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Rendition of larval duration in silkworm reared on mulberry leaves grown with supplementation of Organic nutrients

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Abstract
The present study was undertaken to elucidate the effect of organic manures (Vermicompost, farm yard manure, Silkworm rearing waste, Neem cake) alone and in combination with biofertilizer (*Azospirillum*) on mulberry variety (China white) and its impact was studied on larval duration of silkworm hybrid (FC_1× FC_2). Less significant results were recorded when larvae reared on leaves raised through the application of Vermicompost @ 4kg/plant + *Azospirillum* (4.0g/plant). Further FYM@ 4kg/plant + *Azospirillum* (4.0g/plant) found next best with respect to larval duration. Consequently the present experiment revealed that Vermicompost @ 4kg/plant + *Azospirillum* (4.0g/plant) is responsible to produce good quality mulberry leaves and shorter larval duration followed by FYM@ 4kg/plant + *Azospirillum* (4.0g/plant) found next best with respect to larval duration. Thus, application of Vermicompost + *Azospirillum* (T6) after pruning could form a suitable organic manure and biofertilizer combination from overall sericultural point of view.

Keywords: Mulberry, silkworm hybrid (FC_1×FC_2), larval duration, organic manures, bio-fertilizer

Introduction
Mulberry sericulture is a labour-intensive industry in all its phases, namely, cultivation of silkworm food plants, silkworm rearing, silk reeling and other post cocoon processes such as twisting, dyeing, weaving, printing and finishing [1]. Nutrition is the most important growth regulating factor in silkworm Bombyx mori L. Hence, silkworm should be feed with good quality of mulberry leaves in abundant quantity for the successful cocoon production. Application of manures and biofertilizers after pruning results in increased leaf yield with improved quality parameters of mulberry without effecting the fertility of soil. Bio fertilizer is the substance which contain living micro organisms. When applied to seed, plant surfaces or soil, it colonizes the rhizosphere or the interior of the plant and promotes growth by increasing the supply or availability of primary nutrients to the host plant. Bio fertilizers are renewable source of plant nutrients that can supplement chemical fertilizers. In this context, it is highly imperative to supply major nutrients to mulberry through organic manures and biofertilizers. Organic manures are bulky in nature which encourages the proliferation of soil microflora and supplement the crop with small amounts of major nutrients like NPK and other minor nutrients required by the crop [2]. Introduction of crop benefiting microbial inoculants into soil plays a significant role in the mobilization of various nutrients needed by the crop. Organic manures such as vermicomposting is an eco-friendly technology and has a tremendous scope in the recycling of sericultural residue. Proper utilization of sericulture waste as raw material for vermicomposting serve as organic manure which can substantially bring down the expenditure on chemical fertilizers and helps in improvement of soil health and nutrient availability to mulberry plants leading to leaf quality improvement [3]. Vermicompost are rich in microbial populations and diversity, particularly fungi, bacteria and actinomycetes. Effect of organic manures especially poultry manure in combination with Azotobacter bio- fertilizers followed by reduced doses of inorganic fertilizers had a significant effect on growth and leaf quality of mulberry plants [4]. Application of different organic manures and biofertilizers along with lower dose of fertilizers plays a significant role in enhancing the soil fertility in terms of macronutrients, secondary nutrients and microbial population [5]. With this background the present study was undertaken to work out the effect of organic manures (Vermicompost, farm

yard manure-FYM, Silkworm rearing waste, Neem cake) alone and in combination with Azospirillum on the production of quality mulberry foliage which in turn may exhibit significant bearing on larval duration trait of silkworm.

Materials and Methods

The present study was carried out at the Division of Sericulture, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Chatha, during 2018-19. In this experiment 2 years old plantation of mulberry (var. china white) trees were treated with organic manures alone and in combination with biofertilizer (Azospirillum) on the production of quality mulberry foliage which in turn may exhibit significant bearing on larval duration trait of silkworm (FC1×FC2). The soil structure of the experimental farm is sandy clay loam with pH 7.12. The soil fertility of the experimental site was brought to homogeneous condition without applying any organic manures or fertilizers before raising mulberry crop for the present experiment. Seed of FC1×FC2 was procured from RSRS, Dehradun and released from cold storage, incubated and reared during Spring, 2019 in a Complete Random Block Design as per the standard rearing techniques prescribed by earlier researchers [6]. To know the effect of different organic manures on growth, yield and quality of mulberry in relation to larval duration trait of silkworm, the following treatment combinations were used.

T1: FYM @ 4kg /plant
T2: Vermicompost @ 4kg /plant
T3: Silkworm Rearing Waste @ 3kg /plant
T4: Neem cake @ 2.5kg/plant
T5: FYM @ 4kg /plant + Azospirillum (4.0g /plant)
T6: Vermicompost @ 4kg /plant + Azospirillum (4.0g/plant)
T7: Silkworm Rearing Waste @ 3kg /plant + Azospirillum (4.0g/plant)
T8: Neem cake @ 2.5kg/plant + Azospirillum (4.0 g /plant)
T9: Control (No manure/fertilizer application)

Mulberry leaves raised by application of the above treatments were fed to silkworm, Bombyx mori larvae (FC1×FC2) three times a day. The newly hatched silkworm larvae were divided into nine treatments including control. The rearing tray with 100 larvae fed with mulberry leaves grown without the application of manures/fertilizers served as control (standard). Each treatment represented by three replicates. Each replicate one hundred larvae. For each chopped leaves were offered three times daily to young silkworm (I, II & III instars). While, whole leaves were offered for grown silkworm (IV and V insatrs). As the larvae grew, the required spacing was appropriately provided. In order to control the incidence of diseases, vijetha (recommended bed disinfectant) was dusted at the rate of 5.5 kg/100 disease free layings (dfls) after bed cleaning and 30 minutes before feeding resumes as per the recommendation [7]. Following observations were recorded for each laraval instar durations with given formulae.

1. Age larval duration

It is the duration of larvae from the day of brushing to 1st moult and was recorded in days and hours for each replicate.

2. Age larval duration

It is the duration of larvae from 1st moult to initiation of 2nd moult and was recorded in days and hours for each replicate.

3. Age larval duration

It is the duration of larvae from 2nd moult to initiation of 3rd moult and was recorded in days and hours for each replicate.

4. Age larval duration

It is the duration of larvae from 3rd moult to initiation of 4th moult and was recorded in days and hours for each replicate.

V age larval duration

It is the duration of larvae from 4th moult upto pre-spinning and was recorded in days and hours for each replicate.

Total larval life duration (Days and Hours)

It was recorded as average larval life in days from brushing to pre-spinning stage including moulting duration for each replication.

All the data recorded during the course of experimentation was analyzed by using statistical package (SPSS 16.0). Effects of different treatments on mulberry, larval durations of silkworm parameters were analyzed using one way ANOVA. Differences between means were tested by using Tukey's HSD (P<0.05).

Results and Discussion

Locale of the study: The present study was conducted during spring, 2019 at Division of Sericulture, SKUAST-Jammu in order to know the effect of organic based nutrients on larval duration of silkworm, Bombyx mori L (FC1×FC2). The experimental results obtained from this investigation are presented here under:

At larval stages the observations were recorded on the duration of larval instars, moulting and total larval duration (D:H). The data presented in Table revealed that Ist instar larval duration was 4:00 ± 0.00 (D: H). However, IInd instar larval duration was 3:00 ± 0.00 (D:H) and there is no significant difference was found between the treatments in Ist and IInd instar duration. IIIrd instar larval duration (D:H) (F = 19.551; df = 8; p = 0.000), in respect of this parameter application of vermicompost + Azospirillum (T6) resulted in significantly shorter larval duration (4:01 ± 0.01) followed by T5 (4:03 ± 0.01), T8 (4:03 ± 0.01) and T2 (4:04 ± 0.01) while significantly higher larval duration was registered in Control (T9) (4:12 ± 0.01).

However, non-significant differences were observed between T1 (4:06 ± 0.01) and T4 (4:07 ± 0.01). IVth instar duration (D:H) (F = 36.705; df = 8; P = 0.000), in respect of this parameter application of vermicompost + Azospirillum (T6) resulted in significantly shorter larval duration (5:01 ± 0.00) followed by T5 (5:03 ± 0.01) and T8 (5:04 ± 0.00) respectively over other treatments while significantly higher larval duration was registered in Control (T9) (5:13 ± 0.01). However, non-significant differences were observed between T2 (5:05 ± 0.01) and T7 (5:06 ± 0.01). Vth instar duration (D:H) (F = 83.585; df = 8; P = 0.000) in respect of this parameter application of vermicompost + Azospirillum (T6) resulted in significantly shorter larval duration (7:00 ± 0.00) which was found statistically at par with T5 (7:02 ± 0.01) followed by T8 (7:03 ± 0.01) while significantly higher larval duration was recorded in Control (T9) (7:19 ± 0.01). However, non-significant differences were observed between T3 (7:14 ± 0.01) and T4 (7:13 ± 0.01). Total larval duration (D:H) (F = 1183.000; df = 8; P = 0.000), in respect of this parameter application of vermicompost + Azospirillum (T6) resulted in significantly shorter larval duration (27:02 ± 0.01) followed by T5 (27:09 ± 0.01) which was found statistically at par with T8 (27:11 ± 0.01). While significantly higher total larval duration was observed in Control (T9) (29:02± 0.01).

Silkworm larvae fed with mulberry leaves grown with

different treatments of organic based nutrients showed positive impact in various stages of larval durations in comparison to control (T9) in which no supplement application was given. The importance of mulberry in sericulture industry can be realized from the fact that mulberry leaves form the only food material required by silkworm Bombyx mori L [8]. Production of high quality silk therefore demands the overall improvement of the host plant manifested in terms of qualitative and quantative leaf production. Silkworm larvae fed with mulberry leaves raised with the application of vermicompost + Azospirilum (T6) showed significant results for larval duration of silkworm (27:02 ± 0.01). These results are in confirmation with the findings [9-12] who revealed the positive impact of Vermicompost and Azospirillum on mulberry leaves and other important larval characters. Application of vermicompost results in better growth and yield in mulberry as well as in silkworm [13]. Similar results reported when silkworm larvae were fed with mulberry leaves supplemented with FYM and different doses of NPK [14].

Table: Effect of organic manures alone and in combination with *Azospirillum* on total larval duration (D: H) of bivoltine silkworm hybrid ($FC_1 \times FC_2$)

Treatments	I age larval duration (D:H)	Ist moult	II age larval duration (D:H)	II nd moult	III age larval duration (D:H)	III rd moult	IV age larval duration (D:H)	IV th moult	V age larval duration (D:H)	Total larval duration (D:H)
T_1	4:00±0.00 a	0.24	3:00±0.00 a	0.23	4:06±0.01 bc	0.24	5:07±0.01 cde	0.27	7:11±0.01 de	28:02±0.01 e
T_2	4:00±0.00 a	0.24	3:00±0.00 a	0.23	4:04±0.01 ab	0.24	5:05±0.01 bcd	0.26	7:08±0.01 bc	27:16±0.01 c
T_3	4:00±0.00 a	0.24	3:00±0.00 a	0.23	4:09±0.01 cd	0.24	5:10±0.01 ef	0.28	7:14±0.01 e	28:12±0.01 g
T_4	4:00±0.00 a	0.24	3:00±0.00 a	0.23	4:07±0.01 bc	0.24	5:08±0.01 de	0.27	7:13±0.01 e	28:06±0.01 f
T_5	4:00±0.00 a	0.24	3:00±0.00 a	0.23	4:03±0.01 ab	0.24	5:03±0.01 ab	0.26	7:02±0.01 a	27:09±0.01 b
T_6	4:00±0.00 a	0.24	3:00±0.00 a	0.23	4:01±0.01 a	0.24	5:01±0.00 a	0.25	7:00±0.00 a	27:02±0.01 a
T_7	4:00±0.00 a	0.24	3:00±0.00 a	0.23	4:05±0.01 abc	0.24	5:06±0.01 bcd	0.27	7:08±0.01 cd	27:20±0.01 d
T_8	4:00±0.00 a	0.24	3:00±0.00 a	0.23	4:03±0.01 ab	0.24	5:04±0.00 abc	0.26	7:03±0.01 ab	27:11±0.01 b
T_9	4:00±0.00 a	0.24	3:00±0.00 a	0.24	4:12±0.01 d	0.24	5:13±0.01 f	0.30	7:19±0.01 f	29:02±0.01 h

Values are Means ± SE

Means within a column followed by different letters are significantly different $P<0.01$

Conclusion

Based on the current findings, it has been concluded that, mulberry leaves treated with the application of vermicompost (4.0 Kg) + Azospirillum (4.0 g/plant) followed by supported positive impact on larval duration of silkworm. This could be due to considerable research evidence that earthworms stimulate the microbial decomposition of organic matter significantly, thereby releasing the nutrients in available form to mulberry tree which has a direct effect on quality of mulberry leaves, which might have enhanced palatability and acceptability of leaves, increased feeding efficiency of silkworms and thereby resulting in good cocoon yield. Whereas, other organic manures like FYM, silkworm rearing waste and neem cake may require some more time to breakdown into simpler molecules and to release nutrients to the soil and making them available to mulberry tree for its utilization. Thus, application of vermicompost + Azospirillum (T6) could form a suitable organic manure and biofertilizer combination from overall sericultural point of view.

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