spring, summer, rainy and autumn of the year 2004-05 and 2005-06 in order to study the effect of organic manures and biofertilizers on silkworm rearing and raw silk production. Newly hatched silkworm larvae were fed with leaves harvested from five plots separately under specific set of fertilizers application i.e. T₁, T₂, T₃, T₄ and T₅ treatment wise and cellular rearing (one disease free layings for each treatment with three replications) was conducted upto chawki stage. Afterwards, an uniform number of larvae (300) per replication were retained and reared until the end. The mature silkworms were mounted on a mountage (chandrike) and cocoons were harvested after 4 days of mounting. Weight of 10 mature larvae was recorded on fifth day at fifth instar. Cocoons were harvested on fifth day of spinning for assessment of yield, effective rate of rearing (ERR in %), cocoon weight, shell weight, silk ratio (SR %), leaf cocoon ratio (LCR), absolute silk content, filament length, denier of the silk filament and renditta.

Different sericultural attributes pertaining to the present silkworm rearing

- Larval weight: From each replication, the weight of 10 mature larvae, selected randomly at fifth instar was recorded and the average weight was evaluated.
- Single cocoon /shell weight: Five days after cocoon formation 10 male and 10 female cocoons were randomly selected from each replication and subjected to take the weight. Similarly shell weight (cocoon weight-pupal weight) was also determined from above cocoons and mean values were calculated. Therefore, cocoon yield (kg/dfls.) was studied.
- Effective rearing rate: The success of rearing was determined by effective rearing rate (ERR). ERR has been calculated on two ways, i.e., on number (No.) and on weight (wt.).

$$\text{ERR (No.)} = \frac{\text{No. of good cocoons harvested}}{\text{No. of worms brushed}} \times 10000$$

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 12, December 2016

$$\text{ERR (wt.)} = \frac{\text{Weight of total good cocoons harvested}}{\text{No. of worms brushed}} \times 10000$$

- Leaf cocoon ratio = $\frac{\text{Total quantity of leaf used for rearing (Kg.)}}{\text{Total cocoon harvested (Kg.)}}$
- Shell ratio: Silk ratio (S.R.) which indicated the silk content in the cocoons, and calculated by the following formula

$$\text{S.R. (\%)} = \frac{\text{Average shell weight (g)}}{\text{Average cocoon weight (g)}} \times 100$$

Ten cocoons, male and female (1:1) from each replication were assessed and the calculation was finally made on the basis of mean value.

- Absolute silk content: Absolute silk content of harvested lot of cocoons was determined by the following formula:

$$\text{Absolute silk content (g)} = \text{ERR (No.)} \times \text{Average single shell weight (g)}$$

- Filament length of cocoons: The assessment of the quality leaves, specifically, was done by considering the yield of animal protein (silk). Thus average filament length from single cocoon harvested from treated and control lots were measured by the help of reeling machine in meter scale. Average of 4 replications containing 10 cocoons for each replication was calculated.
- Denier of silk filament: Denier of silk fiber is a unit of measuring the thickness/weight of a tiny spun fiber. It indicates the durability, plus the fineness of fiber filaments and yarns. The higher the denier, the fiber will be thicker; the lower value of the denier, the fiber will be fine. Calculation was done as under

$$\text{Denier size of reeled thread} = \frac{\text{Weight of reeled silk}}{\text{Length of reeled silk}} \times 9000$$

This value obtained was very important as it indicated the number of cocoon filaments to be assembled for obtaining the required size of reeled silk. It further indicated the quantity of reeled silk that could be expected in a unit time.

- Renditta: Raw silk recovery can be calculated from shell %. Renditta is the amount of green cocoon (Kg.) required obtaining 1kg. of raw silk. If in a given cocoon lot shell ratio %, good cocoon % and recovery % of silk is taken for consideration then renditta may be easily calculated by the following formula.

$$\text{Renditta} = \frac{1}{\text{Cocoon shell\%} \times \text{Good cocoon\%} \times \text{Raw silk recovery\%}}$$

- Reelability: This is the easiness of reeling silk thread from cocoons, and is an important character of the cocoons for reeling. It may be easily calculated by the following formula.

$$\text{Reelability\%} = \frac{\text{Number of reeling cocoons}}{\text{Number of feeding end}}$$

a) Number of reeling cocoons: (Testing cocoons – number of unreeled cocoons) – number of carry over conversion cocoons

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 12, December 2016

b) Number of feeding end: (Measurement of feeding ends + number of carry over cocoons) - number of carry over conversion cocoons.

IV. EXPERIMENTAL RESULTS

Silkworms and cocoons of different treatments were analyzed for larval weight, single cocoon weight, single shell weight, shell percentage, filament length and filament denier. Rearing results of silkworm hybrids (multivoltine X bivoltine, N X YB) and reeling performance of cocoon harvested from the same cultural practice during favourable season (November and February) had been registered to be the average weight of 10 mature larvae ranging from 31.73-38.18 gm., survival rate 78.46-79.58% ERR weight /10000 larvae 8.03-8.33kg., single shell weight 0.214-0.220 gm., single cocoon weight 1.30-1.32 gm., Leaf cocoon ratio 16.00-19.00, SR% 16.23-16.60, filament length 673.66-680.66 m. with reelability 88.16-88.26 %, absolute silk content 2759.33-3185.00 , denier 2.49-2.57 and renditta 12.41-12.48 respectively. Moreover, the treatment T₃ established its superiority recorded 38.183 gm. The average weight of 10 mature larvae was found to be in contrast to 36.483gm. as in control(T₁). Effective rearing rate (ERR) by number/10000 worms resulted 7958.67 against 7858.33 as in control (T₁).

Treatments	Weight of 10 mature larvae (gm.)	ERR no./10000 larvae	ERR wt./10000 larvae (kg.)	Single shell wt. (gm.)	Single cocoon wt. (gm.)	Leaf cocoon ratio
T1	36.483	7858.33	8.310	0.217	1.307	19.00:1
T2	36.640	7946.33	8.240	0.218	1.312	16.33:1
T3	38.183	7958.67	8.333	0.220	1.324	16.00:1
T4	34.377	7954.33	8.137	0.216	1.318	17.00:1
T5	31.730	7846.67	8.083	0.214	1.318	17.33:1
Mean	35.48	7912.87	8.220	0.220	1.320	17.13
CD at 5%	NS	NS	NS	NS	NS	NS
CD at 1%	NS	NS	NS	NS	NS	NS

Table-1. Effect of different treatments on different rearing performance. Silkworm hybrid – Multivoltine x Bivoltine (N x YB)

Similarly, in respect of ERR value by weight, it resulted 8.310kg. which was at par with T₁ (Table-1). Leaf cocoon ratio was recorded as to be 16.00: 1.00 in the same treatment (T₃) while in the treatment T₁ (control) resulted the leaf cocoon ratio 19.00:1.00. Analyzed data on cocoon quality (Table-2) exhibited that in most of the cases; the cocoon parameters did not reveal significant variation in terms of improvement over control. However, significant improvement was noticed in worms fed with treated leaves with SR% and absolute silk content.

Treatments	SR %	Filament length	Denier	Renditta	Absolute Silk content	Reelability
T ₁	16.60	675.667	2.567	12.433	2759.333	88.203
T ₂	16.61	673.667	2.490	12.483	3053.667	88.217
T ₃	16.61	680.667	2.570	12.423	3185.00	88.260
T ₄	16.38	676.000	2.547	12.413	3104.333	88.197
T ₅	16.23	679.333	2.520	12.460	3000.333	88.167
Mean	16.37	677.067	2.539	12.443	3020.530	88.210
cd at 5%	0.422	NS	NS	NS	62.463	NS
CD at 1%	0.600	NS	NS	NS	NS	NS

Table-2. Effect of different treatments on different reeling performance. Silkworm hybrid – Multivoltine x Bivoltine (N x YB)

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 12, December 2016

However, as regard of *renditta*, no significant improvement was noticed. The effect of treatments T_3 and T_2 on silk ratio % showed same result which appeared to be maximum (16.61) in comparison to the result as registered by T_1 (16.60). No significant differences were observed among the treatments in respect of filament length but the performance (680.667) recorded in T_3 was highly promising. In case of absolute silk content significant differences were observed among the treatments and the best performance was shown by T_3 (3185.00) and lowest performance was shown by T_1 (2759.33). No significant variation was found among the treatments in case of reelability, although T_3 (88.26) exhibited highest performance in contrast to T_1 (88.20).

So far the mulberry leaf, tender to mature, comprised of water (80-70%), crude protein (36.3-24.1%) crude carbohydrate (12.2-20.2%), crude fat (2.8-3.4%) an addition to mineral (10%) and vitamins (Hiratsuka, 1917). The increased larval weight might be due to the fact that the application of different sources of organic manures might have influenced the uptake of macro and secondary nutrients, which in turn increased the leaf quality which enhanced the growth and development of silkworms resulting in higher larval weight (Shankar, 1990; Shivaprakash, 1991; Siddappakore, 1992). Increase in ERR and lower disease incidence might be due to application of different types of organic manures due to nitrogen management in particular, bio-inoculants and chemical fertilizers at recommended dose, might have increased soil fertility and productive potentiality (Shankar, 1990; Siddappakore, 1992; Ravikumar et al., 2005). Among the available sugar, sucrose in particular stimulates the gustatory activity in silkworm (Ito, 1960). In addition to that role of ascorbic acid (Ito, 1961) and chlorogenic acid (Naito and Hayashiya, 1965) has been also confirmed to stimulate gustatory activity. Ingestion of tender succulent leaves need to be digested that demands protein requirement for the brilliant growth of the tissue and organs of the larval body is equally indispensable throughout the larval stage and maximum during fifth instar, which is synthesized in the body from available mulberry leaf raised in different fertilization treatments. In addition to that vitamins function as growth factor and cofactor of enzymes (Watanabe et al., 1971). Gallic acid (Hamamura et al. 1966) and chlorogenic acid (Naito and Hayashiya, 1965) were also found to boost the growth. However, all the basic nutrients required for optimum growth were found to be above the threshold level in the organic manure and biofertilizers applied (treatments T1-T5) leaves to fulfil the nutrient consumption level and further highlighted in maintaining sound health of the larvae as measured by ten mature larval weights and cocoon production. Generally silkworms consume twenty kilogram leaves to produce one kg. cocoon in the tropical climate of Indian subcontinent (Jolly, 1987), so that leaf-cocoon ratio (LCR) becomes 1:20, The ratio of cocoon and leaf yield was approximately 16-19:1, Further scrupulous scrutiny on the quality aspect of the cocoon yield showed the similar positive trend, where single cocoon weight was 1.3gm., shell wt. 0.214-0.220gm., shell ratio in percent (SR%) 16.2-16.6, filament length 673.6-680.6m. against average larval weight (single) 3.1-3.8 gm. Sannappa et al. 2005 and Raje Gowda, 1996 found that, application of organic fertilizers to mulberry had a significance influence on on cocoon yield, shell ratio, silk productivity and single cocoon filament length. The present study were also in conformity with above findings. In respect of quality aspect, the reelability and denier particularly highlighted the recovery of silk in the tune of 88.1 – 88.2 % and denier 2.5 gm. in Multi x Bi hybrid (N x YB). Raw silk recovery in terms of *renditta* N x YB races gave 12.4 kg. Ramakrishna et al 2011. Reported that post cocoon parameters were significantly more in the worms fed by the organic manures treated leaves and the present findings was in conformity with above study.

Analysed data on rearing performance during favourable season revealed that dose standardization of inorganic fertilizers (1/2N:1/3P: K) to the level of 50% dose for N and 33% dose for P supplemented with organic manure along with selected biofertilizers did not hamper the quality of leaf treatment wise, since excellent spinning of cocoons was observed in all the cases

V. CONCLUSION

The present study has revealed that bio and organic amendments with the application of organic manures and bio-fertilizers have sound effect on leaf yield of mulberry which did not hamper the quality of leaf treatment wise, since excellent spinning of cocoons was observed in all the cases. The study can be further explored by the application of poultry manures along with biofertilizers for sustainable farming in mulberry in vast lateritic terrain of south west Bengal

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 12, December 2016

in order to increase the nutrient status of leaves which may ultimately give rise to compact and quality cocoons for commercial purposes.

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