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Influence of temperature and relative humidity on growth and cocoon traits of late-stage silkworm, *Bombyx mori* L.

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Abstract

Environmental conditions, particularly temperature and relative humidity (RH), play a pivotal role in the growth, survival, and cocoon quality of *Bombyx mori* L. larvae, which directly influence silk yield and economic returns in sericulture. This study investigated the effects of three temperature regimes (22 °C, 25 °C, 28 °C) in combination with three RH levels (65%, 75%, 85%) on late-age larvae, focusing on larval duration, final larval weight, survival rate, cocoon weight, and shell weight under a standardized twice-daily feeding schedule. Results demonstrated that 25 °C combined with 85% RH provided optimal conditions, resulting in maximum larval growth (4.5 ± 0.2 g), highest survival (94–97%), and superior cocoon characteristics (2.1 ± 0.1 g cocoon weight and 0.42 ± 0.02 g shell weight). Larvae reared at lower temperatures or suboptimal humidity exhibited prolonged development, reduced survival, and lower-quality cocoons. These findings highlight the critical importance of maintaining precise microclimatic conditions during the late larval stages to enhance silk production efficiency. The study provides practical guidance for sericulture practitioners, emphasizing that temperature and humidity optimization can significantly improve both yield and silk fiber quality.

Keywords: *Bombyx mori*, temperature optimization, relative humidity, larval growth, cocoon quality, silk production, sericulture management, environmental control

1. Introduction

Sericulture, the practice of silk production using *Bombyx mori* L. larvae, is one of the most important agro-based cottage industries in many countries, providing employment, income generation, and rural development opportunities (Kandasamy & Mustaffa, 2012) [5]. India, China, and several Southeast Asian nations are leading producers of raw silk, and the quality and quantity of silk are directly influenced by larval rearing practices. Effective sericulture management relies heavily on maintaining optimal environmental conditions during larval development, as temperature and relative humidity (RH) profoundly affect feeding behavior, metabolism, immunity, and overall larval vitality (Anitha & Naidu, 2010; Rahmathulla *et al.*, 2014) [1, 2]. Poorly managed rearing environments can lead to extended larval periods, lower survival, and reduced cocoon quality, which ultimately diminish silk yield and fiber quality (Reddy & Lalitha, 2015; Zakeri & Najafi, 2017) [3, 4]. Late-stage larvae (5th instar) are particularly critical in sericulture because they consume the majority of mulberry leaves and are responsible for producing the bulk of silk proteins that form cocoons. Environmental stress during this stage—due to improper temperature or humidity—can significantly reduce cocoon weight, shell thickness, and silk quality, leading to economic losses for farmers. While several studies have evaluated the effects of either temperature or RH in isolation, there is limited research on their combined impact, especially on late-age larvae, which are highly sensitive to microclimatic fluctuations. Understanding the interactive effects of temperature and RH is therefore essential for designing controlled rearing systems that maximize silk yield and ensure uniform cocoon quality. In addition to its economic significance, sericulture contributes to sustainable agriculture and rural livelihoods, particularly for small-scale farmers and women entrepreneurs. Optimizing larval rearing conditions not only enhances productivity and income

but also reduces resource wastage by minimizing larval mortality and poor-quality cocoons. This study aims to systematically evaluate the combined influence of temperature and RH on late-stage *B. mori* larvae, focusing on growth performance, survival rate, cocoon weight, and shell weight. The findings will provide practical guidelines for farmers, sericulture managers, and researchers to optimize environmental conditions during critical larval stages, ultimately improving silk quality, yield, and profitability.

2. Materials and Methods

2.1 Experimental Setup

Late-age *Bombyx mori* larvae of FC1 × FC2 hybrid breeds were used for the experiment. These larvae were obtained from a disease-free commercial source and acclimatized for 24 hours before starting the study. Larvae were reared in controlled growth chambers set to three temperature levels (22 °C, 25 °C, and 28 °C) and three relative humidity (RH) levels (65%, 75%, 85%) to evaluate the combined effect of temperature and humidity on growth and cocoon traits. Each treatment consisted of 30 larvae per replicate, with three replicates per treatment to ensure statistical reliability. Temperature and RH were monitored continuously using digital thermohygrometers, with an accuracy of ± 0.5 °C for temperature and $\pm 2\%$ for RH. Any deviations from the set conditions were immediately corrected to maintain stable microclimatic conditions. Larvae were fed fresh mulberry leaves twice daily at 8:00 AM and 4:00 PM. Uneaten leaves were removed after each feeding to maintain hygiene and prevent fungal growth. Feeding practices were standardized across all treatment groups to ensure uniform nutrition. All experimental conditions were based on standard sericultural protocols (Kandasamy & Mustafa, 2012) [5] and previous studies on larval rearing optimization (Anitha & Naidu, 2010; Reddy & Lalitha, 2015) [1, 3]. Larvae were observed daily for general health, feeding activity, molting behavior, and signs of stress.

2.2 Measured Parameters

The following larval and cocoon characteristics were recorded for each replicate:

1. 5th Instar Larval Duration (days)

- Recorded from the onset of the 5th instar to the initiation of cocoon spinning.
- Observations were made twice daily to capture accurate timing of developmental stages.

2. Final Larval Weight (g)

- Measured individually using an analytical balance (± 0.01 g) immediately before cocoon formation.
- This reflects growth rate and nutritional efficiency.

3. Survival Rate (%)

- Calculated as:
- Survival Rate (%) = $\frac{\text{Total number of larvae at start}}{\text{Number of larvae reaching cocoon stage}} \times 100$

4. Cocoon Weight (g)

- Measured after air-drying cocoons for 24 hours at room temperature to ensure uniform moisture content.

5. Shell Weight (g)

- Determined by carefully removing pupae from the cocoons

and weighing the remaining shell.

- Shell weight is a direct indicator of silk fiber yield and quality.

Data from each replicate were averaged, and results are presented as mean $\pm$ standard deviation. All procedures were performed under controlled and hygienic conditions to minimize environmental and microbial variability.

2.3 Statistical Analysis

Analysis of variance (ANOVA) was conducted to compare group means.

3. Results

3.1 Larval Growth

Temperature and relative humidity (RH) had a significant effect on larval development. The shortest larval duration was observed at 25 °C with higher RH levels (75–85%), where larvae completed the 5th instar in 7–8 days. In contrast, larvae reared at 22 °C experienced extended development cycles of 9–11 days, likely due to reduced metabolic activity and slower nutrient assimilation under cooler conditions (Anitha & Naidu, 2010) [1]. Increasing RH at a constant temperature also positively influenced growth. For example, at 25 °C, larvae under 85% RH reached higher final weights (4.5 ± 0.2 g) compared to those under 65% RH (3.9 ± 0.2 g), indicating that adequate humidity facilitates efficient feeding and digestion, leading to faster growth. At 28 °C, although larval duration was slightly reduced compared to 22 °C, growth did not improve proportionally, suggesting that temperatures above the optimal range may introduce thermal stress, limiting nutrient conversion and weight gain.

3.2 Survival Rate

Survival rate was strongly influenced by RH. Larvae maintained at higher humidity levels demonstrated improved survival across all temperatures, with the highest survival rate (94–97%) at 25 °C and 85% RH. In contrast, lower RH environments (65%) resulted in increased desiccation stress, reduced feeding activity, and lower survival rates (83–86% at 22 °C). This highlights the critical role of moisture in maintaining larval hydration and physiological homeostasis, particularly during the late 5th instar, which is the most metabolically active stage (Reddy & Lalitha, 2015). Temperature also played a role: while 25 °C provided optimal survival, slightly higher temperatures (28 °C) slightly reduced survival, likely due to thermal stress affecting enzymatic activity and immune function.

3.3 Cocoon and Shell Weight

Cocoon and shell weights increased with rising temperature up to the optimal level of 25 °C and higher RH (85%). The heaviest cocoons (2.1 ± 0.1 g) and shells (0.42 ± 0.02 g) were produced under these conditions. At lower temperatures (22 °C), cocoon weights were smaller (1.4 – 1.7 g) regardless of RH, reflecting slower silk protein synthesis and reduced larval feeding efficiency. At 28 °C, although larvae developed faster, cocoon weights did not increase significantly, suggesting thermal stress may limit silk deposition despite reduced larval duration. Higher RH facilitated proper fiber hydration, ensuring thicker and more uniform shells. Lower RH resulted in thin, brittle cocoons, demonstrating the importance of moisture in cocoon formation and silk quality (Zakeri & Najafi, 2017) [4].

Table 3.4: Effect of Temperature and Relative Humidity on Growth Performance and Cocoon Traits of Late Age *Bombyx mori* L.

Temperature (°C)	Relative Humidity (%)	Feeding Schedule (times/day)	5 th instar Larval Duration (days)	Final Larval Weight (g)	Survival Rate (%)	Cocoon Weight (g)	Shell Weight (g)
22	65	2	10–11	3.3 ± 0.1	83–86	1.4 ± 0.1	0.28 ± 0.02
22	75	2	9–10	3.4 ± 0.1	84–87	1.5 ± 0.1	0.30 ± 0.02
22	85	2	9–10	3.5 ± 0.2	87–90	1.7 ± 0.1	0.33 ± 0.02
25	65	2	8–9	3.9 ± 0.2	89–91	1.8 ± 0.1	0.36 ± 0.02
25	75	2	7–8	4.3 ± 0.2	91–94	1.9 ± 0.1	0.38 ± 0.02
25	85	2	7–8	4.5 ± 0.2	94–97	2.1 ± 0.1	0.42 ± 0.02
28	65	2	8–9	3.4 ± 0.2	84–87	1.4 ± 0.1	0.30 ± 0.02
28	75	2	7–8	3.6 ± 0.2	86–90	1.6 ± 0.1	0.33 ± 0.02
28	85	2	7–8	3.7 ± 0.2	88–92	1.7 ± 0.1	0.35 ± 0.02

4. Discussion

Temperature and humidity are critical environmental factors that directly influence the physiological and developmental processes of *Bombyx mori* larvae. The results of this study indicate that moderate temperature (25 °C) combined with high relative humidity (85%) provides optimal conditions for larval growth, survival, and cocoon formation. Larval metabolic activity peaks near 25 °C, facilitating efficient nutrient assimilation, rapid growth, and proper silk gland development (Anitha & Naidu, 2010) ^[1]. Cooler temperatures, such as 22 °C, slow metabolism, resulting in prolonged larval duration, reduced feeding efficiency, and lower final larval weights (Reddy & Lalitha, 2015) ^[3]. In contrast, higher temperatures (28 °C) accelerate development but can induce thermal stress, slightly reducing weight gains despite shorter larval durations. Humidity also plays a vital role; adequate relative humidity prevents dehydration, maintains enzyme function, and supports silk fibroin synthesis, leading to thicker and higher-quality cocoons (Rahmathulla *et al.*, 2014) ^[2]. Low humidity conditions (65%) were associated with increased desiccation, lower survival rates, and thin, brittle cocoons, demonstrating the critical role of moisture in maintaining larval homeostasis and silk deposition. The combination of optimal temperature and humidity not only maximized larval weight, survival, and cocoon quality but also emphasizes the importance of precise microclimatic control in sericulture. These findings align with previous studies highlighting that both temperature and humidity must be optimized simultaneously to achieve efficient silk production (Zakeri & Najafi, 2017) ^[4]. Overall, this study confirms that careful environmental management during late-stage larval development is essential for improving silk yield and quality, providing practical guidance for sericulture practitioners.

5. Conclusion

The present study demonstrates that the combination of 25 °C temperature and 85% relative humidity provides optimal conditions for the growth, survival, and cocoon development of late-age *Bombyx mori* larvae. Under these conditions, larvae exhibited shorter developmental duration, higher final weights, maximum survival rates, and superior cocoon and shell characteristics, highlighting the critical role of precise environmental management in sericulture. Implementing these rearing environment parameters in commercial operations can significantly improve silk yield and fiber quality, reduce larval mortality, and enhance economic returns for farmers. Moreover, maintaining controlled temperature and humidity not only ensures uniformity and consistency in cocoon production but also supports sustainable sericulture practices by minimizing stress-related losses.

References

1. Anitha N, Naidu KA. Effect of temperature and humidity on mulberry silkworm. *Journal of Insect Physiology*. 2010;56(8):1021-1027.
2. Rahmathulla V, Chandrasekaran M, Jalaja KS. Influence of microclimate on silkworm biology. *International Journal of Sericulture*. 2014;4(2):87-94.
3. Reddy GN, Lalitha R. Temperature and humidity effects on larval development. *Sericultural Research Journal*. 2015;10(1):1-11.
4. Zakeri S, Najafi A. Environmental parameters and silk quality. *Journal of Applied Entomology*. 2017;141(5):406-413.
5. Kandasamy R, Mustaffa PS. Standard rearing procedures for silkworms. *Sericulture Manuals*. 2012;2:47-61.
6. Goomer SR, Sharma V, Kaushik H. Statistical approaches in sericulture research. *Journal of Statistical Applications*. 2013;9(4):451-461.
7. Krishnaswami S. New technology of silkworm rearing. Mysore: Central Sericultural Research and Training Institute; 1978.
8. Ito T. Silkworm nutrition and artificial diets. *Annual Review of Entomology*. 1978;23:309-330.
9. Benchamin KV, Jolly MS. Principles of silkworm rearing. In: *Proceedings of Seminar on Problems and Prospects of Sericulture*; 1986.
10. Rahmathulla VK. Management of climatic factors for successful silkworm rearing. *International Journal of Industrial Entomology*. 2012;25(2):145-155.
11. Effect of environmental factors on silkworm growth and cocoon production. *Indian Journal of Sericulture*. 34(1):1-7.
12. Gaviria DA, Aguilar E, Serrano HJ, Alegría AH. DNA fingerprinting using AFLP markers to search for markers associated with yield attributes in silkworm. *Journal of Insect Science*. 2006;6(1):1-10.
13. Nagaraju J. Application of genetic principles in improving silkworm productivity. *Current Science*. 2002;83(4):409-414.
14. Datta RK. Studies on the role of environmental factors on silkworm rearing. *Indian Silk*. 1984;23(7):3-9.
15. Tazima Y. The silkworm: An important laboratory tool. Tokyo: Kodansha Ltd.; 1978.
16. Sengupta K, Benchamin KV. A review of silkworm nutrition and rearing techniques. *Indian Journal of Sericulture*. 1990;29(1):1-12.