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TITLE: Effect of Temperature on Growth and Development of Silkworm *(Bombyx mori L.)*

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Effect of Temperature on Growth and Development of Silkworm

(Bombyx mori L.)

Abstract

Growth and development of the silkworm larvae are strongly influenced by environmental changes such as temperature. The varieties in the ecological condition every day and season to season stress the need of administration of temperature and relative moistness for feasible cover generation. The seasonal differences in the environmental components considerably affect the genotypic expression in the form of phenotypic output of silkworm crop such as cocoon weight, shell weight, and cocoon shell ratio. The present study examine the effect of temperature on silkworm. The treatment consists of administering heat shock at temperature of 34, 38 and 42°C, and without heat shock (ambient temperature). Heat shock was conducted in early 4th instar for 3 hours. The study results showed that of the heat shock can increase the percentage of mortality, accelerate the larval stage, reducing larvae weight by lowering the growth; consumption and digestibility. It also decrease productivity and lead to failure of the formation of cocoon, pupae and imago.

Introduction

Sericulture is the science that arrangements with the creation of silk by rising of silkworm. Silk is known as the ruler of materials because of its sparkling gloss, delicate quality, tastefulness, toughness, and pliable properties and is found in China in the vicinity of 2600 and 2700 BC. Silk beginning in the saliva of a bug is a characteristic stringy substance and is gotten from pupal homes or cases spun by hatchlings known as silkworm. The silk is favored over every single other kind of filaments because of its surprising properties like water permeableness, warm protection, coloring effectiveness, and gloss. Factors chiefly impact the physiology of creepy crawlies is temperature and moistness. In spite of wide variances in their environment, creepy crawlies demonstrate an exceptional scope of adjustments to fluctuating natural conditions and keep up their inside temperature and water content inside middle of as far as possible.

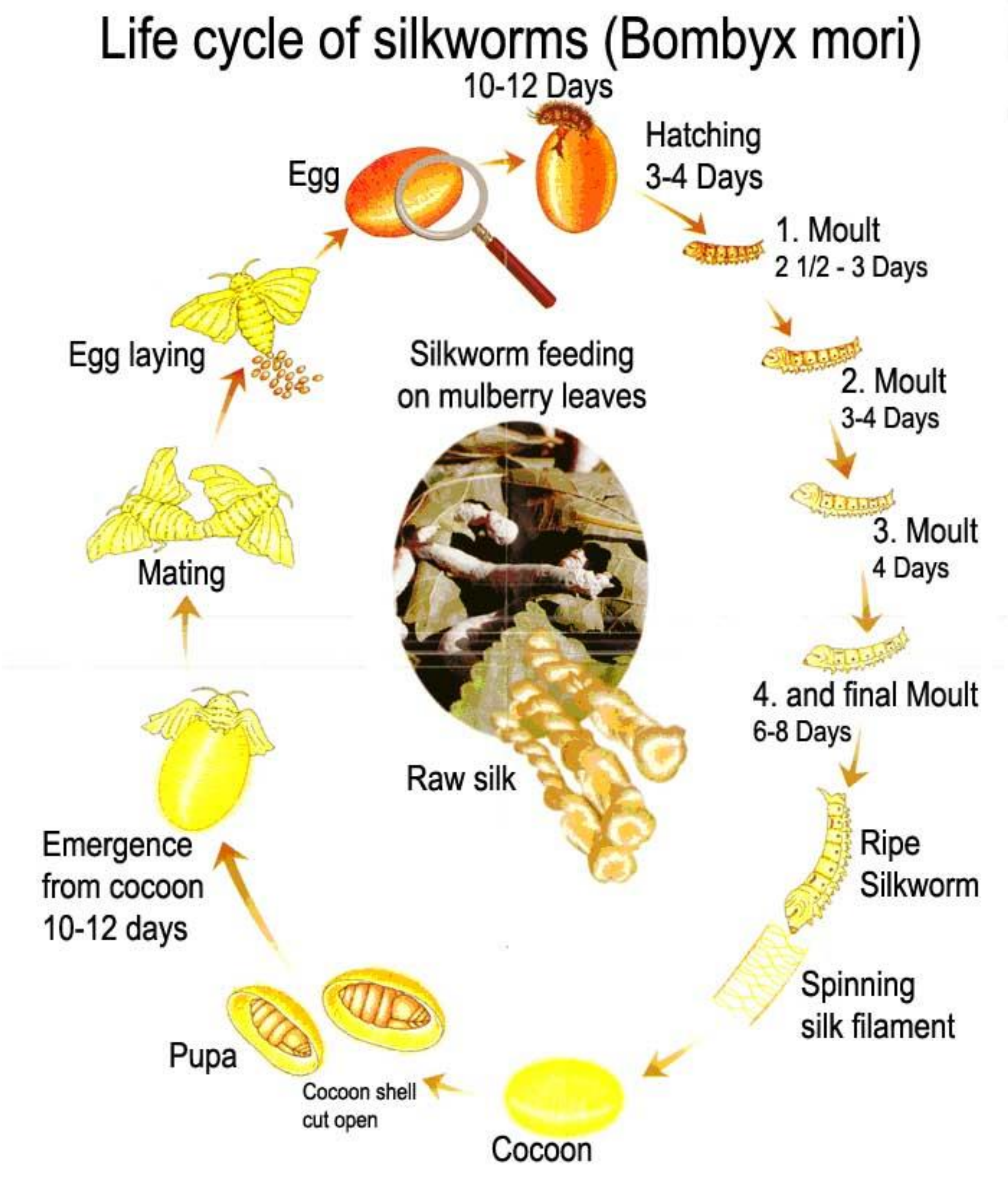
Life cycle of Silkworm

B.mori is a holometabolous and oligophagus insect feeding of mulberry plant. It has four developmental stages namely; egg, larva, pupa and adult. The two stages were classified as the growth phase, the third phase is called as metamorphic phase and the last one is the reproductive phase (Murakami, 1994). It takes about 30 days to complete one cycle. The duration of these stages varies and dependents on the rearing condition.

The stage generally last for about 10 days and is highly sensitive to temperature. Of the total life cycle, about half is larval period which last for about 20-22 days. This is the most active period in the life cycle of this animal feeds and accumulates the nutrients required for its physiological activity at later stages. The silk worm keeping pace with its physiological growth moults 4 times to cast off the old skin.

Growth between the moult (24 hours) is called instar. There are 4 moults and 5 instars during the larval period of the silk worm. Rest period for moulting is often referred to as instar. Larvae itself spinning cocoon by voracious feeding and gains maximum growth during fifth instar. When larvae attain maturity the larvae empties its gut, stops feeding and they emit silk thread to spin the cocoon around itself. The material is emitted in a liquid state but immediately turns into fibrils. At this stage it is called as a prepupa and this period last for 3 days. After spinning it is transformed into pupa inside the cocoon. This period is a non-feeding and inactive stage which lasts for 8-10 days. The adult emerges out by piercing through the cocoon with the help of the fluid secreted in their digestive tract (eclosion fluid).

The adults are non-feeding and live for 2-3 days. The female moth lays eggs immediately after mating. The eggs continue with another round of life cycle.



Materials and Methods

The silkworm larvae used in this study are collected from Darpally, Nizamabad. The study was conducted using completely randomized design, which consists of four treatments and each consisted of 20 larvae. The treatments are heat shock, given to early instar 4th stage for 3 hours at a temperature of 34°, 38°, 42°C and without heat shock (ambient temperature). Mulberry leave which used as feed is Morus sp. Heat shock treatment is done by placing the larvae into the oven for 3 hours. After 3 hours the larvae are removed from the oven and then put back in rearing room.

Result

Larval Stage

The percentage of mortality, length of the larval stage and larval weight gain by heat shock at a different temperature can is observed. The percentage of mortality in the treatment varies, the higher the heat shock temperature given, the mortality percentage rate is increased, which means a lot of dead larvae were found during rearing to be cocoon. Mortality percentage without heat shock treatment (ambient temperature range 28-31°C) is 0%, at the end of instar 4th and 5th stages, or no larvae were found dead. The percentage of mortality in late instar 4th and 5th with heat shock treatment temperature 34°C is 20%, from 20 larvae, there were four dead larvae.

Pupae Stage

Bombyx mori larvae by heat shock with different temperatures have different effects on the picture cocoon and pupa. Weight of cocoon decrease in without heat shock treatment and showed a significantly different with heat shock treatment ($P < 0.05$). In without heat shock treatment, cocoon weight is 1.26 g. While on treatment by heat shock at a temperature of 34, 38 and 42°C are 1.10 g; 0.90 g and 0.61 g. In this case it can be said that the treatment of heat shock reducing the weight of cocoons.

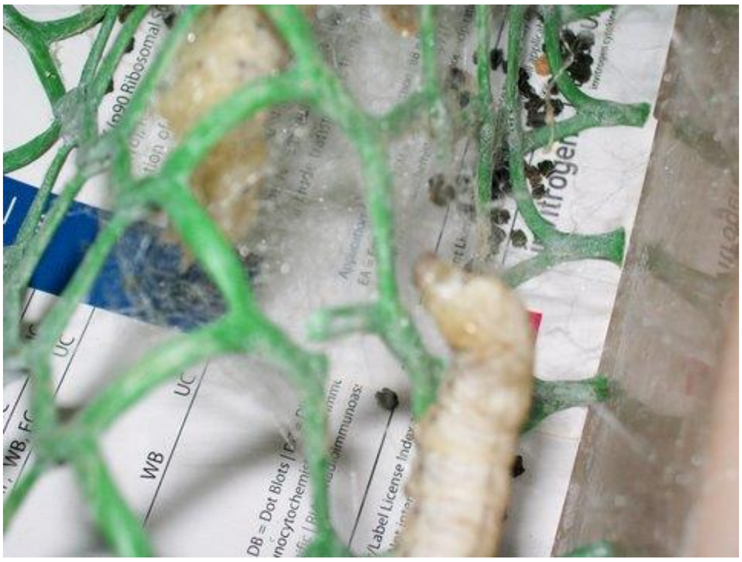


Table -1 The average of single cocoon, single shell and pupa weight larvae Bombyx mori by heat shock with different temperatures

Treatment	Single Cocoon Weight (g)	Single Shell Weight (g)	Pupa Weight (g)
P0	**1.26**	**0.28**	**0.99**
P1	**1.10**	**0.19**	**0.89**
P2	**0.90**	**0.09**	**0.78**
P3	**0.61**	**0.08**	**0.49**

In Table-1 shows that cocoon shell weight and pupa weight was decreased too. The higher the temperature of the heat shock treatment, the cocoon and pupa shell weight is getting down. Cocoon shell weight reduction between without heat shock treatment and heat shock treatment temperature of 34°C is not different significantly; 0.28 and 0.19 g, yet it significantly different from heat shock treatment of 38 and 42°C degree; 0.09 and 0.08 g. Observation of the pupa weight between no heat shock and 34°C heat shock treatment was not significantly different but it significantly different when applied in heat shock treatment temperature of 38 and 42°C, the weight data in sequence are 0.99; 0.89; 0.78 and 0.49 g. From the above observations can be expressed that heat shock treatment affects quality of cocoons which is lowering the quality of cocoon and pupae.

Discussion

The changes in temperature rearing cause dead for larval. It also occurs in (Sinha and Sanyal research 2013) exposure to heat at a temperature of 17°C and 33°C to silkworm is still able to be tolerated while the temperature 43°C cause deadly effect. This is happened due to the inability of larvae to adapt themselves against the heat shock. Deaths caused by the heat shock will give stress, inability to cope with stress can be fatal and cause death at the individual level and extinction at the level of population (Badyaev, 2005). High temperatures affect almost all biological processes, including biochemical and physiological reactions (Willmer et al., 2004; Regniere et al., 2012). Larval rearing at high temperatures can cause death (Khaliq et al., 2014). The optimum temperature for the normal growth of silkworm larvae is between 20 and 28°C, the desired temperature range for maximum productivity is from 23 to 28°C. Temperatures above 30°C directly affect the health of larvae. Effect of temperature and humidity on the growth and development of larvae including new studies on heat shock proteins (Neven, 2000; Rahmathulla, 2012). Dead silkworm larvae characterized by declining growth and issued a yellow liquid. The dead larvae always issue a yellow liquid. The release of these fluids due to the inability of larvae in adapting to extreme environmental changes, causing inability in maintaining body fluid homeostasis.

Imago Stage

Silkworm's fecundity with heat shock treatment differs when exposed to different temperatures. From the observation showed that heat shock as previously discussed may affect mortality, instar stage and growth as well as the development of pupa stage which finally also affect the development of the imago. Fertilization and eggs producing is occurred in no heat shock treatment. Meanwhile, heat shock treatment given to five pairs of the inbred resulting in failure of fertilization. With the result of fewer eggs produced or even does not produce eggs at all. Especially at a temperature of 42°C heat shock. The level of egg production is varied due to temperature changes. Appropriate changes of temperature will be able to stimulate the production of eggs. But in otherwise, if the changes are not optimal, egg cannot be produced.

To get the size of the fi lament, cocoon even size and good quality, required heat-resistant larvae rear. Basic genetic and genetic variability in expression of quantitative and qualitative nature when exposed to high temperatures is an important step for the selection of the oldest thermotolerance resource potential for the breeding program. To achieve greater success, it’s necessary to understand the molecular mechanisms of larval temperature tolerance, identification of various heat shock protein (Hsp) groups (Neven, 2000). It is necessary to find genes that are responsible for the induction of heat with the steps on finding their genomes in silkworm.

Impact of Temperature

The optimum temperature for normal growth of silkworms is between 20°C and 28°C and the desirable temperature for maximum productivity ranges from 23°C to 28°C. Temperature above 30°C directly affects the health of the worm. If the temperature is below 20°C all the physiological activities are retarded, especially in early instars; as a result, worms become too weak and susceptible to various diseases. The temperature requirements during the early instars are high and the worms feed actively, grow very vigorously, and lead to high growth rate. Such vigorous worms can withstand better even at adverse conditions in later instars. For the most part, the room temperature is low amid winter and blustery season, which ought to be directed by warming the stay with electric radiators or charcoal flames. Thermo regulator–fitted electrical warmers are best since they don’t produce any damaging gases. At the point when power turns out to be expensive and not accessible in numerous country zones of sericulture belt, legitimately dried charcoal can be utilized. In any case, the carbon dioxide and different gases discharged in this copying procedure are damaging to silkworms and they can be managed by giving more ventilation especially in daytime. Other than this, the entryways and windows ought to be kept shut especially amid night. Late in the day, as the outside temperature goes up, entryways and windows ought to be opened to enable warm air to the room. Amid summer season when day temperature is high, every one of the windows ought to be kept open. All the while, windows and entryways are secured with wet gunny fabric amid hot days to lessen the temperature and increment dampness. Something else, reasonable air coolers can be utilized for this reason.

There is plentiful writing expressing that great quality covers are delivered inside a temperature scope of 22– 27°C and that casing quality is poorer over these levels. Be that as it may, polyvoltine breeds raised in tropical nations are known to endure marginally higher temperature and change with tropical climatic conditions. So as to utilize bivoltine races in a tropical nation like India, it is important to have a steady case edit in a high temperature condition. High temperature antagonistically influences almost all organic procedures including the rates of biochemical and physiological responses, and can in the long run influence the quality or amount of cover edits in the silkworm and along these lines silk created. A few examinations showed that silkworms were more delicate to high temperature amid the fourth and fifth stages.

Environmental Factor	Incubation	I instar	II instar	III instar	IV inatar	V instar	Spinning	Cocoon Preservation
Temperature	25^0C	28^0C	27^0C	26^0C	25^0C	24^0C	25^0C	25^0C

Conclusion

The development and growth of the silkworm larvae is greatly influenced by it temperature of rearing. The heat shock treatment given in early larval instar stage 4th led to a faster period of larval stage, reducing the weight of larvae and the index value of nutrition and productivity of cocoon.

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