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A systematic review on influence of temperature on fecundity, incubation period and fertility of multivoltine mulberry silkworm *(Bombyx mori* linn.) eggs

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Abstract
The influence of temperature changes and period of incubation of silk worm eggs lines was found in 10˚, 14˚, 18˚, 26˚, 34˚, and 38˚C by exposing the fifth and the fourth larvae. The minimum level of fecundity that is 248 female eggs and the period of incubation of eggs reduced at a very fast rate 21. 67 days at 10 degree Celsius while the maximum fecundity rate 385 per female and the period of incubation were 9. 47 days at 26 degree Celsius. Above 26 degree both the fecundity and the incubation decreased considerably. The best temperature that is needed for rearing silkworm lines for cocoons production obtaining highest number of eggs with short period of incubation with increased rate of fertility is at 26 degree Celsius and 12 hours day light in one day that can be used in seed cocoon for hybridization and production. Investigations have shown that variation in temperature and humidity during the rearing of larvae resulted in low fecundity and high incidence of eggs that are not yet fertilized. The study has shown that incubation period, fecundity and fertility can be increased by avoiding temperature and levels of humidity.

Keywords: mulberry silkworm, fecundity, incubation period and influence of temperature

Introduction

Within India, sericulture has been regarded as a key element of economic growth. Its peculiarity rests on the notion that sericulture practices not only involve rural population in mulberry or silkworm production, but include a diverse group of reelers and weavers. The current communication concerns sericulture, where it is well recognised that various factors influence the incubation duration, silkworm fertility, as well as the generation of high-quality eggs [1]. Silkworm seed excellence pertains to egg survivability, hatching consistency, and, most critically, offspring rearing ability [2]. The key determinants in seed generation are abundance, fertility, as well as the incubating time. The effect of weather upon silkworm races' abundance, fertility, and gestation duration encompassing abnormalities in reproductive organs, incorrect moth management during adulthood and egg-laying mating, and improper egg-laying. Temperature is one of the most significant environmental elements affecting the biology of *Bombyx mori* bugs.

In comparison to other nations involved in sericulture, India's silkworm hatch output lags below the capability of silkworm breeds. Sericulture's industrial seed generation procedures ought to be optimised in order to increase farmer profits and unprocessed silk yield. The difficult process of creating silkworm breeds capable of producing larvae in a temperature-controlled environment. The abundance, fertility, and incubating duration of silkworm larvae have not been studied, according to a review of the research. The purpose of this research was to determine the impact of temperature variations on silkworm embryo generation (fecundity), embryonic fertility, and silkworm embryo incubation times. The research will aid in determining the explanation of low production and egg development throughout all sericulture stations.

Materials and Method

Six sets of studies were developed to see how temperature affected the behavior of Bombyx mori. The temperature ranges used for the trials were 10, 14, 18, 26, 34, and 38 degrees Celsius. DFLs derived from silk moths grown in the research laboratory were periodically moved to a BOD incubator controlled at 101°C in the research laboratory during the first set of tests. The ideal experimental circumstances, which included a range of 261 degrees Celsius, a RH of 80 percent, and 12 hours of illumination every day, served as a baseline for the studies. The disease free lay (DFLs) were cleaned in 2 percent formalin for 15 minutes to enhance egg adhesion to the card and to sterilise the area before being continuously moved to the BOD incubator. For every replication, 30 regular egg laying (three sets of 10 laying in every set) were collected to determine abundance. Each experiment was duplicated three times. The duration necessary for incubating until the hatch of eggs was estimated for every set of trials separately to evaluate the impact of weather on the incubating duration of silkworm embryos. There were three duplicates of ten embryos from each replication. Using the average figure of the information gathered, the mean of the time needed by embryos for incubating until emergence of larvae was computed. For each group of the research, the mean hatching of 10 layings was used as an indicative hatchability rate per laying. Every replication had thirty laying (three batches of 10 lying in every set). Every test was duplicated thrice.

$$\text{Hatchability (fertility) \%} = \frac{\text{No. of hatched eggs per laying}}{\text{No. of fertilised eggs per laying}} \times 100$$

Statistically analysed by one –way ANOVA of all experimental parameters

Result and Discussion

According to statistics on the effect of weather on Bombyx mori production, the egg production potential of *Bombyx mori* grew as the heat went from 14 to 26 degrees Celsius, but beyond 26 degrees Celsius, fertility began to fall as the heat went up to 34 degrees Celsius. At 14 degrees Celsius, the lowest count of eggs released each female moth was248; at 26 degrees Celsius, the highest count of eggs released each female was 385. With temperature rise from 14 to 18 C, there was a noticeable tendency of difference in growing fecundity, but the pattern of difference in reproduction with rising heat up till 26 C was stable. The capacity of the bugs to fertilize eggs reduced gradually above 26 degrees Celsius, and only up to 34 degrees Celsius. Fertility is a genetic trait, and its manifestation in the genetic of a species of insects such as the mulberry silkworm is linked to a range of biological and environmental conditions [3]. The abundance of moths hatched from pupae derived from chilled embryos and pupae was found to be impacted, with a dramatic drop in silkworm egg releasing capability [4]. When *Bombyx mori* maggots were fed ascorbic acid-treated mulberry leaves, however, there was a lot of production [5]. The grade of mulberry leaf was identified as one of the most important elements for optimal productivity in *Bombyx mori,* whereas it was hypothesised that the coupling length influences egg development in *Bombyx mori* [6]. *Bombyx mori* was also subjected to a thermal therapy [7]. Silkworm fertility was improved by pupae, whilst *Bombyx mori* production was positively correlated with incubation temperature [8]. It is possible that decreased productivity at very reduced temperatures is caused by a lack of substance, crucial oogenesis (silkworm hatchlings swallow the least quantity of mulberry leaf at really reduced temperatures) and metabolism speed and weather are the key factors [8, 9, 10].

According to statistics from the study Effects of heat on the incubating length of *Bombyx mori* embryos, temperature variations had a significant impact on the incubating time of *Bombyx mori* embryos [11, 12]. The incubating time of eggs reduced significantly as the heat increased from 10 to 38 degrees Celsius, from 21.67 days at 10 degrees Celsius to 6.57 days at 38 degrees Celsius. At increased temperatures the level of reduction in the time of the incubating time was moderate, whereas at lower temperatures, the level of decline was average. The embryos took 9.47 days to incubate at 26 degrees Celsius. The incubating time of Antheraea assama is significantly influenced by heat adaptation. *Bombyx mori's* gestation time was likewise modified by the length of coupling [13]. The incubating duration of *Bombyx mori* embryos was significantly influenced by the activation of immature hormones [14, 15]. Inadequate egg development may be caused by genetic variation amongst silkworm breeds in various conditions [16]. Ahsan and Rahman [17, 18] both came to the same conclusion. It seems to be possible that the maturation of embryos was slowed in extremely reduced temperature settings owing to a sluggish mobilisation of power resources to meet the primary demand for embryo implantation.

According to studies on the effect of weather on the survival rate of *Bombyx mori* eggs, weather change had a significant impact on the Percentage of survival rate of *Bombyx mori* embryos. The survival rate rose significantly as the temperature rose from 10 to 26 degrees Celsius, rising from 45.16 percent at 10 degrees Celsius to 92.70 percent at 26 degrees Celsius. Additional increases in heat exceeding 26°C resulted in a significant drop in the breeding rate, which fell to 73.70 percent at 38°C. At 10 degrees Celsius, the lowest survival rate was 45.16 percent. The ability of behaviours to survive and grow is limited to some extent by their genetic structure [19]. The percentage of hatching of *Bombyx mori* embryos decreased significantly as the period of chilling increased [20]. The ability of bug embryos to hatch is harmed when early stage embryos are refrigerated, whereas mature eggs are better suited to long-term cold storage [21]. The percentage of *Bombyx mori* embryos that mature has no effect when they are treated with ascorbic acid [22]. The percentage of development of *Bombyx mori* was unaffected by numerous or single coupling, however therapy of *Bombyx mori* embryos with HCL resulted in the maximum hatchability embryos [23]. Overall development percentage of *Bombyx mori* embryos was influenced by environmental conditions [24]. The mobilisation of required components for the normal growth of fertilised eggs, as well as the functioning of enzymes are thought to play a role in the growth of embryos, leading in a poor hatching percentage [25]. On either side, at extremely high temperatures (38°C), the elevated metabolism of the embryos may lead in the waste of energy materials at the expense of the valuable resources necessary for embryo implantation, leading to a low hatch percentage [26].

Table 1: Influence of temperature on the fecundity (No. of eggs) of *Bombyx mori*

Temperature (^{O}C)						**F- ratio**
10*	14*	18*	26*	34*	38*	**$n_1 = 3$ $n_2 = 8$**
175±5.35	248±6.35	345±6.89	385±7.72	344±5.44	144±4.35	246*

Each value represents mean ± SD of three replicates, *P < 0.01

Table 2: Influence of temperature on the incubation period (days) of *Bombyx mori*

Temperature (^{O}C)						**F- ratio**
10*	14*	18*	26*	34*	38*	**$n_1 = 5$ $n_2 = 12$**
21.67±0.47	15.17±0.61	13.33±0.65	9.47±0.28	8.33±0.18	6.57±0.33	297.23*

Each value represents mean ± SD of three replicates, *P < 0.01

Table 3: Influence of temperature on Hatchability (%) of *Bombyx mori*

Temperature (^{O}C)						**F- ratio**
10*	14*	18*	26*	34*	38*	**$n_1 = 3$ $n_2 =8$**
4.16±1.36	62.73±2.49	76.50±2.42	92.70±2.72	81.96±2.09	73.70±2.09	334.94 *

N.Sd = Not Survived; P* < 0.01

Conclusion

Additional factors of seed cocoon formation, such as reproduction, embryo incubating time and hatchability percentage, should be considered alongside commercial features when selecting silkworm strains for further research by using the Evaluation Index Method (EIM).

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