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INFLUENCE OF TEMPERATURE VARIATION ON THE PUPAL PERFORMANCE OF MULTIVOLTINE MULBERRY SILKWORM *BOMBYX MORI* LINN.

Zoology

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ABSTRACT

The variation in temperature significantly (P<0.01) influenced the pupae duration, pupae weight and survival of pupae of silkworm. With the increase in rearing temperature from 14 to 34˚C, the pupae duration decreased from the maximum of 13.14 days at 14˚C to the minimum duration of 8.23 days at 34˚C, the pupae weight increased from 0.74gm at 14 ˚C to 0.92gm at 26˚C and the survival of pupae increased from 58.38% at 14˚C to the maximum level of 92.72% at 26˚C. Further increase in temperature above 26˚C caused notable decline in survival of pupae, pupae weight and pupae duration. At 10˚C and 38˚C, the larvae did not pupate. The success of the sericulture industry depends upon several variables, but environment conditions such as biotic and a-biotic factors are of particular importance to the study include future strategies to be taken for the management climatic temperature like 26±1˚C for successful cocoon crop and rearers.

KEYWORDS

Cocoon, eggs, BOD incubator.

Introduction:

For the success of sericulture industry in India, the rearers must be aware that the variation in climatic condition may cause considerable effect on the rearing programs and general performance of silkworm. There have been various opinions about the optimum temperature of silkworm rearing. Some expressed an opinion in favor of cool rearing, some recommended warm rearing and some suggested cool warm mixed rearing of silkworm. The variation in rearing temperature influences the physiological status of silkworm. Insect metabolism produces heat and if this is not dissipated it causes a local rise of temperature. Temperature is usually a key factor of the environment but it interacts jointly with others like humidity, food, light and well-being of the insects. The rate of growth and development of insects are obviously affected by temperature. The accumulation of ill effects from exposure to low temperature appliances to each step of development through the life cycle and short exposures to warmer conditions lowers the threshold for subsequent stages. Temperature that stops certain vital chemical reactions determines the developmental threshold. The outcome of this study is expected to have tremendous ecological and applied significance and the knowledge derived from this study will be helpful in the rearing of silkworm at farmers' level. Apart from adding our knowledge of insect pupal development and growth, it may also help to device suitable rearing programmed of multivoltine mulberry silkworm in the varying conditions of temperature to increase the production of silk and generate more employment opportunities.

Materials and Methods: For determining the effect of temperature on the pupal duration, pupal weight and survival of pupae, the ripe worm (Vth instar larvae when stop feeding), reared at 10˚C, 80±5%RH and 12±1 hours light a day, were put on mountages for spinning. Thus the formation of cocoon takes place and larva changes in the pupal stage. The pupae were remaining maintained in the same BOD incubator at similar condition. After few days of pupae period moths emerged from the pupae.

For determining the pupae duration, the time required from the third day of spinning (formation of pupae) to emerge of moth was considered. For this purpose, 75 cocoons along with their pupae (three batches of 25 cocoons in each batch) were taken for observation. Three replicates of each experiment were made.

For estimation the pupae weight the weight of 30 normal pupae (three batches of 10 pupae in each batch) were recorded for each replicate. The pupae weight was taken on 7th day of the formation of pupae.

For recording the survival of pupae, 75 pupae (three batches of 25 normal pupae in each batch) were observed. The number of pupae emerged as moth was counted for calculating the survival of pupae as following:-

$$\text{Survival of Pupae} = \frac{\text{No. of moths emerged}}{\text{No. of pupae taken for observation}} \times 100$$

The result obtained was analyzed statistically by One-Way ANOVA test.

Results:-

The pupal duration data given **(Table-1)** indicate that the temperature variation considerably influenced the pupae duration of silkworm. With the increasing temperature from 14 to 34˚C, the pupal duration decreased from the maximum of 13.14 days at 14˚C to the maximum duration of 8.23 days at 34˚C. The decreasing trend of the pupae duration was recorded to be almost of similar fashion from 14˚C to 34˚C. At very low 10˚C and higher 38˚C temperature the larvae did not pupate. One –Way ANOVA indicates that the temperature variation has significant (P<0.01) influence on the pupae duration of silkworm.

Pupae weight data presented in **(Table-2)** indicates that temperature variation slightly influenced the pupae weight of silkworm. With the increasing temperature from 14 to 26˚C the pupae weight increased from the minimum of 0.74 gm at 14˚C to the maximum of 0.92 gm at 26˚C. But with the further increase in temperature from 26 to 34˚C, the pupae weight declined and reached to the level of 0.76 gm. The increasing trend of the pupae weight with the increasing temperature from 14 to 26˚C was almost of similar fashion. At higher temperature of 34˚C the pupae weight decreased sharply and reached to the level of 0.76 gm. The increasing trend of the pupae weight with the increasing temperature from 14 to 26˚C was almost of similar fashion. At higher temperature of 34˚C the pupae weight decreased sharply and reached to the level of 0.76 gm.

Survival of pupae data given **(Table-3)** clearly indicate that variation in rearing temperature notably influenced the percent survival of silkworm pupae. With the increasing temperature from 14˚C to 26˚C, the survival rate of pupae increased from the minimum of 58.38% at 14˚C to the maximum level of 92.72% at 26˚C. But further increase in temperature from 26 to 34˚C caused notable decline in the survival of pupae, which reached to the level of 86.16% with the increase in temperature from 14 to 18˚C the rate of increase in the survival of pupae was very sharp but with the further increase in temperature from 18 to 26˚C the rate of increase in the pupae survival slowed down. At 10˚C and 38˚C the larvae did not pupate. One–Way ANOVA indicate that variation in rearing temperature caused significant (P<0.01) influence on the survival of pupae.

Table-1 Influence of temperature on the pupae duration (days) of *Bombyx mori*.

TEMPERATURE(˚C)						F-ratio n_1=3 n_2=8
10˚	14˚	18˚	26˚	34˚	38˚	
N.Sd	13.14 ±0.66	11.21 ±0.58	9.24 ± 0.47	8.23 ±0.47	N.Sd	29.89*

N.Sd = Not Survived *P<0.01

Each value represents mean ±SD of three replicates.

Table-2- Influence of temperature on the pupae weight (gm) of *Bombyx mori.*

TEMPERATURE(˚C)						F-ratio n_1=3 n_2=8
10˚	14˚	18˚	26˚	34˚	38˚	
N.Sd	0.74 ±0.041	0.85 ±0.049	0.92 ± 0.041	0.76 ±0.035	N.Sd	7.15*

N.Sd = Not Survived *= Not-significant
Each value represents mean ±SD of three replicates.

Table- 3- Influence of temperature on the survival (%) of *Bombyx mori.*

TEMPERATURE(˚C)						F-ratio n_1=3 n_2=8
10˚	14˚	18˚	26˚	34˚	38˚	
N.Sd	58.38 ±1.17	83.30 ±1.89	92.72 ±1.48	86.16 ±1.25	N.Sd	

N.Sd = Not Survived *P<0.01
Each value represents mean ±SD of three replicates.

Discussion:-

The temperature variation considerably influenced the pupae duration of silkworm. With the increasing temperature from 14 to 34˚C, the pupae duration decreased from the maximum of 13.14 days at 14˚C to the level of 8.23 days at 34˚C. The decreasing trend of the pupae duration was recorded to be almost of similar fashion from 14 to 34˚C. At very low 10˚C and high 38˚C temperature, larvae did not pupate (Table-1). The pupae duration of *Bombyx mori* was influenced by the varieties of mulberry, given as food, to the larvae **(Bheemnna et al., 1989)** and certain types of hormones **(Khan et al., 1997).** Variation in refrigeration periods of silkworm eggs **(Pandey and Upadhyay., 1999)** and ecological factors **(Gaur and Upadhyay., 2002)** caused considerable influence on the pupal duration of *Bombyx mori*.

Temperature variation slightly influenced the pupae weight of silkworm. With the increasing temperature from 14 to 26˚C, the pupae weight increased from the minimum of 0.74gm at 14˚C to the maximum of 0.92gm at 26˚C. But with the further increase in temperature from 26 to 34˚C, the pupae weight declined. At 10 and 38˚C the larvae did not pupated **(Table-2)**. The gain in pupae weight of *Bombyx mori* was influenced by the variation in hormonal secretion **(Khanet al., 1997)** and genotype variation **(Rajshekher Goude et al., 1997; Rajan and puttarraju, 1998).** The pupal weight plays an important role to the fecundity of *Bombyx mori* **(Rahman et al., 1990).** The mature larvae and pupae of *Bombyx mori* weight more than reared at 25˚C in comparison to the reared at 30˚C **(Verma and Atwal.,1968;Gomma et al., 1973; Ali et al.,1990)** and similarly **(Gaur and Upadhyay.,2002)** at 80±5%RH and 12±1 hours light a day. On the other hand the refrigeration of silkworm eggs significantly influenced the pupae weight of *Bombyx mori* **(Vishweswara Gowda et al.,1987).** The cold storage of silkworm eggs considerably influenced the pupae weight of silkworm but the pre refrigeration period of eggs has no appreciable impact on the pupae weight **(Pandey and Upadhyay., 2001)** and the changes in the volatile exposure affect the pupal trait of silkworm. The silkworm larvae, exposed to 14hours light a day, caused an increase in the pupal weight **(Janarthanan et al., 1994).**

The variation in rearing temperature notably influenced the percent survival of silkworm pupae. With the increasing temperature from 14 to 26˚C, the survival rate of pupae increased from the minimum of 58.38% at 14˚C to the maximum level of 92.72% at 26˚C. But further increase in temperature from 26 to 34˚C caused notable decline in the survival of pupae. At 10˚C and 38˚C, the larvae did not pupate **(Table-3)**. **Pandey and Upadhyay., 1999** opined that certain physiological alteration influenced the rate of pupal survival in *Bombyx mori* and double treatment with 60% phytoecdysteroids increase the survival of pupae in silkworm **(Upadhyay and Purnima., 2012).** Thus the pupae durations, pupae weight and survival of pupae had been influenced by the variation in temperature. At 10˚C and 14˚C of lower temperature regimes, the pupae performance declined. At 38˚C of higher temperature regimes the pupae performance was noticed to be declined in comparison to the performance at 26˚C. The pupae period is already an inactive phase of insect life cycle. Therefore, when it is given cold treatment of 10˚C and the heat treatment of 38˚C, there may be the occurrence of certain extremes in the metabolism of silkworm pupae resulting in the poor performance of pupae.

Thus it may infer that temperature plays a vital role on the growth of silkworms. As silkworm is cold-blooded animals temperature will have a direct effect on various physiological activities. In general the early pupae stage are resistant to high temperature which also helps in improving survival rate of pupae. The temperature has a direct correlation with the growth of silkworm; wide fluctuation of temperature is harmful to the development of silkworm. Raise in temperatures various physiological functions and with a fall in temperature, the physiological activities are decreases. With the increasing temperature of silkworm; rearing particularly in pupae performance. On the other hand, at low temperature the growth is slow and pupae duration is prolonged. Temperature above 26˚C and below 26˚C directly affects the pupae health of silkworm.

Future strategies:-

India enjoys the patronage of second position for the production of silk in the world next only to china. Sericulture in India is practiced predominantly in tropical environmental regions. Though the introduction of robust and thermo tolerant races in the field during summer month had considerable impact on the productivity level and returns in some selected areas, later planners realized this in some selected areas, later planners realized this does not match to that of other productive bivoltine hybrids. Therefore the acceptance level of this hybrid with the farmers was not up to the expected level because of low productivity traits. This has necessitated the development of a more suitable temperature tolerant hybrid with better productivity traits than existing races. Mulberry and silkworm improvement programmers are continuous processes for evolving newer and high yielding genotype, which can sustain productivity under biotic and a-biotic stress. Genetic transformation techniques need to be further fine tuned for developing transgenic silkworm with stable expression of cloned genes of commercial importance.

Some of the earlier studies addressed the selection of silkworm breeds in respect of thermo tolerance by identifying thermo tolerant silkworm breeds. However a clear understanding of genetic basis and variability in the expression of qualitative and quantitative genetic traits during exposure to high temperature is an important step for the selection of potential thermo tolerance parental resources for breeding programmers. To achieve greater success, there is a necessity of understanding the molecular mechanism of temperature tolerance in silkworm, identification of various groups of heat shocking protein (HSPS), understanding of different expression patterns of various (HSPs),in polyvoltine races to locate the responsible for the heat inducible (HSPS) and subsequent steps to introduce

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