

Larval Traits of Pure Mysore (PM) and CSR2 Seed Cocoons as Influenced by Nutritional Management of Mulberry Through Integration of Organic and Inorganic Fertilizers

N. Amarnatha, T. K. Narayanaswamy, K. C. Narayanaswamy,
 Manjunath Gowda, N. S. Mamatha, Vasudha Prabhakar

Received 10 March 2016; Accepted 12 April 2016; Published online 11 May 2016

Abstract The effect of integrated mulberry nutrition on S36 and M5 mulberry and its influence on larval and cocoon parameters of PM and CSR2 were studied. The results revealed that, among the various treatments, larvae of PM and CSR2 fed on mulberry leaves raised through the application of biofertilizer @ 10 kg/ha each of *Azospirillum brasilense* + *Aspergillus awamori* + 20% recommended nitrogen each through compost, vermicompost, green manure, castor oil cake

and remaining 20% N through inorganic fertilizer with recommended dose of P and K through inorganic fertilizers exhibited significantly higher grownup larval weight (1.824 and 3.911 g), effective rate of rearing (96.81 and 96.38%) and cocoon yield (43.59 and 70.29 kg / 100 DFLs) with significantly minimum disease incidence (2.89 and 3.32%), chawki duration (246.38 and 232.75 h), fifth instar larval duration (173.73 and 165.90 h), total moulting duration (100.65 and 105.67 h) and total larval duration (651.79 and 615.75 h) in PM and CSR2 breeds, respectively. Though the grownup larval volume was non-significant, it was highest in PM (7.34 ml / 5 worms) and CSR2 (12.47 ml / 5 worms) when they were reared on mulberry leaves from the same treatment.

N. Amarnatha*
 Department of Sericulture,
 USA, GKVK, Bengaluru 560065, India

T. K. Narayanaswamy, K. C. Narayanaswamy,
 N. S. Mamatha, V. Prabhakar
 Department of Sericulture,
 College of Sericulture, UAS (B),
 Chintamani 563125, India

M. Gowda
 Krishi Vignana Kendra,
 UAS (B), Chintamani 563125, India
 e-mail : amarseri@gmail.com
 *Correspondence

Keywords Inorganic fertilizers, Mulberry, Nutrition management, Seed cocoons, Silkworm.

Introduction

Among the numerous factors which influence the productivity in sericulture, silkworm seed is of prime importance. As it is known that, the quality silkworm seed is the backbone of the sericulture industry, which plays a decisive role in the success of commercial cocoon crop. Thus, silk industry sustains on the

strength of silkworm seed quality, crop performance and productivity at basic seed farms and seed areas. The timely supply of required quantity of quality disease free layings (dfls) to the sericulturists is one of the major responsibilities for achieving stable cocoon production. So, to generate good quality seed cocoons for the production of quality commercial silkworm dfls, feeding nutritive mulberry leaf to the parent silkworm races is a pre-requisite. That is the nutrition is one among the best to fulfill the surging demands of producing quality seeds. The supplementation of nutritive mulberry leaves during larval stage not only improves the quality and quantity of silk but also improves the quality of silk moth eggs. One of the major factors responsible for yield gap in sericulture is the nutritional status of mulberry leaf. Moreover, with the application of inorganic fertilizers alone, particularly in unbalanced manner, problems such as diminishing soil productivity and multiple nutrient deficiencies appear. Hence, the integrative use organic manures, biofertilizers with small dose of chemical fertilizers not only give higher yield but also help in maintaining the soil fertility for a long period and besides quality and quantity of mulberry. With this background, the present investigation was carried out to study the seed technological traits of multivoltine and bivoltine seed cocoons as influenced by nutritional management of mulberry through organic and inorganic fertilizers.

(The investigation is part of the PhD (Sericulture) thesis work and also which forms the part of Department of Science and Technology (DST), New Delhi funded project entitled "Significance of organically grown mulberry on bio-chemical and reproductive biology of silkworm seed cocoons (*Bombyx mori* L.). The financial help received for conducting research from the DST is greatly acknowledged).

Materials and Methods

A field experiment was carried out at Main Research Station, Hebbal, University of Agricultural Sciences, Bengaluru in irrigated S36 and M5 mulberry garden with spacing of 60 × 60 cm. The experiment was laid out in a randomized complete block design (RCBD) with six treatments of three replications each. The

improved mulberry cultivation aspects were followed as per the recommended practices [1]. The six treatments were as follows: T₁ : 50% recommended N through castor oil cake + 50% recommended N and recommended dose of P and K through inorganic fertilizers; T₂ : 50% recommended N through vermicompost + 50% recommended N and recommended dose of P and K through inorganic fertilizers; T₃ : Biofertilizers @ 10 kg/ha each of *Azospirillum brasilense* + *Aspergillus awamori* + 25% recommended N each through compost, green manure (*Glyricidia maculata*), castor oil cake, vermicompost with recommended dose of P and K through inorganic fertilizers; T₄ : Biofertilizers @ 10 kg/ha each of *Azospirillum brasilense* + *Aspergillus awamori* + 20% recommended nitrogen each through compost, vermicompost, green manure, castor oil cake and 20% N with recommended dose of P and K through inorganic fertilizers; T₅ : Recommended 20 tonnes FYM/ha / year + 300: 120: 120 NPK kgs/ha/year through chemical fertilizers (control); T₆ : Only chemical fertilizers applied @ 300 : 120 : 120 NPK kgs/ha/year (control).

Recommended P and K fertilizers were applied in the form of single super phosphate and muriate of potash, respectively. Organic manures and fertilizers were applied by ring and basin method at a distance of 15 cm from the base of each plant. The recommended dose of 300 kg N/ha/yr was taken as base for supplying N through different organic manures at different leaves and recommended dose as per package of practices i.e., 300:120:120 kg NPK/ha/yr as base for the supply of NPK through chemical fertilizers at different levels. After 30 days of pruning, the mulberry levels raised through different treatments were used for rearing the pure silkworm breeds viz., PM and CSR2. The silkworm rearing was conducted as per the laid out standard procedure [1] and the data on larval traits were analyzed statistically.

Results and Discussion

The observations with respect to the performance of Pure Mysore (PM) and CSR2 silkworm breeds as influenced by nutritional management of mulberry through organic and inorganic fertilizers are presented in Tables 1 to 2.

Table 1. Larval parameters of silkworm as influenced by feeding mulberry leaf raised through integrated nutrient management. * : Significant at 5%, NS : Non-significant. Figures in the parentheses are angular transformed values.

Treatments	Grownup larval weight (g)		Grownup larval volume (ml/5 worms)		Effective rate of rearing (%)		Disease incidence (%)		Cocoon yield (kg/100 DFLs)	
	PM	CSR2	PM	CSR2	PM	CSR2	PM	CSR2	PM	CSR2
T ₁	1.626	3.520	7.24	12.44	94.89 (73.10)	91.57 (76.91)	4.82 (12.66)	8.13 (16.56)	33.90	55.89
T ₂	1.703	3.598	7.30	12.45	95.34 (74.10)	92.48 (77.52)	4.36 (12.03)	7.22 (15.58)	35.85	59.05
T ₃	1.788	3.677	7.30	12.46	95.83 (75.23)	93.52 (78.19)	3.87 (11.33)	6.18 (14.38)	37.58	62.37
T ₄	1.824	3.911	7.34	12.47	96.81 (79.02)	96.38 (79.70)	2.89 (9.76)	3.32 (10.47)	43.59	70.29
T ₅	1.803	3.755	7.31	12.46	96.32 (76.33)	94.43 (78.93)	3.38 (10.57)	5.27 (13.26)	41.32	65.14
T ₆	1.612	3.442	7.23	12.42	94.43 (72.14)	90.63 (76.33)	6.15 (14.20)	9.08 (17.52)	32.59	53.38
<i>F</i> -test	*	*	NS	NS	*	*	*	*	*	*
SEm ±	0.003	0.016	–	–	0.248	0.282	0.310	0.233	0.592	0.344
CD at 5%	0.009	0.048	–	–	0.742	0.696	0.928	0.696	1.845	1.071

Larval parameters of silkworm as influenced by feeding mulberry leaf raised through integrated nutrient management

Grownup larval weight (g)

The grownup larval weight of both PM and CSR2 breeds differed significantly among different treatments (Table 1). The larval of PM and CSR2 fed on mulberry leaves raised through the application of biofertilizers @ 10 kg/ha each of *Azospirillum brasilense* + *Aspergillus awamori* + 20% recommended nitrogen each through compost, vermicompost, green manure, castor oil cake and 20% N with recommended dose of P and K through inorganic fertilizers (T₄) exhibited maximum grownup larval weight (1.824 and 3.911 g) followed by T₅ (recommended 20 tonnes FYM/ha/year + 300:120:120 NPK kgs/ha/year through inorganic fertilizers), T₃ (Biofertilizers @ 10 kg/ha each of *Azospirillum brasilense* + *Aspergillus awamori* + 25% recommended N each through compost, green manure, castor oil cake and vermicompost with recommended dose of P and K through inorganic fertilizers), T₂ (50% recommended N through vermicompost + 50% recommended N and recommended dose of P and K through inorganic fertilizers) and T₁ (50% recom-

mended N through castor oil cake + 50% recommended N and recommended dose of P and K through inorganic fertilizers) (1.803, 1.788, 1.703 and 1.626 g in PM and 3.755, 3.677, 3.598 and 3.520 g in CSR2, respectively). Whereas, lowest larval weight in PM (1.612 g) and CSR2 (3.442 g) was found in T₆ (only chemical fertilizers applied @ 300:120:120 NPK kgs/ha/year). 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. Thus, enhancing the growth and development of silkworm resulting in higher larval weight [2–5].

Grownup larval volume (ml/5 worms)

The grownup larval volume did not vary significantly among the treatments in both PM and CSR2 breeds (Table 1). However, the larval volume was maximum (7.34 and 12.47 ml/5 worms) in larvae fed with mulberry leaves from the plot applied with biofertilizers @ 10 kg/ha each of *Azospirillum brasilense* + *Aspergillus awamori* + 20% recommended nitrogen each through compost, vermicompost, green manure, castor oil cake and 20% N with recommended dose of P and K through inorganic fertilizers (T₄) followed by

recommended 20 tonnes FYM/ha/year + 300:120:120 NPK kgs/ha/year through chemical fertilizers (T_5), biofertilizers @ 10 kg/ha each of *Azospirillum brasilense* + *Aspergillus awamori* + 25% recommended N each through compost, green manure (*Glyricidia maculata*), castor oil cake, vermicompost with recommended dose of P and K through inorganic fertilizers (T_3), 50% recommended N through vermicompost + 50% recommended N and recommended dose of P and K through inorganic fertilizers (T_2) and 50% recommended N through castor oil cake + 50% recommended N and recommended dose of P and K through inorganic fertilizers (T_1) (7.34, 7.31, 7.30, 7.30 and 7.24 ml/5 worms in PM and 12.47, 12.46, 12.46, 12.45 and 12.44 ml/5 worms in CSR2, respectively). While it was minimum, when both PM and CSR2 silkworms races were fed on leaves raised from mulberry applied with only chemical fertilizers @ 300:120:120 NPK kgs/ha/year (T_6) (7.23 and 12.42 ml/5 worms, respectively). The application of different sources of organic manures resulted increased grownup larval weight and larval volume in both the breeds. Further, the findings are clear indicative of the fact that, male and female worms require differential nutrition in order to obtain healthy growth and development of worms. It can be further conclude that female moths require more carbohydrates in order to accumulate adequate energy to distribute among the newly formed eggs. Besides providing energy to the eggs, then they get fertilizer after getting the sperm from the male moth. However, more research is required before drawing conclusion in this regard.

Effective rate of rearing (%) and disease incidence (%)

Significantly maximum ERR and lower disease incidence was observed when the larvae of PM and CSR2 were fed on mulberry leaves obtained from the field supplied with biofertilizers @ 10 kg/ha each of *Azospirillum brasilense* + *Aspergillus awamori* + 20% recommended nitrogen each through compost, vermicompost, green manure, castor oil cake and 20% N with recommended dose of P and K through inorganic fertilizers (T_4) (96.81 and 96.38%, 2.89 and 3.32%, respectively) followed by recommended 20 tonnes FYM/ha/year + 300:120:120 NPK kgs/ha/year through

chemical fertilizers (T_5) (96.32 and 94.43%, 3.38 and 5.27%, respectively), biofertilizers @ 10 kg/ha each of *Azospirillum brasilense* + *Aspergillus awamori* + 25% recommended N each through compost, green manure (*Glyricidia maculata*), castor oil cake, vermicompost with recommended dose of P and K through inorganic fertilizers (T_3) (95.83 and 93.52%, 3.87 and 6.18%, respectively), 50% recommended N through vermicompost + 50% recommended N and recommended dose of P and K through inorganic fertilizers (T_2) (95.34 and 92.48%, 4.36 and 7.22% respectively) and 50% recommended N through castor oil cake + 50% recommended N and recommended dose of P and K through inorganic fertilizers (T_1) (94.89 and 91.57%, 4.82 and 8.13%, respectively). The minimum ERR was noticed in both PM and CSR2 (94.43 and 90.63%) reared on mulberry leaves from only chemical fertilizer applied @ 300: 120:120 NPK kgs/ha/year (T_6) applied mulberry plots. Increase in ERR and lower disease incidence might be due to application of different types of organic manures, bio-inoculants and chemical fertilizers at recommended dose, when applied to mulberry might have increased soil fertility and productive potentiality. The resultant quality leaves will superior when fed to silkworms, which grow healthy enough to give higher ERR with good quality cocoons [2—5]. Similarly, higher ERR in silkworms fed on mulberry leaves which are grown by applying lower dose of inorganic fertilizer with higher dose of organic manures [6].

Cocoon yield (kg/100 DFLs)

Among different treatments, significantly higher cocoon yield in PM and CSR2 was obtained, when fed on the mulberry leaves obtained by the application of biofertilizers @ 10 kg/ha each of *Azospirillum brasilense* + *Aspergillus awamori* + 20% recommended nitrogen each through compost, vermicompost, green manure, castor oil cake and 20% N through inorganic fertilizers with recommended dose of P and K through inorganic fertilizers (T_4) (43.59 and 70.29 kg/100 DFLs) followed by recommended 20 tonnes FYM/ha/year + 300:120:120 NPK kgs/ha/year through chemical fertilizers (T_5) (41.32 and 65.14 kg/100 DFLs), biofertilizers @ 10 kg/ha each of *Azospirillum brasilense* + *Aspergillus awamori* + 25% recommended N each through compost, green

Table 2. Larval duration of silkworm as influenced by feeding mulberry leaf raised through integrated nutrient management. * : Significant at 5%, NS : Non-Significant.

Treatments	Chawki duration (h)		Fifth instar larval duration (h)		Total moulting duration (h)		Total larval duration (h)	
	PM	CSR2	PM	CSR2	PM	CSR2	PM	CSR2
T ₁	261.16	246.72	184.15	175.85	106.69	112.01	690.90	652.69
T ₂	258.69	244.39	182.41	174.19	105.69	110.95	684.38	646.53
T ₃	256.23	242.06	180.68	172.54	104.68	109.90	677.86	640.38
T ₄	246.38	232.75	173.73	165.90	100.65	105.67	651.79	615.75
T ₅	251.30	237.41	177.20	169.22	102.67	107.78	664.82	628.06
T ₆	263.62	249.05	185.89	177.51	107.70	113.07	697.41	658.85
F-test	*	*	*	*	*	*	*	*
SEm ±	0.795	0.857	0.802	0.793	0.800	1.202	2.103	2.267
CD at 5%	2.380	2.565	2.400	2.380	2.390	3.599	6.296	6.787

manure (*Glyricidia maculata*), castor oil cake, vermicompost with recommended dose of P and K through inorganic fertilizers (T₃) (37.58 and 62.37 kg/100 DFLs), 50% recommended N through vermicompost + 50% recommended N and recommended dose of P and K through inorganic fertilizers (T₂) (35.85 and 59.05 kg/100 DFLs) and 50% recommended N through castor oil cake + 50% recommended N and recommended dose of P and K through inorganic fertilizers (T₁) (33.90 and 55.89 kg/100 DFLs). Whereas lower cocoon yield was found in only chemical fertilizers applied @ 300:120:120 NPK kgs/ha/year (T₆) in both PM and CSR2 breeds (32.59 and 53.38 kg/100 DFLs). The may be due to increase in the quality of mulberry leaves which might have enhanced palatability and acceptability of leaves, which lead to increased feeding efficiency of silkworm and thereby resulting in good cocoon yield. Superior cocoon yield was obtained by feeding silkworms with mulberry leaves obtained by the application of 30 MT of FYM and 50% NPK through inorganic fertilizers. Further, the cocoon yield in the present study followed almost similar trend of the previous workers who worked on organic sericulture practices in mulberry [2—8].

Larval duration (h) of silkworm as influenced by feeding mulberry leaf raised through integrated nutrient management

Larval duration of silkworm as influenced by feeding mulberry leaf raised through integrated nutrient man-

agement was differed significantly among the treatments (Table 2). The chawki duration varied significantly among the different treatments in both PM and CSR2 breeds. Significantly, shorter chawki duration (246.38 and 232.75 h, respectively), fifth instar duration (173.73 and 165.90 h), total moulting duration (100.65 and 105.67 h) and total larval duration (651.79 and 615.75 h) were recorded in PM and CSR2, when reared on mulberry leaves obtained by the application of biofertilizers @ 10 kg/ha each of *Azospirillum brasilense* + *Aspergillus awamori* + 20% recommended nitrogen each through compost, vermicompost, green manure, castor oil cake and 20% N with recommended dose of P and K through inorganic fertilizers (T₄), followed by recommended 20 tonnes FYM/ha/year + 300:120:120 NPK kgs/ha/year through chemical fertilizers (T₅) (251.30 and 237.41 h, 177.20 and 169.22 h, 102.67 and 107.78 h, 664.82 and 628.06 h, respectively), biofertilizers @ 10 kg/ha each of *Azospirillum brasilense* + *Aspergillus awamori* + 25% recommended N each through compost, green manure (*Glyricidia maculata*), castor oil cake, vermicompost with recommended dose of P and K through inorganic fertilizers (T₃) (256.23 and 242.06 h, 180.68 and 172.54 h, 104.68 and 109.90 h, 677.86 and 640.38 h, respectively), 50% recommended N through vermicompost + 50% recommended N and recommended dose of P and K through inorganic fertilizers (T₂) (258.69 and 244.39 h, 182.41 and 174.19 h, 105.69 and 110.95 h, 684.38 and 646.53 h, respectively) and 50% recommended N through castor oil cake + 50% recommended N and recommended dose of P and K

through inorganic fertilizers (T_1) (261.16 and 246.72 h, 184.15 and 175.85 h, 106.69 and 112.01 h, 690.90 and 652.69 h, respectively). However, the total chawki period was significantly prolonged with larvae reared on leaves obtained by the fertilization from only chemical fertilizers applied @ 300:120:120 NPK kgs/ha/year (T_6) (263.62 and 249.05 h, 185.89 and 177.51 h, 107.70 and 113.07 h, 697.41 and 658.85 h, respectively). This might be due to the presence of required nutrients supplied through feeding of chawki worms with S36 leaf. The increased larval weight might be due to the fact that the application of different types of organic manures might have influenced the uptake of macro and secondary nutrients, which in turn increased the leaf quality. Thus, enhancing the growth and development of silkworms resulting in higher larval weight. The shortest larval duration which may be due to fact that, balanced nutritional status of the leaves which enabled the worms to mature early due to the faster metabolic activity [2—8]. It is clear that, leaves from FYM with recommended NPK had higher calcium and magnesium content, which might have accelerated the growth of the silkworm. The shorter larval durations corresponding to all the N sources may be attributed to the fact that these leaves might have fulfilled the nutritional requirements of silkworms both qualitatively and quantitatively, thereby contributing for reduction of larval durations compared to other treatments.

Conclusion

The present findings indicated that, it is always better to integrate the nutrient sources to mulberry through the combination of organic and inorganic.

However, the application of nutrients to the mulberry by more of organic sources recorded healthy growth and development of silkworms which leads to higher larval weight and shorter larval duration rather going for only inorganic sources of nutrients.

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