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Influence of abiotic factors in emergence and fecundity rate of *Antheraea proylei*

Gunjan Pathak[1], Himanshu Pande Lohani[1*], Jeetika Siddhu[1], B R Kaushal[1], A S Verma[2]
[1] Department of Zoology, Kumaun University, Nainital, Uttarakhand, India
[2] Regional Sericultural Research Station (RSRS), Bhimtal, Uttarakhand, India

Abstract
Abiotic factors such as temperature and relative humidity are plays most vital role in an insect's growth and development. Abiotic factors must be considered in sericulture. Temperature and humidity show significant impact on cocoons of oak Tasar silk moth (*Antheraea proylei)* along with pupal diapause breakdown during storage in grainage. To achieve a high rate of emergence and fecundity, six different treatments were conducted using environmental chambers or climatic chambers. The current study focused on the influence of temperatures variation that is ranging from 18.5°C to 32°C and relative humidity levels ranging from 65-80 percent showed variation in the rate of emergence and fecundity.

Keywords: grainage, abiotic factors, cocoon garland, silk moth

Introduction
Silk has been utilized by humans for a variety of purposes since the prehistoric period. Pure silk is known as the "Queen of Fibers" because it is one of the world's finest and most attractive natural fibers (Ahsan and Sinha, 2000) [1, 15]. India is home to a large variety of silk-secreting fauna, including an extraordinary diversity of silk moths, allowing it to have the remarkable distinction of producing all five commercially traded species of natural silk, namely Mulberry, Tropical Tasar, Oak Tasar, Eri, and Muga (Giridhar *et al*., 2010) [6]. Insects are poikilothermic animals that are largely affected by various environmental factors. Among all the climatic factors, temperature has probably the greatest effect on insect development (Taylor, 1981; Pedigo, 1989; Tobin *et al.*, 2003) [18, 13, 19].
Insects are poikilothermic animals that are highly influenced by environmental conditions (Benchamin and Jolly, 1986) [3]. Temperature has the most impact on insect development of any climatic component. One of the most important abiotic elements influencing insect survival, development rate, abundance, behavior, and fitness is ambient temperature. (Harrington *et al.,* 2001; Zheng *et al.,* 2008) [8, 23]. The sericulture industry's success is determined by a number of elements, but environmental considerations such as biotic and abiotic factors are particularly important (Ranjan *et al.,* 2012) [14]. *Antheraea proylei* is reared in both the north-eastern and north-western regions. The physiology and life cycle parameters are highly influenced by the geography and climatic variables of the location, resulting in significant differences in physiology and economic yield in both zones. There is a lot of climate fluctuation in terms of altitude in the northwest region. Temperature and humidity are two abiotic elements that have a significant effect on silkworm growth and output (Ueda *et al*., 1975) [20]. Several studies have found that host plants affect larval weight gain, survival percentage, growth index, pupal weight, adult emergence, and fecundity. (Pandey, 1968; Singh and Byas, 1975; Dubey *et al.*, 1981) [12, 16, 5]. Several researchers found that during the fourth and fifth instars, silkworm larvae are susceptible to high temperatures, and lower or higher levels of relative humidity affect the growth and development of silkworm larvae (Mubashar *et al.*, 2011; Tajima and Ohnuma, 1995) [11, 17]. The significance of humidity in seed cocoon storage and egg laying potential was examined, and researchers also studied the freezing of cocoons and their impact on grainage characteristics and egg production (Mubashar *et al.*, 2011; Upadhaya *et al.*, 2006) [11].

Metrial and Methods
1. Formation of cocoon garland from Grainage
Cocoons are stored for a particular time period in grainage, which is quite selective and of good quality. Five garland replicants (C1, C2, C3, C4, & C5) are formed from grainage for the experiments (treatments) to be conducted. Each garland consists of 20 cocoons in it. All five garlands for each treatment were hung in the chamber, providing the temperature and relative humidity with the aim of resulting in the emergence of moths.

2. Treatments
Cocoon garlands were collected from grainage and treated with six different treatments: T1 (18.5°C & 60% RH), T2 (22°C & 65% RH), T3 (25°C & 70% RH), T4 (28°C & 75% RH), T5 (30.5°C & 75% RH), and T6 (32.5°C & 80% RH). To achieve maximum accuracy, all specified treatments were performed in a controlled environment using a climatic chamber, growth chamber, or environmental chamber. All these provided treatments were done in controlled manners using climatic chambers or growth chamber or environmental chamber for attaining optimum accuracy.

3. Moth emergence

When the proper temperature and relative humidity were reached, the moth emerged from the garlands strung in the chamber's cage.

While developing moths were allowed to mate for 8-12 hours, each treatment found that 4–6 hours was sufficient for coupling. In the case of a limited supply of males, these individuals are decoupled after coupling and can be reused the next time.

After emergence was completed, the total number of emergences and emergence % were calculated using the following formula:

$$Emergence\ percentage\ (\%) = \frac{Total\ no.of\ emerged\ moths}{Total\ no\ of\ cocoon} \times 100$$

After emergence sex ratio observed by calculating total number of male and female moths.

The sex ratio after emergence was determined by calculating the total number of male and female moths.

4. Fecundity

The female moths, after the process of coupling, were kept in the nylon netted bags for 3 days. The eggs laid on the first and second days were good for further processes like rearing. The total number of laid eggs after completion of 3 days was collected from net bags and the total number of eggs was calculated to estimate the fecundity rate.

Results and Discussion

The following data of experiment conducted on emergence rate, male and female moth and fecundity rate is given in table 1.

Moth Emergence

On each treatment emerged moth showed differentiation per garland. From following data, it was observed that treatment T1 showed lowest percentage of emergence (2.8±0.83), while treatment T3 showed highest no. of emergence (15.2±0.3) showed in table1. From table 1. it is illustrated that treatments T3 and T4 are slightly different from each other in terms of percentage of emergence. In treatment T3 shown by garland C4 and C5 is 80% of both while in case of treatment T4. The percentage emergence by garland C3 only shows 80% (fig1.).

Thus, it also concludes that T3 and T4 treatment showed slight variation in % emergence, out of which treatment T3 being the highest one as picturized on the (fig 2). Also, it's reflected in fig.1 that with increase in temp up to 30 to 32°C, the % of emergence was decreased. (i.e., T5 &T6). Climatic factors play an important role in growth of larvae and cocoon production. Cocoon preserved in grainage, the cocoons (pupa) that undergo diapause state were broken down from their dormant state by providing necessary conditions like limit of increases in temperature and relative humidity (Yumnam *et at.*, 2013) [22].

Table 1: Emergence, sex ratio and fecundity of *Antheraea proylei* J. moths in different treatments.

Treatments	Total no. of emerged moth (Mean±SD)	No. of emerged male moth (Mean±SD)	No. of emerged female moth (Mean±SD)	Average Fecundity (Mean±SD)
T1	2.8±0.83	1.8±0.83	1.0±0.00	91.2±4.816
T2	9.2±1.643	5.4±1.14	3.8 ±0.83	155.85±13.06
T3	15.2±0.83	8.4±1.14	6.8±1.30	184.44±9.07
T4	14.4±1.516	7.8±1.09	6.6±1.14	165.03±10.08
T5	10.6±1.14	6.2±0.83	4.4±0.54	92.89±3.51
T6	8.8±1.64	5.0±1.22	3.8±0.83	78.76±3.78

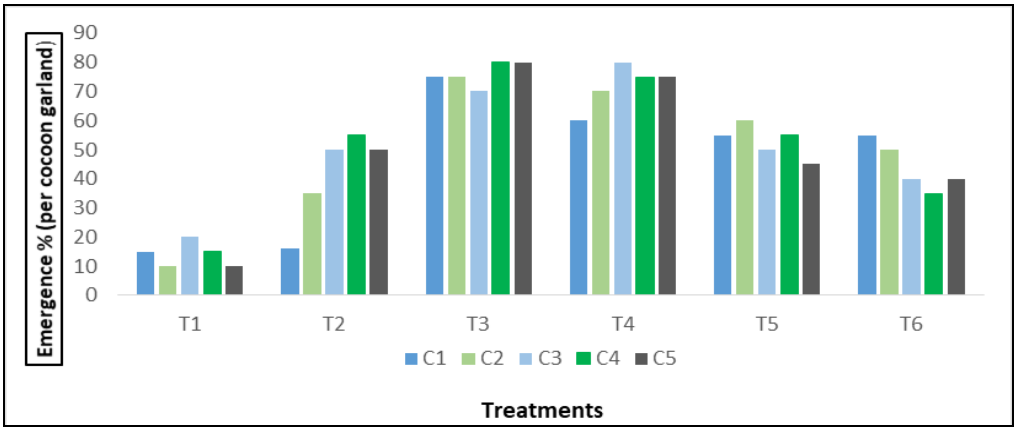

Fig 1: Emergence percentage of cocoon garland replicants in different treatments.

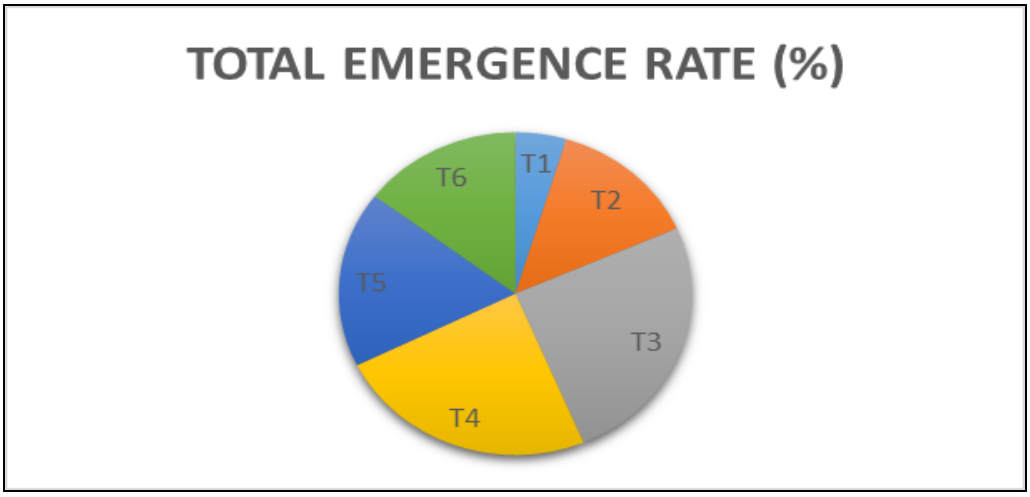

Fig 2: Total emergence percentage in different treatments.

Sex ratio and Fecundity

In all treatments from T1 to T6, it was observed that no. of female moths were less as compared to male moths. However, the data showed the highest no. of emerged female moths in treatment T3 while it was lowest in treatments T1.

For good fecundity no. of female emerged moths should be maximum regardless of male moths as male moths can be utilized again after decoupling.

Fecundity depends on the nature of coupling from overall study it states that moths were coupled in late hours, which is good for coupling as discussed by Rao *et al*., 2002 [15].

Due to lower temperature and humidity, treatment T1 showed very less no. of emergence, therefore, female moths (1.0 ± 0.00) and male moth (1.8 ± 0.83) sex ratio was less as compared to other treatments. Nature of coupling, fecundity depends on the position of female moths. The female moths were kept in oviposition using nylon netted bag and providing rough surface for 3 to 4 days. According to Kavane and Sathe (2011) [9], basic range of oviposition period is 3 to 5 days after 3 days, all laid eggs can be used for further processes.

The present study showed higher fecundity rate (184.44±9.07) when moth was treated with 25°C and 70% relative humidity similar result analyzed by several experiment (Bambhaniya, 2014; Hailu *et al.*, 2018; Mansotra *et al*., 2019) [2, 7, 10]. But at maximum temperature, treatment T6 should sudden drop in the rate of fecundity. However, on increasing the temperature up to 30°C &32°C the fecundity rate decreased (Cui *et al*., 2008) [4].

Conclusion

Based on the results of the experiments, it can be concluded that at temperatures ranging from 25° C to 28° C, the rate of emergence, sex ratio, and fecundity are higher, and as the temperature rises to 28 to 30° C, the number of emerged moths increases. So, according to this study, we can control the temperature and humidity according to data for greater emergence and fecundity. At this temperature, i.e., 25°C to 28°C, and relative humidity 70 to 75 percent, good quality seeds or dfls are produced, which are very beneficial in commercial and farmer's rearing purposes.

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