Influence of Illumination on Economic Traits of Bombyx.mori

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Abstract- The domesticated silkworm, *Bombyx.mori* has been the objective of demanding scientific study. The nurture of silkworm is extremely vulnerable to change in environmental conditions especially in larval stages. Fluctuations in the larval stages with reference to light (artificial and sunlight) changed the larval survival duration and also shows its effect on the yields of profitable crops. Keeping this view in context, the present study is designed to find out the consequences of complete darkness, artificial light (for shorter duration) and also early morning sunlight for the same. The present results revealed that mean life cycle of larval stages of *Bombyx.mori* was 35.5 days in dark, 34 days in artificial light and 32.5 days in sunlight. The mean length and weight of all the larval stages in three different situations strengthened the productiveness of the larvae. Generally the duration of life cycle, length, weight and fecundity rate of the larvae reared in early morning sunlight was significantly better than the larvae kept in artificial light and in dark condition.

Keywords: *Bombyx.mori*, Early morning sunlight, Artificial light, Dark, Growth parameters.

INTRODUCTION

Sericulture is the discipline of rearing silkworm for the commercial production of raw silk. Silk is mostly used in manufacturing of cloth apart from that it is also used in surgical sutures, electric insulating material, oil protein, parachute making, artificial blood vessel etc. Almost all-commercial silk is made from cocoons spun by silkworms of the genus *Bombyx* (Lee, 1999). Silkworm, *Bombyx.mori* is the most familiar species used for the production of silk. Silkworm, in all stages of its growth, excluding egg stage, is characterized as a stenothermal and particularly a midthermal animal, according to its demands for environmental temperatures i.e. 22-28^{0}C (Alexandros and Harizanis, 2004). Silkworms are cold blooded insect; as such the temperature has direct influence on the various physiological activities of the system. Low and high temperature has adverse affect on the silkworm growth and development. On the other hand, light also plays a influential role in the silkworm rearing. In silkworm rearing, it is vital to maintain the optimum environmental as well as conditions like light availability to ensure for maximum productivity of cocoons. Silkworms are photosensitive and they have a tendency to crawl towards dim light. They do not like either strong light or complete darkness. Rearing of silkworms in continuous light delays the growth. Further, it causes pentamoulters and reduces both larval and cocoon weights. Researchers have conducted experiments to find out high yielding strains of B. mori and mulberry. The growth rate of B. mori larvae and subsequent silk production depend mainly on the nutrient content of mulberry leaves. Hoffman and Subramanian (2005) found in their experiment, the role of light exposure on the final stages of development of *Anopheles stephensi* that there was a significant reduction in the development of adult mosquitoes when larvae were bred in the absence of light compared with the control group bred in alternating 12h light and 12h dark. It has been observed that electric light can affect the behavior of nocturnal insects. A high level of illumination causes night flying insects to settle as they would normally do at daybreak, so feeding, breeding and egg laying activities cease. Furthermore, it was found that

artificial light can affect mating of moths e.g., females do not produce the sex pheromones to attract males (Anonymous, 1998). Silkworms are fond of dim light of 15 to 20 lux and avoid strong light and darkness. Late-age worms survive better in 16-hour light and 8-hour dark periods. However, young-age worm prefers 16 hr darkness and 8 hr light period. Larvae of silkworm do not prefer either strong light or complete darkness but usually light phase, in contrast to the dark phase, activates the larvae. Silkworm is an insect of small lifespan with positive phototactism (Mathur and Rajan,1991); the silkworm larvae are fed in complete darkness during the life cycle, their larval duration is longer, and cocoon quality becomes poor (Patil and Gowda, 1986). Rearing in either complete darkness or in bright light leads to irregularity in growth and moulting. Light phase usually makes larval duration longer than the dark phase. The influence of light and temperature on growth of silkworm was studied in detail (Kogure, 1932). (Iqbal et al., 2008) has observed that mean life cycle of B. mori was 62 days in dark and 68 days in light. The diurnal variation in the activity persisted in constant darkness, but was suppressed by constant light. Generally, that the duration of life cycle of the larvae reared in dark was significantly better than the larvae kept in light condition. Less work has been done on the influence of light on silkworm larvae. So the present study sought to determine the effects of various light i.e. artificial light and early morning sunlight on growth parameters of larvae of silkworm *Bombyx.mori*.

MATERIAL AND METHODS

Preparation of larval rearing: The larvae were reared in room disinfected with 4% formalin sprayers prior to shift the larvae. The rearing of larvae should be done at temperature (25 ± 2^0 C) and RH conditions (70±5%) following Krishnaswami, (1978). The larvae of control group was kept in dark and for 2 hours in artificial light and also for 2 hours in early morning sunlight as followed by Hussain et al., (2011).

Collection of Larvae : The first instar of CSR hybrid of silkworm *Bombyx.mori* (Multivoltine) were collected from Sericulture Farm at Seoni Tola and maintained upto cocoon stage. The larvae collected from Seoni Tola were transferred to bamboo basket of 27-29 cm diameter and 8-10 cm height as described by Govindan et al.(1981). The bamboo baskets were covered with bamboo lid and moist gunny bags.

Larval Rearing : The larvae were reared simultaneously both in control and experimental groups like sunlight and artificial light separately on Victory 1 mulberry leaves in the separate room. The first instar larvae from day 1 placed at ambient temperature of 25 ± 2^0 C and relative humidity of 70±5%. The larvae were reared in cardboard boxes measuring 30 x 20 x 30 cms covered with nylon net and placed in a separate room. The larvae of control and experimental group were fed with Victory 1 mulberry leaves accordingly.

Mulberry (Morus alba L.) V-1 Variety:This is one of the variety of mulberries selected from Sericulture Farm, Seoni Tola. Branches are simple vertical, leaves are darkly green , unlobed, elliptic, palmate veined, smooth and juicy. It has good agronomic characters.

Experimental Group: There are two experimental groups 1^{st} , 2^{nd} , 3^{rd} , 4^{th} and 5^{th} instars of *Bombyx.mori* larvae fed with V-1 mulberry leaves. The control groups 1^{st} , 2^{nd} , 3^{rd} , 4^{th} and 5^{th} instars of *Bombyx.mori* larvae, which was kept in dark also fed with V-1 mulberry leaves. They were maintained upto cocoon stage.

Data Collection and Analysis

Larval length in each instars was recorded with the help of measuring scale and larval weight was documented with the help of Pocket Balance (Hussain et al., 2011). Data recording on larval length and weight were accomplished on the completion of 3^{rd}, 4^{th} and 5^{th} instars before moulting.

Table – 1: Different conditions used in the study to evaluate the impact of darkness, artificial light and early morning sunlight on silkworm larvae of CSR hybrid fed on Mulberry variety Victory – 1

Treatments	Description
Control	Complete Darkness
Artificial Light	0-1W LED light
Sunlight	Early Morning.

RESULTS

The impact of sunlight and artificial light on growth of silkworm larvae and their larval life cycle was investigated in the present study. The data on larval length and weight were recorded from 1^{st} – 5^{th} instars and also their lifecycle were observed.

Larval Body Length (1^{st} Instar)

The larval lengths recorded at the end of 1st instar not showed significant differences in means i.e. 1.00, 1.50, and 1.80cm in control, artificial light and sunlight respectively (Table 2).

Larval Body Length (2nd Instar)

The larval lengths recorded at the end of 2nd instar not showed significant differences in means i.e. 1.50, 2.00, and 2.50cm in control, artificial light and sunlight respectively (Table 2).

Larval Body Length (3rd Instar)

The larval lengths recorded at the end of 3rd instar showed significant differences in means i.e. 2.45, 2.80 and 3.45 cm in control, artificial light and sunlight respectively (Table 2).

Larval Body Length (4th Instar)

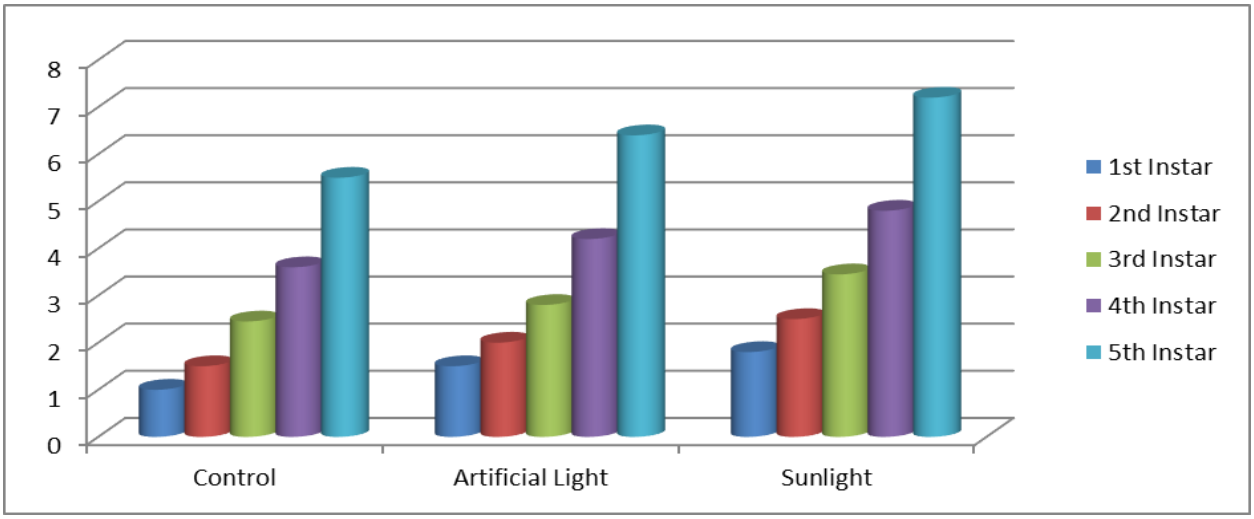
Larval length recorded at the end of 4th instar indicated significant variations in larval length i.e. 3.60, 4.20 and 4.80 cm in control, artificial light and sunlight respectively (Table 2).

Larval Body Length (5th Instar)

Data recorded at the end of 5th instar showed significant differences in larval length i.e. 5.50, 6.40 and 7.20 cm in control, artificial light and sunlight respectively (Table 2).

Table – 2: Effect of dark, artificial light and sunlight on larval length during 1st Instar to 5th Instar of silkworm reared at controlled conditions of Temperature and RH

Group	Body Length				
	1st Instar	2nd Instar	3rd Instar	4th Instar	5th Instar
Control	1.00 cm	1.50 cm	2.45 cm	3.60 cm	5.50 cm
Artificial Light	1.50 cm	2.00 cm	2.80 cm	4.20 cm	6.40 cm
Sunlight	1.80 cm	2.50 cm	3.45 cm	4.80 cm	7.20 cm



Larval Body Weight (1st Instar)

Larval weight (g) recorded at the end of 1st instar not yielded significant differences in larval weight i.e. 0.01, 0.02 and 0.03 g in control, artificial light and sunlight respectively (Table 3).

Larval Body Weight (2nd Instar)

Larval weight (g) recorded at the end of 2nd instar not yielded significant differences in larval weight i.e. 0.12, 0.18 and 0.25 g in control, artificial light and sunlight respectively (Table 3).

Larval Body Weight (3rd Instar)

Larval weight (g) recorded at the end of 3rd instar yielded significant differences in larval weight i.e. 0.25, 0.30 and 0.38 g in control, artificial light and sunlight respectively (Table 3).

Larval Body Weight (4th Instar)

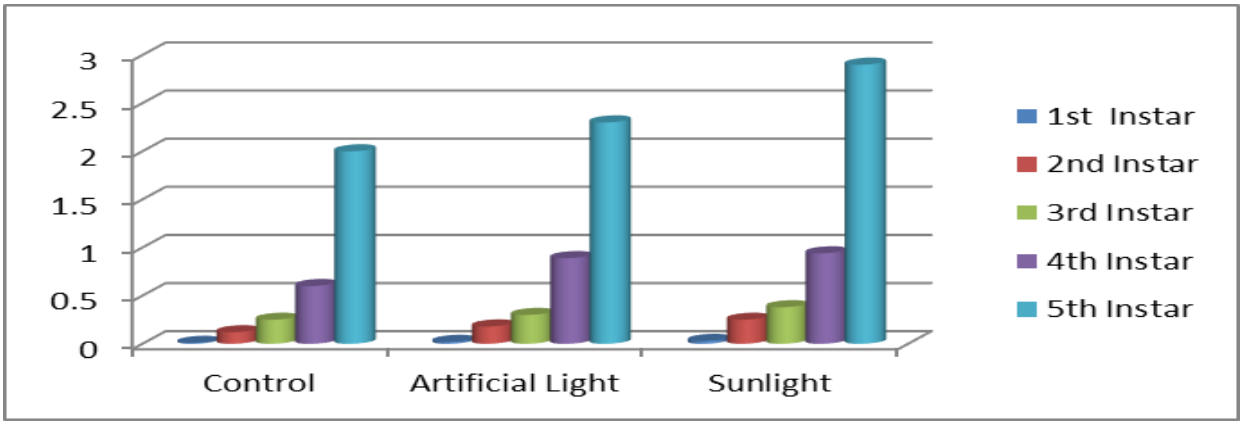
Larval weight (g) recorded at the end of 4th instar showed significant differences in larval weight i.e. 0.60, 0.89 and 0.94 g in control, artificial light and sunlight respectively (Table 3).

Larval Body Weight (5th Instar)

Larval weight (g) recorded at the end of 5th instar showed significant differences in larval weight i.e. 2.00, 2.30 and 2.90 g in control, artificial light and sunlight respectively (Table 3).

Table – 3 : Effect of dark, artificial light and sunlight on larval weight during 1st Instar to 5th Instar of silkworm reared at controlled conditions of Temperature and RH

Group	Body Weight				
	1st Instar	2nd Instar	3rd Instar	4th Instar	5th Instar
Control	0.01 gm	0.12 gm	0.25 gm	0.60 gm	2.00 gm
Artificial Light	0.02 gm	0.18 gm	0.30 gm	0.89 gm	2.30 gm
Sunlight	0.03 gm	0.25 gm	0.38 gm	0.94 gm	2.90 gm

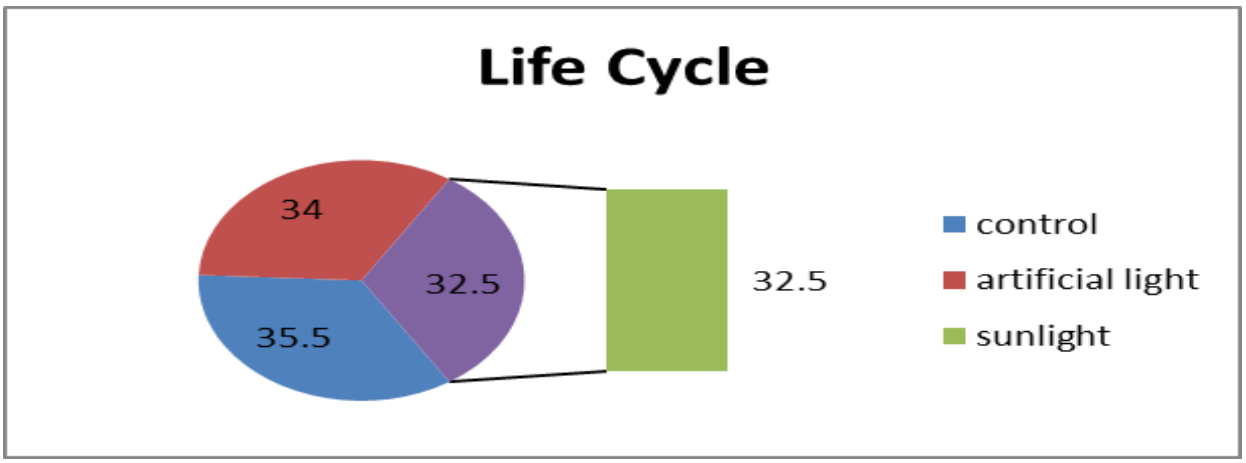


LARVAL LIFE SPAN

Larval life span (days) recorded at the end of every instar and mean larval life span showed significant differences i.e. 35.5, 34 and 32.5 days in control, artificial light and sunlight respectively (Table 4).

Table – 4 : Effect of dark, artificial light and sunlight on larval life span during 1st Instar to 5th Instar of silkworm reared at controlled conditions of Temperature and RH

Instar	Larval Life Span (Days)		
	Control	Artificial Light	Sunlight
I	6.5	6.5	6.5
II	6.5	6.5	6.0
III	6.5	5.5	5.5
IV	5.5	5.5	5.5
V	10.5	10	9
Total	35.5	34	32.5



DISCUSSION

The growth parameters of *Bombyx.mori* larvae kept in dark, artificial light and sunlight for 2 hours provided with same conditions of temperature (25 ± 2^0) and humidity (70±5%) is shown in Table 2, 3 and 4. The larvae kept in early morning sunlight expressed significantly better results than the larvae in artificial light and in dark in respect of larval length, weight and larval lifespan. In contrast, when B.mori was exposed to a 12h light/ 12h dark lighting schedule, the HIOMT like activity showed a significant diurnal variation with high levels during the dark period (Itoh et al., 2004). The change in body length of larvae was observed on every alternate day. The results showed that larvae undervent significant change in body length but with faster growth rate under 12L: 12D photoperiod in comparison to 8L: 16D and 16L: 8D (Renthlei et al., 2016).

The need for managing temperature and humidity for cocoon and larvae growth was confirmed by changes in ambient variables and seasonal variations According to Madhusudhan et al., (2017) temperature has a direct impact on growth, development, physiological activities, nutritional absorption, digestion, egg hatching, growth and cocoon quality. According to the current findings, the parameters of larvae and cocoons were significantly influenced by photoperiod. Since silkworms are poikilothermic insects, their extensive physiological activity is directly influenced by photoperiod. The effect of sunlight is comparatively better for the proper growth of silkworm which in turn give quality product as cocoon. Intermittent photoperiodic condition such as sunlight, artificial light and dark condition applied on the developmental stages of silkworm larvae have observed. In the current study, the ideal photoperiodic condition was the early morning sunlight between 7:00 am to 9:00 am which reduces the duration of silkworm life cycle and also give maximum productivity as well. It was contradicted by the report given by Iqbal et al. (2008) which shows the highest outcome in darkness rather than sunlight. Sharma et al. (2022) also reported that at optimum conditions of temperature, humidity and photoperiodism dark conditions showed better performances as compared to light conditions. Yadhav and Jadhav (2014) reported the effectiveness of normal, dark and light for 24 hours with respect to temperature 25 ± 2^oC and relative humidity 75±5 % was observed in *Philosomia ricini* larvae and found better result in dark setting as compared to light conditions which was quite dissimilar with the current investigation.

CONCLUSIONS

From the present results, it is concluded that *Bombyx mori* larvae shows shorter life cycle along with maximum length and weight in the early morning sunlight than in artificial light and in dark conditions, when kept under the same conditions of humidity and temperature. The present research is an attempt to highlight the conducive and the best possible conditions for the growth of larvae in order to provide satisfactory knowledge about more proficient methods of silkworm rearing. These practices facilitate the farmers to provide better care to silkworm and its rearing to improve the quality as well as quantity of the product.

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