Original Research Article

Study on the effect of liquid organic manures on larval and cocoon traits of silkworm (*Bombyx mori* L.)

Abstract

The study was carried out at Department of Sericulture, UAS, GKVK, Bengaluru under irrigated condition during the year 2020-21 to study the effect of soil application liquid organic manures in mulberry and its effect on larval and cocoon traits of silkworm, V-1 mulberry variety planted at 90+150 × 60 cm spacing. Three different liquid organic manures were tested against recommended dose of fertilizer (control), leaf quality was assessed via feeding to silkworm. Significantly increased fifth instar larval weight (27.66 and 41.15 g/10 larvae, respectively) was recorded in both cross breed (PM x CSR2) and double hybrid (FC1 x FC2) silkworms fed with mulberry leaves produced from soil application of bio digested liquid organic manure equivalent to 150 % N ha^{-1} (T_9). Double hybrid (FC1 x FC2) silkworm fed with treatment (T_9) showed significantly higher cocoon weight (24.76 g/10 cocoons), shell weight (5.89 g/10 shells), cocoon shell ratio (23.78 %), single cocoon filament length (1138.80 m) and filament denier (3.65).

Keywords: Mulberry, jeevamrutha, amritpani, bio digested, cocoon traits, silkworm.

Introduction

Sericulture is a low input, income generating occupation and highly suited to rural and semi urban areas. India's traditional and culture-bound internal market, as well as an amazing divergence of silk garments that reflect geographic specificity, have aided the country to reach top of the seri-enterprise world, producing all five types of commercial silks, *viz.*, Mulberry, Tropical Tasar, Oak Tasar, Eri and Muga.

The nature of seri enterprise is a rural-based on-farm and off-farm activities clubbed with enormous employment and income generation potentials, makes it as one of the most appropriate tools to improve socio-economic status of India. The high population density is exerting a demand on the use of natural resources. (Bui Xuan and Preston, 1999). Increased depletion of soil fertility is caused due to indiscriminate use of chemical fertilizers and pesticides. Adoption of an integrated farming system that uses minimal external inputs and waste recycling is one option to solve the problem (Preston and Leng, 1989). Sericulture waste has been used as a growing medium for mushrooms and as a source of biogas due to its abundance, mostly in sericulture areas. It was suggested that it can be used for composting other plant leftovers in order to produce organic manures and vermicompost (Sakthivel *et al.*, 2014).

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Apart from using conventional farm-based products, there is a growing demand for improvised materials such as jeevamrutha, panchagavya, amritpani, bio-digested liquid organic manures, sasyagavya, kunapajala, vermiwash, fish amino acids, fermented plant juices, and other improvised materials that primarily enrich the soil with indigenous microorganisms. Though chemical farming has positive results at first, the sericulture farmers soon notice the negative effects on mulberry leaf yield as well as quality and cocoon productivity. Hence, practice of organic farming is need of the hour in sericulture to avoid indiscriminate use of chemicals in mulberry garden. In this context, this study enumerates possible organic inputs and their utility in mulberry farming as well as quality and cocoon productivity for sustainable sericulture.

Material and Methods

The study was carried out at Department of Sericulture, UAS, GKVK, Bengaluru under irrigated condition during the year 2020-21, well established V-1 mulberry garden planted at 90 x 150 + 60 cm spacing was selected to conduct research. The commercial bivoltine double hybrid, Krishnaraja [FC1 (CSR6 x CSR26) x FC2 (CSR2 x CSR27)] and cross breed PM x CSR2 were used in the study. The Chawki worms were procured from the registered Chawki rearing centre, Kirangere. Different treatments of nutrient liquid organic manures were tested against the control (100 % Recommended Dose of Fertilizer (RDF)).

Treatment details

T_1 : Jeevamrutha equivalent to 100 % N ha^{-1}
T_2 : Jeevamrutha equivalent to 125 % N ha^{-1}
T_3 : Jeevamrutha equivalent to 150 % N ha^{-1}
T_4 : Amritpani equivalent to 100 % N ha^{-1}
T_5 : Amritpani equivalent to 125 % N ha^{-1}
T_6 : Amritpani equivalent to 150 % N ha^{-1}
T_7 : Bio digested liquid organic manure equivalent to 100 % N ha^{-1}
T_8 : Bio digested liquid organic manure equivalent to 125 % N ha^{-1}
T_9 : Bio digested liquid organic manure equivalent to 150 % N ha^{-1}
T_{10} : 100 % RDF (as per POP)- control

Preparation of liquid organic manures

Jeevamrutha

Jeevamrutha was prepared by mixing 10 kg cow dung, 10 litres cow urine, 2 kg local jaggery, 2 kg pulse grain flour and hand full of soil. All these were put in 200 litre capacity drum and mixed thoroughly and volume was made up to 200 litres. The mixture was stirred well in clock wise direction and kept in shade covered with wet jute bag. The solution was regularly stirred clockwise in the morning, afternoon and in the evening continuously for 7-8 days and it was then used for soil application (Palekar, 2006).

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Amritpani

Amritpani was prepared by thorough mixing of 10 kg cow dung with 500 grams honey to form a creamy paste, then 250 grams of cow ghee was added to the mixture and it was diluted with 200 litres of water. Then the final mixture was digested for 7 days (Pathak and Ram, 2018).

Bio digested liquid organic manure

Enriched bio digested liquid organic manure was prepared by using 30 kg of green biomass of selected plant species (pongamia, glyricidia, neem, subabul and mulberry leaves), 15 kg cow dung and 20 litres of cow urine. 20 litres of cow urine was taken separately in 200 litres cylindrical cement tank. 100 litres of water was added to the tank. The contents were kept incubated for 45 days. During the period the contents were digested by the microorganisms present in cow dung (Shetty *et al.*, 2014).

The nitrogen, phosphorous and potassium contents (1.86 %, 0.21 % and 0.12 % per 100L (Jeevamrutha), 1.61 %, 0.32 % and 0.22 % per 100L (Amritpani) and 1.29 %, 0.39 % and 0.57 % (Bio digested liquid organic manure) of liquid organic manures were analysed prior to the soil application. Soil application of liquid organic manures to the mulberry garden was done in two intervals. First application was at 10 days after pruning and second application was at 25-30 days after pruning. Fertilizer dose of 350:140:140 kg N: P_2O_5: K_2O ha^{-1} $year^{-1}$ was applied for irrigated mulberry (control) in the form of urea, di ammonium phosphate and murate of potash as a source of nitrogen, phosphorous and potash, respectively. A basal dose of 60:60:60 kg N: P_2O_5: K_2O ha^{-1} was applied after pruning of mulberry during third week of December, 2020 by broadcasting method.

The Chawki worms were reared in a paper boat (1 feet x 1 feet), thirty worms per treatment per replication were reared. Feeding is given three times a day (8.00 AM, 2.00 PM and 8.00 PM) with leaves of respective treatments. Bed cleaning was done two times each in IV and V instar by lifting the uneaten, left over leaves from the paper boat. The rearing was carried out in March 2021.

Larval and cocoon parameters

Fifth instar larval weight (g)

Weight of 10 larvae was recorded on fifth day of fifth instar in all the treatments of each replication and mean was computed.

Fifth instar larval duration (hours)

Total number of days taken from the time of fourth moult to the time of spinning was recorded in all the treatments with replication wise and the mean duration was worked out.

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Cocoon weight (g)

After the cocoon harvest, ten cocoons from each treatment with respective replications were randomly selected and the mean cocoon weight was computed.

Cocoon shell weight (g)

The 10 cocoon shells weight was recorded, after removing the pupa and last larval skin (exuvium) from the cocoon.

Pupal weight (g)

After obtaining the cocoon weight, same cocoons were cut open and pupal weight was taken.

Cocoon shell ratio (%)

The cocoon shell ratio percentage was calculated by the formula

$$\text{Cocoon shell ratio (\%)} = \frac{\text{Weight of 10 cocoon shells (g)}}{\text{Weight of 10 cocoons (g)}} \times 100$$

Single cocoon filament length (m)

Ten cocoons were randomly selected from three replication of each treatment were reeled using epprouvette. Number of revolutions were recorded and converted into meters by the formula,

$L = R \times 1.125$

Where, L = total filament length (m/cocoon)

R = number of revolutions

1.125 =circumference of epprouvette

Denier

The raw silk filament was taken out from the epprouvette and was dried using hot air oven at 70°C to 80°C and weighed to determine the denier using the standard formula.

$$\text{Denier} = \frac{\text{Weight of single cocoon filament (g)}}{\text{Length of single cocoon filament (m)}} \times 100$$

Where, 9000 = constant value

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Results and Discussion

Rearing performance of PM x CSR2 cross breed and FC1 x FC2 double hybrid silkworms

The fifth instar larval weight of both cross breed and double hybrid silkworms was significantly influenced by soil application of liquid organic manures in mulberry garden (Table 1). Significantly higher larval weight of 27.66 and 41.15 g/10 larvae was recorded in cross breed and double hybrid silkworms fed with mulberry leaves produced from soil application of bio digested liquid organic manure equivalent to 150 % N ha^{-1} (T_9) compared to control 27.23 and 39.09 g/10 larvae, respectively. Fifth instar larval duration of both silkworm breeds due to soil application of liquid organic manures in V-1 mulberry garden were found non-significant. The results are comparable with the findings of Devamani (2018), who reported that the higher larval weight was recorded in mulberry treated with 3 MT vermicompost + 12 litres panchagavya at 3 per cent level $acre^{-1}$ $year^{-1}$ compared to control. This clearly shows that increase in the nutritional quality of the leaves increases the larval weight. The results are also in conformity with the earlier findings of Yamgar (2008) and Mala (2018).

Table 1: Performance of cross breed silkworms PM x CSR2 and double hybrid silkworms FC1 x FC2 on larval weight and larval duration as influenced by soil applied liquid organic manures

Treatments	PM x CSR2		FC1 x FC2	
	Larval weight (g / 10 larvae)	Fifth instar larval duration (days)	Larval weight (g / 10 larvae)	Fifth instar larval duration (days)
T_1	26.19	7.57	37.71	7.69
T_2	26.79	7.58	38.98	7.58
T_3	27.44	7.56	39.73	7.56
T_4	24.48	7.56	37.74	7.75
T_5	25.59	7.58	38.15	7.76
T_6	27.32	7.56	39.36	7.80
T_7	26.48	7.56	38.71	7.70
T_8	27.55	7.36	40.44	7.88
T_9	27.66	7.35	41.15	7.63
T_{10}	27.23	7.56	39.09	7.76
F test	*	NS	*	NS
S. Em±	0.458	0.097	0.540	0.064
CD at 5 %	1.361	-	1.606	-

The effect of soil application of liquid organic manures in V-1 mulberry garden and its influence on cocoons weight and pupal weight of cross breed silkworms showed a non-significant difference. Whereas, cocoon weight and pupal weight of double hybrid silkworms were significantly influenced by soil application of liquid organic manures in mulberry garden (Table 2). Maximum cocoon weight of 24.76 g/10 cocoons was recorded in silkworms fed with

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bio digested liquid organic manure equivalent to 150 % N ha^{-1} treated mulberry leaves compared to control (23.01 g/10 cocoons). Significantly higher pupal weight of 18.68 and 18.67 g/10 pupae was recorded in double hybrid silkworms fed with mulberry leaves produced from jeevamrutha equivalent to 150 % N ha^{-1} and bio digested liquid organic manure equivalent to 150 % N ha^{-1}, respectively. The results are in accordance with Devamani (2018) who reported that maximum cocoon weight (4.1 g/cocoon) was recorded in 3 MT vermicompost + 12 L panchagavya at 3 per cent level acre^{-1} year^{-1}. Similar results were also observed by Vivek (2011). This might be due to higher nutrient content of mulberry leaves.

Table 2: Performance of cross breed silkworms PM x CSR2 and double hybrid silkworms FC1 x FC2 on cocoon weight and pupal weight as influenced by soil applied liquid organic manures

Treatments	PM x CSR2		FC1 x FC2	
	Cocoon weight (g / 10 cocoons)	Pupal weight (g/ 10 pupae)	Cocoon weight (g / 10 cocoons)	Pupal weight (g/ 10 pupae)
T_1	17.25	14.04	21.36	16.66
T_2	17.40	14.37	22.59	17.28
T_3	17.50	14.60	24.53	18.68
T_4	17.47	13.69	20.79	16.49
T_5	16.87	13.76	21.25	16.65
T_6	16.62	14.57	24.23	18.47
T_7	17.24	14.31	21.15	16.38
T_8	17.88	15.15	24.56	18.67
T_9	18.04	15.20	24.76	18.67
T_{10}	16.47	14.50	23.01	17.46
F test	NS	NS	*	*
S. Em±	0.352	0.349	0.483	0.377
CD at 5 %	-	-	1.435	1.120

Soil application of liquid organic manures in V-1 mulberry garden showed a non-significant difference on the cocoon shell weight and cocoon shell ratio of cross breed silkworms among different treatments. The cocoon shell weight and cocoon shell ratio of double hybrid silkworms was significantly influenced by soil application of liquid organic manures in mulberry garden (Table 3). Maximum cocoon shell weight of 5.89 g/10 cocoon shells and cocoon shell ratio of 23.78 per cent were recorded in silkworms fed with bio digested liquid organic manure equivalent to 150 % N ha^{-1} treated mulberry leaves. The current investigation is in line with the results of Sudhir (2016) who reported that highest cocoon shell weight and cocoon shell ratio were recorded in 10 per cent vermiwash treated mulberry plot over untreated control.

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Table 3: Performance of cross breed silkworms PM x CSR2 and double hybrid silkworms FC1 x FC2 on cocoon shell weight and cocoon shell ratio as influenced by soil applied liquid organic manures

Treatments	PM x CSR2		FC1 x FC2	
	Cocoon shell weight (g / 10 cocoon shells)	Cocoon shell ratio (%)	Cocoon shell weight (g / 10 cocoon shells)	Cocoon shell ratio (%)
T_1	2.79	16.20	4.54	21.27
T_2	2.86	16.45	5.14	22.77
T_3	2.89	16.51	5.67	23.10
T_4	2.81	16.07	4.11	19.77
T_5	2.82	16.69	4.43	20.82
T_6	2.81	16.91	5.55	22.92
T_7	2.83	16.44	4.56	21.58
T_8	2.91	16.25	5.72	23.28
T_9	2.93	16.26	5.89	23.78
T_{10}	2.66	16.19	5.31	23.08
F test	NS	NS	*	*
S. Em±	0.052	0.423	0.102	0.096
CD at 5 %	-	-	0.303	0.286

Soil application of liquid organic manures in mulberry exhibited significant difference on single cocoon filament length and filament denier of both cross breed and double hybrid silkworms (Table 4). Significantly higher single cocoon filament length and filament denier (826.40 and 1138.80 m and 3.43 and 3.65) were recorded in silkworms fed with mulberry leaves produced from soil application of bio digested liquid organic manure equivalent to 150 % N ha^{-1} (T_9) compared to control (738.60 and 1067.27 m and 2.96 and 3.06) in cross breed and double hybrid silkworms, respectively. Vivek (2011) reported higher filament length of 924.54 m in mulberry leaves sprayed with vermiwash at 5 per cent. Sudhir (2016) reported higher denier in 10 per cent vermiwash treated mulberry leaves. This may be due to the increase in nutrient quality of mulberry leaves due to the soil application of liquid organic manures.

Table 4: Performance of cross breed silkworms PM x CSR2 and double hybrid silkworms FC1 x FC2 on single cocoon filament length and filament denier as influenced by soil applied liquid organic manures

Treatments	PM x CSR2		FC1 x FC2	
	Single cocoon filament length (m)	Filament denier	Single cocoon filament length (m)	Filament denier
T_1	712.37	2.89	967.60	2.72
T_2	735.40	2.96	1049.73	3.03
T_3	756.93	3.04	1051.33	3.45
T_4	659.87	2.72	934.67	2.64
T_5	692.93	2.89	964.93	2.70
T_6	755.13	2.98	1051.27	3.25
T_7	761.00	3.13	1023.80	2.72
T_8	769.60	3.26	1070.47	3.59

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T_9	826.40	3.43	1138.80	3.65
T_{10}	738.60	2.96	1067.27	3.06
F test	*	*	*	*
S. Em±	5.726	0.070	6.598	0.113
CD at 5 %	17.014	0.209	19.605	0.336

Conclusion

The study revealed that the economic traits of double hybrid silkworms were significantly influenced by the soil application of liquid organic manures compared to cross breed silkworms. Constant and long term application of liquid organic manures is necessary to know the effect on cocoon quality. The use of chemical fertilizers in soil and its impact on silkworm hinders their potentiality to produce good quality cocoons. Hence, long term use of liquid organic manures can definitely make a way for organic and sustainable sericulture.

References

BUI XUAN AND PRESTON, T, R., 1999, Low-cost polyethylene tube bio-digesters on small-scale farms in Vietnam. *Second Int. Conf. on Increasing Animal Produc. Local Resources*,**9**(2):1-10.

DEVAMANI, M., 2018, Impact of INM on selected mulberry and silkworm traits. *Int. J. Sci. Res.*, **8**(3): 1207-1210.

MALA, P.H., 2018, Influence of sericulture waste bio digester on growth and yield of mulberry and silkworm. *M. Sc. (Agri.) Thesis*, Univ. Agric. Sci., Bengaluru, Karnataka, India. p. 30-49.

PALEKAR, S., 2006, Text book on Shoonya Bandovalada Naisargika Krushi. Swamy Anand Agri Prakashana, Bangalore.

PATHAK, R. K. AND RAM, R. A., 2018, Indigenous technologies of organic agriculture: A review. *Progressive Horticulture*, **50**(1&2): 70-81.

PRESTON, T. R. AND LENG, R, A., 1989, The greenhouse effect and its implications for world agriculture. The need for environmentally friendly development. *Livestock Res. Rural Dev.*, **1**(1): 21-30.

SAKTHIVEL, N., RAVIKUMAR, J., CHIKKANNA, MUKUND, V. K., BINDROO, B. B. AND SIVAPRASAD, V., 2014, Organic farming in mulberry: Recent breakthrough. *Tech. Bull*., RSRS, Salem, Tamil nadu (India).

SHETTY, P. K., CLAUDE, A. AND ASHOK, K. Y., 2014, Organic farming and sustainability. National Institute of Advanced Studies, Indian Institute of Science Campus, Bangalore, p: 259-261.

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SUDHIR K., 2016, Effect of foliar spray of organic formulations on biochemical constituents of mulberry and growth parameters of silkworm (*Bombyx mori* L.). *M. Sc. (Agri.) Thesis,* Univ. Agric. Sci., Dharwad. p. 39-86.

VIVEK, U., 2011, Effect of foliar spray of organic formulations on mulberry and its influence in silkworm, *Bombyx mori* L. *M.Sc. (Agri.) Thesis,* Univ. Agric. Sci., Dharwad, Karnataka, India.

YAMGAR T. D., 2008, Effect of organic fertilizers on growth of mulberry (*Morus alba* L.) and economic traits of silkworm (*Bombyx mori* L.). *Ph. D. (Agri.) Thesis*, Marathwada Agricultural University, Parbhani.

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