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UNSEASONAL EMERGENCE PATTERN OF TROPICAL TASAR SILK MOTHS (*ANTHERAEA MYLITTA* D.) AND ITS IMPACT ON OVULATION, FECUNDITY AND RETENTION OF EGGS

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ABSTRACT

In tasar sericulture, it is an established fact that many factors contribute to the growth and development of silkworms for production of quality eggs. In order to produce quality eggs, diapause tasar seed cocoons are preserved in grainage house. These preserved cocoons undergo various biotic and abiotic stresses. The abiotic factors, especially temperature and relative humidity influence moth emergence and egg laying. The silkworm being sensitive to environmental fluctuations and availability of congenial environmental conditions during preservation results in emergence of moths in unseason i.e. unseasonal emergence or erratic emergence and leading to preservation loss which has a direct bearing on egg/seed production. Hence, a study was conducted in the year 2022 at Bilaspur, Chhattisgarh to analyse the Daba TV tasar silk moth emergence pattern and its fecundity. The results revealed that the moths emerged erratically from January to May (2022) and a total number of 670 female moths and 932 male moths have emerged. Due to unsynchronized emergence of male and female moths, the coupling was 23 %. The coupled female moths were selected for oviposition whereas uncoupled moths were directly taken for dissection in order to analyse the mature eggs. In case of coupled female moth the average number of eggs laid on first day (24h), second day (48h) and third day (72h) was 58.60, 17.76 and 10.24 respectively. However, the average number of eggs retained in ovaries was 83.69. Ovulation was found to have a positive relation with fecundity and retention capacity. In case of uncoupled female moths the mature eggs in the ovaries was found to be very minimum (34.45 No.). Also observed that the formation of eggs in the ovaries was not normal and also in few cases no eggs (Nil) were recorded when the average temperature was >43 ℃ with relative humidity <33 % and rainfall <10 mm. This indicated that higher temperature and lower relative humidity were detrimental for formation of eggs in the ovaries and the innate reproductive ability of tasar silk moth was interrupted due to extreme climatic factors.

Keywords **:** Tasar silk moth, unseasonal emergence, ovulation, fecundity.

Introduction

Tropical tasar silkworm *Antheraea mylitta* D. has a unique feature of exhibiting diapause in pupal stage to avoid unfavouarable or adverse environmental conditions such as temperature extremes, drought or reduced food availability. Diapauseis a state of survival by halting all metabolic activities and delay in development under changing environment and in spite of wide fluctuations in their surroundings, it shows a remarkable range of adaptations to fluctuating environmental conditions and maintains internal temperature and water content within tolerable limits and stores molecules such as lipids, proteins and carbohydrates throughout diapause phase and provide fuel for development following termination.

In tropical insects like tropical tasar silkworm environmental regulators such as temperature, relative humidity, rainfall and day length regulate the diapause (Denlinger, 1986). Tasar silkworm pupae undergo diapause for several days to months and pupal diapause period ranges from 210-225 days, in trivoltine (TV) the pupa undergoes diapause in January and terminates in the month of May whereas, in case of bivoltine (BV) stock pupae remains in diapause from December to June. The low temperature as experienced in winter increases diapause incidence (Hackett and Gatehouse, 1982). Similarly, high temperature blocks the initiation of development and lack of rainfall, however, may have an indirect effect. The onset of rain is directly related to diapause termination and the emergence of adult moths.

It is an established fact that many factors contribute to the growth and development of silkworms for production of quality eggs. In order to produce quality eggs, diapause tasar seed cocoons are preserved in grainage house. These preserved cocoons undergo various biotic and abiotic stresses. The abiotic factors, especially temperature and relative humidity influence moth emergence and egg laying (Nadaf *et al.,* 2019; Vishaka *et al*., 2020). The silkworm being sensitive to environmental fluctuations and availability of congenial environmental conditions during cocoon preservation results in emergence of moths in unseason i.e., unseasonal emergence or erratic emergence and leading to cocoon preservation loss which has a direct bearing on

egg/seed production. It is also reported that a long period of diapause and exposure to varied climatic conditions results in the loss of a substantial percent of seed cocoons due to pupal mortality and erratic moth emergence (Kapila *et al.,* 1992). Hence, a study was conducted in the year 2022 at Bilaspur, Chhattisgarh to analyse the Daba TV tasar silk moth erratic emergence pattern and its impact on ovulation, fecundity and retention of eggs.

Materials and Methods

The study was conducted at Basic Tasar Silkworm Seed organization (BTSSO), Central Silk Board, Bilaspur, Chhattisgarh (22.09°N 82.15°E, above mean sea level 207m), India. The materials used and the methods adopted during the study are detailed

Silkworm and eco-race selected

Tropical tasar silkworm *Antheraea mylitta* D.eco race Daba Trivoltine TV (DTV) diapause seed cocoons were utilized for the study.

Collection of erratically emerged tasar silk moths from grainage house

The DTV diapause seed cocoons were preserved in grainage house for production/preparation of Disease free laying (DFLs). During the time of preservation (January to May), the cocoons face extreme temperatures ranging from 8-48°C and relative humidity of 30-85 %. Any favorable conditions like sudden rainfall coupled with an increase in humidity during the preservation lead to erratic emergence of moths. The tasar silkmoths emerged from tasar DTV cocoons were collected in a bamboo basket every morning during the study period. The male and female moths that emerged were counted on a daily basis.

The coupled female moths were selected for oviposition and allowed to lay eggs for 72 hours and then subjected to dissection to check the retention of eggs in the abdomen after oviposition. The eggs laid after 72 hours were collected and counted. Whereas, uncoupled female moths were directly taken for dissection in order to analyse the mature eggs. The dead female moths are taken for dissection and the forewings, hind wings, antennae and legs were cut using the dissection scissors. Later, the anterior and posterior regions of moth were pinned in the dissection tray using the insect pins, sharp cut was made from posterior to anterior end of the abdomen. The abdominal skin was extended using insect pins so has to clearly observe the reproductive system of female tasar silk moth. The ovaries of tasar silk moth was taken out and counted the number of eggs present in the each female moth.

Temperature and relative humidity

The temperature and relative humidity in and out of the grainage house during cocoon preservation and oviposition was recorded by a digital thermometer and humidifier.

Record of Rainfall

The daily rainfall was recorded during the study period.

Results

Unseasonal emergence pattern of tasar silk moths

The *Antheraea mylitta* D. moth emergence pattern during un-season and its impact on Ovulation, Fecundity and Retention of eggs was evaluated and correlated with the temperature and relative humidity (Pearson's correlation test).The results revealed that the moths emerged erratically from January to May (2022) and a total number of 670 female moths and 932 male moths have emerged (Fig. 1 to Fig. 6). Due to unsynchronized emergence of male and female moths, the coupling was 23 %. The highest numbers of male and female moths were emerged in February followed by March. This indicated that the poor diapause in few pupae and also available of congenial temperature and relative humidity trigged in breakage of diapause and moth emergence. There was a positive correlation between relative humidity and male and female moth emergence and also positively correlated with minimum temperature. Whereas, female moth emergence was found to be weakly correlated with maximum temperature. However, relative humidity was found to have negative correlation with temperature (Table 1).

Impact of unseasonal emergence on ovulation, fecundity and retention

The coupled female moths were selected for oviposition whereas uncoupled moths were directly taken for dissection in order to analyse the mature eggs. In case of coupled female moth the average number of eggs laid on first day (24h), second day (48h) and third day (72h) was 58.60, 17.76 and 10.24 respectively. However, the average number of eggs retained in ovaries was 83.69 (Table 2& Plate 1). Ovulation was found to have a positive relation with fecundity and retention capacity. In case of uncoupled female moths the mature eggs in the ovaries was found to be very minimum (34.45 No.) (Plate 1).Data presented in Table 2 reveal that only one factor alone, i.e., temperature (or) relative humidity was not responsible for increasing/ decreasing ovulation, fecundity and retention of eggs, but indicated that it was a combined effect of temperature and relative humidity. Also observed that the formation of eggs in the ovaries was not normal and also in few cases no eggs (Nil) were recorded when the average temperature was >43 ℃ with relative humidity <33 % and rainfall <10 mm (Table 2).

Discussion

It was evident from the study that temperature, relative humidity (RH) and rainfall and their interaction significantly affected the pupal diapause and terminated diapause early in few cases and thus moths were emerged erratically during the non-season or unseason. Any increase or decrease in temperature and relative humidity from optimum level increased retention of eggs or decreased egg production and fecundity respectively. The rate of egg production varies with temperature, accelerated up to a point of optimum temperature and humidity conditions. Keeping all the unseasonal variations in view, the phenomena of reproductive biology, viz., ovulation, fecundity and retention of eggs of tasar silk moth were greatly influenced by both temperature and relative humidity. Wigglesworth (1972) reported that the rate of egg production varies with temperature. It is accelerated up to point and then falls rapidly. The range of temperature, at which reproduction can occur, is often much narrower than that of other normal activities of the same species. Further, if the temperature be of adaptive importance for a particular species, different aspects of life-cycle should be under the strict control of temperature-bound factor (Schnebel and Joseph, 1986).

Congdon and Logan (1983) found that at high temperature (up to 31°C), fecundity decreased in Bank Grass Mites (BGM), *Ollgonlchul paratensis.* Nickel (1960) found that in high humid condition (85-90%) BGM, *Tetranychus desertorum* Banks laid fewer eggs. Boyne and Hain (1983) also witnessed a similar relationship with *Oligonychus* sp.

Temperature stress causes a number of abnormalities at the cellular level as the normal pattern of protein synthesis halts (Sugai and Ashoush, 1968).The combined effect of both temperature and humidity largely determines the moths developmental time, adult longevity, potential fecundity and ovulation are also dependent on temperature and relative humidity (Mathur *et al.,* 1988).

The success of the tasar grainage depends upon several variables, but environmental conditions such as biotic and abiotic factors are of particular importance. As silkworms are cold-blooded animals, temperature will have a direct effect on various physiological activities (Rahmathulla *et al.,* 2004, Upadhaya *et al.,* 2006).High temperature adversely affects nearly all biological processes including the rates of biochemical and physiological reactions and also reproductive ability.

The study indicated that higher temperature and lower relative humidity were detrimental for formation of eggs in the ovaries and the innate reproductive ability of tasar silk moth was interrupted due to extreme climatic factors.

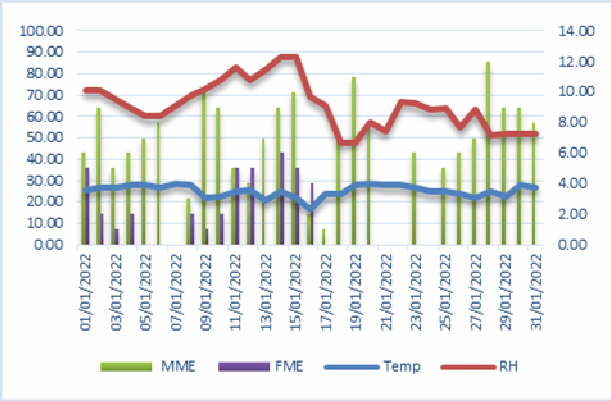

Fig. 1 : Unseasonal male and female moth emergence in DTV diapause seed cocoons in the month of January

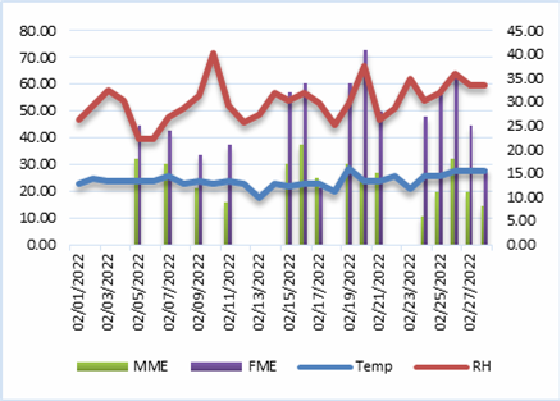

Fig. 2 : Unseasonal male and female moth emergence in DTV diapause seed cocoons in the month of February

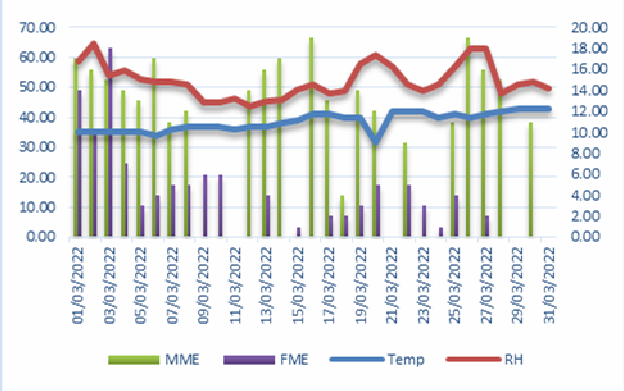

Fig. 3 : Unseasonal male and female moth emergence in DTV diapause seed cocoons in the month of March

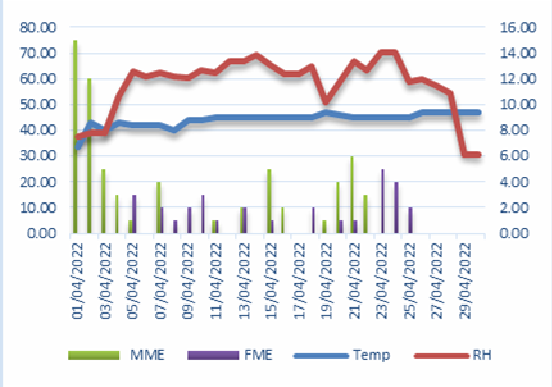

Fig. 4 : Unseasonal male and female moth emergence in DTV diapause seed cocoons in the month of April

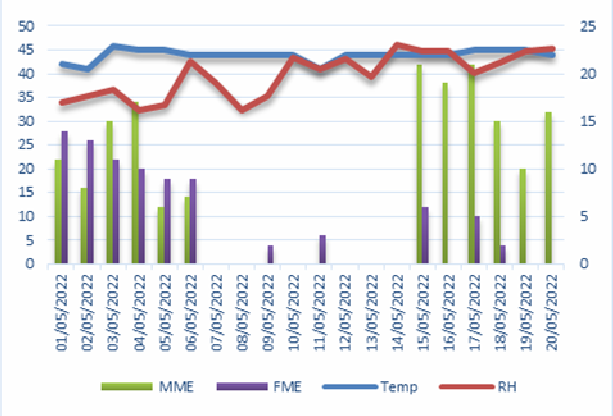

Fig. 5 : Unseasonal male and female moth emergence in DTV diapause seed cocoons in the month of May

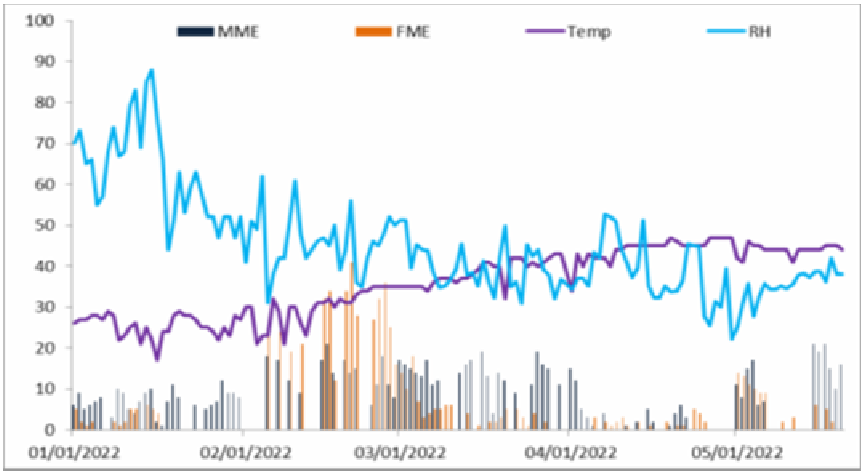

Fig. 6 : Daily male and female moth emergence pattern in relation to abiotic factors in DTV diapause seed cocoons preserved in grainage

Table 1: Correlation of abiotic factors in relation to male and female moth emergence

	Min. Temp	*Max.Temp*	*RH*	*MME*	*FME*
Min.Temp	1				
Max Temp	0.740	1			
RH	-0.261	-0.612	1		
MME	0.203	-0.008	0.402	1	
FME	0.240	0.005	0.326	0.883	1

Table 2 : Average Ovulation, Fecundity and Retention of eggs in coupled female moth and mature eggs in uncoupled female moth

Moth emergence months	**Coupled female moth**					**Uncoupled female moth**	**Temp (℃)**	**RH (%)**	**Rainfall (mm)**
	Fecundity			**Ovulation**	**Retention**	**Mature eggs**			
	Day1	**Day 2**	**Day 3**						
Jan	38	9	12	64	98	17	10-29	64.62	47.50
Feb	80	24	8.2	119	59	25	12-35	53.51	7.50
March	78	28	8	120	76	32	15-43	52.42	0.00
April	48	12.8	11	90	97	46	27-47	40.50	10.00
May	49	15	12	82	88	52	26-46	34.5	24.00
Average	**58.6**	**17.76**	**10.24**	**95.00**	**83.6**	**34.4**	**-**	**-**	**-**

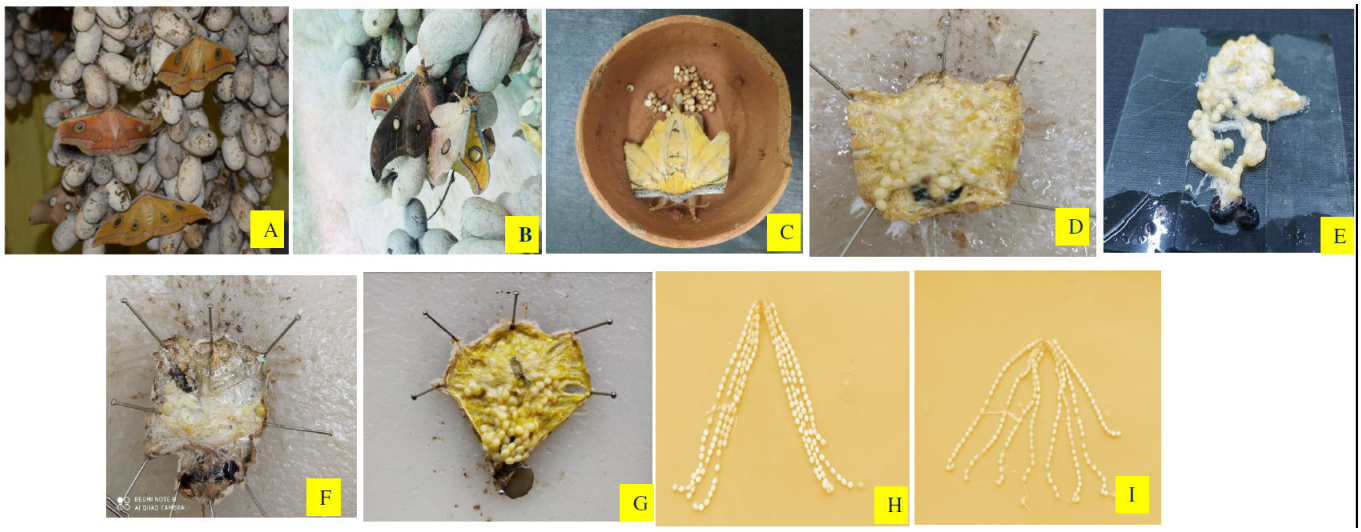

PLATE 1

A) Unseasonal emergence of male & female moths
B) Coupling
C) Gravid female moth kept for egg laying
D) Dissected uncoupled female moth
E) Mature eggs and immature eggs in uncoupled female moth
F) Scanty eggs in female moth
G) Dissected healthy female moth
H) & I) Mature eggs in healthy female moth

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Conflict of Interest

The authors' declare no conflict of interest.

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