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RESEARCH ARTICLE

LATE AGE WORM (BOMBYX MORI L.) REARING PERFORMANCE AS INFLUENCED BY FEEDING SCHEDULES OF MULBERRY LEAF RAISED THROUGH THE CONCEPT OF ORGANIC BASED NUTRIENT MANAGEMENT

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ABSTRACT

Bivoltine silkworm breed CSR_2 was reared at Main Research Station, Hebbal, Bangalore on mulberry grown with the application of at nitrogen at recommended level through organic manures and inorganic fertilizers in different combination with four feeding schedules, treatments and interactions. Among these FS_2 (Chawki worms fed with S_{36} leaf + Late age worm fed with M_5 leaf) and T_{12} (recommended 20 tonnes of compost + 300: 120: 120 kg of NPK / ha / year through fertilizer) exhibited significantly higher mature larval weight (40.42 and 40.62 g/10 larvae) and silkgland weights (0.777 and 0.788 g), effective rate of rearing (85.95 and 94.16 %), while the lower disease incidence (14.17 and 14.17 %), moulting duration (4.98 and 4.30 days) and larval duration (26.83 and 26.12 days) respectively. Among interactions, FS_2T_{12} contributed more towards matured larval weight, silkgland weight and also effective rate of rearing (42.21 g/10 larvae; 0.836 g and 94.16 %). However, lower disease incidence and larval duration was recorded in FS_2T_{12} (5.83 % and 26.08 days), but FS_2T_{11} (FS_2- chawki worms fed with S_{36}+ Late age worm fed with M_5 T_{11} combination of Bio-fertilizers 10 kg each of *Azospirillum* + *Aspergillus awamori*/ha/yr + 20 % recommended N through each of Compost, Green manure (*Glyricidia maculata*), Oil cake (Castor cake), vermicompost and fertilizer, remaining PK through fertilizer) exhibited significantly lower moulting duration (4.13 days).

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INTRODUCTION

Mulberry (*Morus* sp.) is the sole food plant of silkworm, *Bombyx* mori L. being monophagous, the silkworm requires specific quality leaves during different stages of its larval life cycle. The mulberry contributes to the tune of 38.2 % for successful cocoon crop production (Miyashita, 1986). There are distinct differences in quality and quantity of leaves required for young and late age silkworms. Though inorganic nutrition through application of fertilizers increases the mulberry growth and yield, but does not ensure the quality of leaves. Hence, there is an urgent need to include the organic manures in nutrient management system for getting nutritious leaf. Organic manures are bulky in nature but contain all the essential nutrients including micronutrients required for the growth development of plants. In the present day energy crisis, organic manures and chemical fertilizers have become not only expensive but also scarce. To overcome these problems, in recent years, integrated nutrient management is gaining importance where in inclusion of both organic and inorganic manures not only helps in improving the yield and quality of mulberry but also improves soil fertility and health. In this direction, a comprehensive investigation entitles " Influence of feeding schedules of mulberry leaf raised through the concept of organic based nutrition on the late age worm rearing" was undertaken.

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MATERIALS AND METHODS

A research study was under taken at MRS, Hebbal, UAS, Bangalore to work out the influence of feeding mulberry leaf raised through the application of recommended quantity of N through different organic and inorganic sources on late age worm rearing. Silkworm feeding with two different mulberry varieties (S_{36} and M_5) in four feeding schedules (FS) viz., FS_1 (chawki worms fed with S_{36} leaf + late age worms fed with S_{36} leaf), FS_2 (chawki worms fed with S_{36} leaf + late age worms fed with M_5 leaf), FS_3 (chawki worms fed with M_5 leaf + late age worms fed with S_{36} leaf) and FS_4 (chawki worms fed with M_5 leaf + late age worms fed with M_5 leaf) respectively. The leaves of two different mulberry varieties grown under different treatments viz., The experiment was conducted with 13 treatments and 3 replications.

T_1	:	100 % recommended N through Compost
T_2	:	50 % recommended N through Compost + 50 % recommended N and remaining P, K through fertilizer
T_3	:	100 % recommended N through Green manure (*Glyricidia maculata*)
T_4	:	50 % recommended N through Green manure + 50 % recommended N and remaining P, K through Fertilizer
T_5	:	100 % recommended N through Castor oil cake
T_6	:	50 % recommended N through Castor oil cake + 50 % recommended N and remaining P, K through Fertilizer
T_7	:	35 % recommended N through Compost + 30 % recommended N through Castor oil cake + 35 % recommended N through Green manure
T_8	:	100 % recommended N through Vermicompost
T_9	:	50 % recommended N through Vermicompost + 50 % recommended N and remaining P, K through Fertilizer
T_{10}	:	Bio-fertilizers 10 kg each of *Azospirillum* + *Aspergillus awamori*/ha/yr + 25% recommended N through each of Compost, Green manure, Castor oil cake and vermicompost
T_{11}	:	Bio-fertilizers 10 kg each of *Azospirillum* + *Aspergillus awamori*/ha/yr + 20 % recommended N through each of Compost, Green manure, Castor oil cake, vermicompost and fertilizer + remaining P, K through fertilizer
T_{12} (control)	:	Recommended 20 tonnes compost + 300: 120: 120 kg N, P and K / ha / year through fertilizer
T_{13} (control)	:	Only fertilizer 300: 120: 120 kg of N, P and K / ha / year

In each replication 100 worms were maintained. The CSR_2 worms were reared as per package of practices published by Dandin *et al.* (2014). The data was analyzed statistically by using two way factorial RCBD as outlined by Cochron and Cox (2000).

RESULTS

The results of the present study are tabulated in tables 1 to 3 and are interpreted in the light of earlier work are here under. Among different treatments, higher mature larval weight was accounted in T_{12} Recommended 20 tonnes compost + 300: 120: 120 kg N, P and K / ha / year through fertilizer (40.62 g/10 larvae) followed by T_{11} Bio-fertilizers 10 kg each of *Azospirillum* + *Aspergillus awamori*/ha/yr + 20 % recommended N through each of Compost, Green manure, Castor oil cake, vermicompost and fertilizer + remaining P, K through fertilizer (40.35 g/10 larvae), whereas other treatments differed significantly with respect to mature larval weight. Silkgland weight was found significantly higher in T_{12} (0.788 g) followed by T_{11} (0.768 g).

Significant differences were observed with respect to ERR. Among the treatments, T_{12} (89.75 %) exhibited maximum ERR, followed by T_{10} Bio-fertilizers 10 kg each of *Azospirillum* + *Aspergillus awamori*/ha/yr + 25% recommended N through each of Compost, Green manure, Castor oil cake and vermicompost (89.03 %). Shankar (1990) also reported similar type of results, where in application of FYM @ 20 tonnes/ha/yr with full dose of chemical fertilizers in 6 splits recorded higher ERR and larval weight. Significant influence was excerted on disease incidence in treatment T_{12} (10.25 %) followed by T_{10} (10.91 %) but other treatments such as T_2 50 % recommended N through Compost + 50 % recommended N and remaining P, K through fertilizer (14.66 %), T_9 50 % recommended N through Vermicompost + 50 % recommended N and remaining P, K through Fertilizer (14.25 %) and T_4 50 % recommended N through Green manure + 50 % recommended N and remaining P, K through Fertilizer (14.50 %) were on par with each other. Among various treatments shorter larval duration was recorded in T_{12} (26.12 days), but T_6 50 % recommended N through Castor oil cake + 50 % recommended N and remaining P, K through Fertilizer

Table 1. Mature larval weight (g/10 larvae) and Silkgland weight (g) as influenced by feeding of leaf obtained by application of N through different sources of organic manures and inorganic fertilizers

Treatments (T)	Mature larval weight (g/10 larvae) and Silkgland weight (g)								Mean (T)	
	Feeding Schedules (FS)									
	FS_1		FS_2		FS_3		FS_4			
	MLW	SGW	MLW	SGW	MLW	SGW	MLW	SGW	MLW	SGW
T_1	37.21	0.732	40.02	0.753	37.27	0.731	37.22	0.741	37.93	0.739
T_2	38.42	0.744	40.20	0.762	38.41	0.738	38.41	0.744	38.86	0.747
T_3	37.34	0.740	40.11	0.765	37.43	0.739	37.38	0.741	38.06	0.746
T_4	38.66	0.747	40.35	0.762	38.44	0.743	38.69	0.744	39.03	0.749
T_5	37.41	0.737	39.40	0.772	37.43	0.737	37.34	0.748	37.89	0.748
T_6	38.65	0.742	40.30	0.782	38.73	0.740	38.72	0.763	39.10	0.756
T_7	38.62	0.744	40.02	0.779	38.61	0.743	38.57	0.751	38.95	0.754
T_8	38. 65	0.739	40.14	0.766	38.66	0.741	38.67	0.757	39.03	0.750
T_9	38.72	0.763	40.52	0.793	38.82	0.761	38.75	0.772	39.20	0.772
T_{10}	38.77	0.774	41.23	0.786	38.84	0.773	38.82	0.766	39.41	0.774
T_{11}	39.83	0.751	42.22	0.805	39.83	0.753	39.53	0.765	40.35	0.768
T_{12}	40.12	0.772	42.21	0.836	40.13	0.766	40.05	0.779	40.62	0.788
T_{13}	37.57	0.718	38.82	0.748	37.55	0.719	37.50	0.731	37.86	0.729
Mean (S)	38.45	0.746	40.42	0.777	38.47	0.745	38.43	0.754		

MLW = Mature larval weight; SGW = Silkgland weight

	Feeding Schedules (FS)		Treatments (T)		Interactions (FS × T)	
	MLW	SGW	MLW	SGW	MLW	SGW
F-Test	*	*	*	*	*	*
SEm ±	0.015	0.0004	0.027	0.0007	0.055	0.0014
CD at 5 %	0.042	0.0011	0.076	0.0020	0.152	0.0039

Note: FS_1 : Chawki worms fed with S_{36} leaf + Late age worms fed with S_{36} leaf
FS_2 : Chawki worms fed with S_{36} leaf + Late age worms fed with M_5 leaf
FS_3 : Chawki worms fed with M_5 leaf + Late age worms fed with S_{36} leaf
FS_4: Chawki worms fed with M_5 leaf + Late age worms fed with M_5 leaf

Table 2. Disease incidence (%) and Effective rate of rearing (%) as influenced by feeding of leaf obtained by application of N through different sources of organic manures and inorganic fertilizers

Treatments (T)	Disease incidence (%) and Effective rate of rearing (%)								Mean (T)	
	Feeding Schedules (FS)									
	FS_1		FS_2		FS_3		FS_4			
	DI	ERR	DI	ERR	DI	ERR	DI	ERR	DI	ERR
T_1	20.00	79.99	19.16	80.83	17.00	83.00	19.00	81.00	18.79	81.20
T_2	14.16	85.83	12.50	89.54	17.00	83.00	15.00	85.00	14.66	85.81
T_3	17.50	82.50	15.83	84.17	17.00	83.00	17.00	83. 33	15.83	83.25
T_4	15.83	84.16	14.16	85.83	15.00	85.00	13.00	87.00	14.50	85.50
T_5	17.80	82.50	15.83	84.17	15. 00	85.00	16.00	84.00	16.08	83.91
T_6	12.50	87.50	15.00	85.00	13.00	87.00	9.00	81.00	12.37	87.62
T_7	17.50	82.50	19.27	80.83	19.00	81.00	15.00	85.00	17.69	82.33
T_8	15.83	84.17	17.50	82.50	13.00	87.00	17.00	83.00	15.83	84.16
T_9	14.16	85.83	10.83	89.16	17.00	83.00	15.00	85.00	14.25	85.75
T_{10}	10.83	89.16	10.83	89.16	11.00	89.00	11.00	89.00	10.91	89.03
T_{11}	12.50	87.50	7.50	92.50	15.00	84.00	9.00	91.00	11.25	88.75
T_{12}	9.16	90.83	5.83	94.16	13.00	87.00	13.00	87.00	10.25	89.75
T_{13}	20.83	79.16	20.00	80.00	20.23	79.00	21.00	79.00	20.54	79.29
Mean (S)	15.25	84.74	14.17	85.98	15.64	84.30	14.61	85.41		

DI = Disease incidence (%); ERR = Effective rate of rearing (%)

	Feeding Schedules (FS)		Treatments (T)		Interactions (FS × T)	
	DI	ERR	DI	ERR	DI	ERR
F-Test	*	*	*	*	*	*
SEm ±	0.154	0.168	0.278	0.304	0.555	0.608
CD at 5 %	0.427	0.467	0.770	0.843	1.540	1.686

Note: FS_1 : Chawki worms fed with S_{36} leaf + Late age worms fed with S_{36} leaf
FS_2 : Chawki worms fed with S_{36} leaf + Late age worms fed with M_5 leaf
FS_3 : Chawki worms fed with M_5 leaf + Late age worms fed with S_{36} leaf
FS_4: Chawki worms fed with M_5 leaf + Late age worms fed with M_5 leaf

Table 3. Total moulting duration and Total larval duration (days) as influenced by feeding of leaf obtained by application of N through different sources of organic manures and inorganic fertilizers

Treatments (T)	Total moulting duration and Total larval duration (days)								Mean (T)	
	Feeding Schedules (FS)									
	FS_1		FS_2		FS_3		FS_4			
	TMD	TLD	TMD	TLD	TMD	TLD	TMD	TLD	TMD	TLD
T_1	5.21	27.14	5.14	27.10	5.17	26.81	5.15	27.17	5.16	27.05
T_2	5.18	27.15	5.14	27.16	5.15	27.17	5.16	27.13	5.15	27.15
T_3	5.20	27.20	5.19	27.19	5.15	27.22	5.16	28.02	5.17	27.40
T_4	5.15	27.19	5.17	27.17	5.15	27.19	5.13	27.15	5.15	27.17
T_5	5.19	28.02	5.14	27.21	5.21	28.02	5.15	27.19	5.17	27.61
T_6	5.13	26.16	5.03	26.15	5.07	26.17	5.09	26.21	5.08	26.17
T_7	5.15	27.21	5.14	27.21	5.19	27.21	5.17	27.19	5.16	27.20
T_8	5.17	27.19	5.12	27.19	5.17	27.16	5.16	27.17	5.15	27.17
T_9	5.18	26.19	5.05	26.12	5.12	26.18	5.13	26.17	5.12	26.16
T_{10}	5.15	27.05	5.12	26.07	5.11	27.05	5.09	27.08	5.11	26.81
T_{11}	5.03	26.15	4.13	26.12	5.20	27.06	5.03	27.02	4.84	26.58
T_{12}	4.22	26.13	4.21	26.08	4.22	26.13	4.54	26.15	4.30	26.12
T_{13}	5.21	28.11	5.18	28.01	5.21	28.15	5.20	28.17	5.20	28.11
Mean (S)	5.09	26.99	4.98	26.83	5.08	27.04	5.09	27.06		

TMD = Total moulting duration; TLD = Total larval duration

	Feeding Schedules (FS)		Treatments (T)		Interactions (FS × T)	
	TMD	TLD	TMD	TLD	TMD	TLD
F-Test	*	*	*	*	*	*
SEm ±	0.014	0.012	0.025	0.023	0.051	0.046
CD at 5 %	0.039	0.035	0.070	0.064	0.141	0.129

Note: FS_1 : Chawki worms fed with S_{36} leaf + Late age worms fed with S_{36} leaf
FS_2 : Chawki worms fed with S_{36} leaf + Late age worms fed with M_5 leaf
FS_3 : Chawki worms fed with M_5 leaf + Late age worms fed with S_{36} leaf
FS_4: Chawki worms fed with M_5 leaf + Late age worms fed with M_5 leaf

(26.17 days), T9 (26.19 days) and T_{11} (26.58 days) were on par with each other with respect to larval duration. Moulting duration was shorter in T_{12} (4.30 days) followed by T_{11} (4.84 days) and other treatments except T_{13} Only fertilizer 300: 120: 120 kg of N, P and K / ha / year (5.20 days) and T_{10} (5.11 days), which differed, significantly from each other. Among four feeding schedules, FS_2 resulted in significantly maximum towards mature larval weight (40.42 g/10 larvae), silkgland weight (0.777 g), effective rate of rearing (85.98 %), less disease incidence (14.17 %), lowest total larval duration (26.83 days) and lowest total moulting duration (4.98 days). Among interactions, FS_2T_{12} (chawki worms fed with S_{36}+ late-age worms fed with M_5 along with a combination of recommended 20 tonnes compost + 300: 120: 120 kg of NPK / ha / year through fertilizer) contributed more towards mature larval weight, silkgland weights and also effective rate of rearing (42.21 g/10 larvae; 0.836 g and 94.16 %). However, lower disease incidence and larval duration was recorded in FS_2T_{12}

(5.83 % and 26.08 days), but FS_2T_{11} (chawki worms fed with S_{36}+ late-age worms fed with M_5 along with a combination of Bio-fertilizers 10 kg each of *Azospirillum* + *Aspergillus awamori*/ha/yr + 20 % recommended N through each of Compost, Green manure (*Glyricidia maculata*), Oil cake (Castor cake), vermicompost and fertilizer remaining through PK through fertilizer) exhibited significantly lower moulting duration (4.13 days).

DISCUSSION

The higher larval and silkgland weight recorded in T_{12} and T_{11} treatments might be due to worm rearing on nutrition leaf obtained through integrated nutrient management. The application of nitrogen through different organic sources have greatly influenced the uptake of macro and secondary nutrients which inturn increased the leaf quality. Ravikumar (2004) found that the worm fed with leaf raised through application of 50 per cent recommended N through different organics with 50 per cent recommended N through urea recorded maximum larval weight and ERR. Ravikumar (2004) also noticed significant differences with regard to disease incidence as influenced by Farmyard manure, green manure, green leaf manure and castor cake levels. The feeding of chawki worms with S_{36} leaf and late age worms with M_5 leaf has increased the rearing parameters of the silkworm. This might be due to suitability of S_{36} leaf to chawki and M_5 leaf to late age worm rearing in terms of presence of required nutrients supplied through by following feeding schedules. However, there is no such similar work for comparison. Bose (1991) reported that the nutrition requirements of the silkworm vary according to their stages of growth. Thus it depends on the nutritional status of mulberry leaves. Horie *et al.* (1967) reported that, shortest larval duration 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. From this study it can be concluded that rearing of worms with feeding schedules i.e., chawki worms fed with with S_{36} leaf + late age worm fed with M_5 leaf raised through the application of compost and NPK at recommended level ranked top for mature larval weight, silk gland weight and effective rate of rearing. The mulberry leaf obtained through the application of compost NPK at recommended level had higher calcium and magnesium content, which might have accelerated the growth of the worm.

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