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Research Article

Climate Variability Effect on Economic Parameters of Silkworm (*Bombyx mori* L.) Under Normal Rearing Conditions



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ABSTRACT

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Sericulture is a science of art, and the silkworm is considered the queen of textiles, and an important subsistence-supporting activity that contributes to rural economy and is a harbinger in providing employment to women and youth of rural India. The growth, survival, and productivity of the silkworm (*Bombyx mori* L.) are highly dependent on environmental factors, such as temperature and humidity which play exert noticeable effect a critical role in regulating silkworm metabolism, larval development, and cocoon formation. Variability in these climatic parameters may negatively influence the cocoon yield and economic traits associated with silk production. The purpose of the study is to evaluate the influence of climatic variations on important economic parameters of silkworms such as cocoon weight, shell weight, shell ratio, and pupal weight under normal rearing conditions. Silkworm larvae were reared by following standard rearing practices, and cocoons were collected after completion of the rearing period. The harvested cocoons were weighed using a digital weighing balance, and the economic parameters were calculated using standard formulas. The results indicated that climatic fluctuations exert a noticeable effect on the economic traits of cocoon. Variations in temperature and humidity during the larval rearing period affected cocoon weight and shell weight, which are important indicators of silk yield and cocoon quality. Favourable environmental conditions supported better larval growth and cocoon development, resulting in increased silk production. Conversely, unfavourable climatic conditions reduced cocoon quality and economic performance.

1. Introduction

Sericulture is a specialized agricultural practice that focuses on the cultivation of silkworms for the production of natural silk, which is widely used in the textile sector. In addition to its industrial importance, it serves as a dependable source of livelihood for rural populations by creating employment opportunities and supporting income generation in farming communities. Among the various species used in silk production, the mulberry silkworm (*Bombyx mori* L.) is the most extensively reared due to its superior silk-producing capacity, forming the backbone of the global silk industry (Vijayan et al., 2009). The species *Bombyx mori* is highly domesticated and sensitive to environmental fluctuations, making it an excellent biological model for studying the impact of climatic factors on insect growth and productivity (Rahmathulla, 2012; Gujjeti et al., 2014).

Temperature plays a crucial role in determining the growth and survival of *Bombyx mori*, as different strains exhibit varying levels of thermotolerance under changing environmental conditions (Kumari et al., 2011). Exposure to extreme environmental conditions, particularly high temperature and low humidity, has been shown to significantly reduce the overall performance and productivity of silkworms (Kumar & Nath, 2024). In addition, both temperature and humidity directly influence larval duration, feeding efficiency, and cocoon characteristics such as cocoon weight and shell ratio (Zhao et al., 2020; Gurrapu et al., 2017). High temperature stress has also been reported to impair physiological processes, leading to reduced silk synthesis and inferior cocoon quality (Kato & Sato, 2019). Breed-specific differences in growth and development under temperature and humidity stress further indicate that environmental factors affect silkworm performance differently across genetic strains (Late et al., 2025). Moreover, temperature variation has been reported to influence gene expression patterns and metabolic pathways, ultimately affecting cocoon production and silk yield (Lopes et al., 2023).

The productivity of sericulture largely depends on the quality of mulberry leaves provided as feed and the maintenance of favourable environmental conditions during rearing. Temperature and humidity are particularly critical, as they directly influence physiological activities such as feeding efficiency, digestion, metabolic rate, and silk synthesis (Desai & Kadam, 2024; Rahmathulla, 2012). Deviations from the optimal range of these environmental factors can disrupt normal larval growth, prolong developmental duration, and reduce cocoon quality (Hussain, 2011). Earlier studies have demonstrated that unfavourable environmental conditions significantly reduce silkworm performance and spinning behaviour (Ramachandra et al., 2001). Furthermore, temperature-induced stress has been shown to alter internal biological processes, including gut microbial composition and enzymatic activity, thereby affecting larval health and productivity (Sun et al., 2022).

In recent years, increasing climatic variability has posed serious challenges to sericulture by causing irregular fluctuations in temperature and humidity during the rearing period. Such environmental instability can induce stress in silkworm larvae, affecting their survival rate, growth pattern, and cocoon characteristics (Fouad & Ahmed, 2025). Economic traits such as cocoon weight, shell weight, shell ratio, and overall silk yield are highly sensitive to environmental variations (Lopes et al., 2023; Kadam & Manjare, 2025). In addition, prolonged exposure to adverse climatic conditions may increase susceptibility to diseases, thereby further reducing productivity and affecting the economic returns of sericulture farmers (Rabha et al., 2025).

Understanding how climatic factors influence cocoon quality and economic traits is therefore essential for improving silkworm rearing practices and ensuring sustainable silk production. Hence, the present study aims to evaluate the effect of temperature and humidity variations on key economic parameters of *Bombyx mori* cocoons under controlled rearing conditions.

2. Materials and Methods

2.1. Experimental Design for Silkworm Rearing

The present study was carried out to evaluate the influence of environmental factors on the growth and cocoon characteristics of the mulberry silkworm, *Bombyx mori*. A total of 100 healthy, 5-day-old larvae were procured from Jangaon, Telangana, and used for the experiment. The larvae were randomly assigned to 10 groups, each consisting of 10 individuals. Each group was reared separately under controlled environmental conditions, with variations primarily in temperature and relative humidity. The rearing practices, including feeding and maintenance, were carried out following standard sericulture procedures to ensure uniformity across all experimental groups. The experimental setup was designed to examine the effect of varying environmental conditions on larval growth, development, and cocoon-related economic traits.

2.2. Environmental Regulation

To evaluate the effect of climatic variation, temperature levels ranging from 18°C to 30°C (18, 20, 22, 24, 26, 28, and 30°C) were maintained throughout the experimental period, while relative humidity was regulated between 70% and 80%. Each temperature treatment was maintained in duplicate to ensure experimental accuracy. These environmental conditions were maintained using a controlled rearing system, which allowed

precise regulation and monitoring of temperature and humidity parameters, following standard sericulture practices (Hussain, 2011)

2.3. Rearing Conditions and Management Practices

Each experimental group was maintained separately in clean and properly labelled rearing trays to ensure uniformity and to prevent intermixing of larvae. The trays were kept under controlled environmental conditions with adequate illumination and a moderately warm atmosphere, simulating standard silkworm rearing conditions, as influenced by temperature and humidity factors (Sun et al., 2022). Fresh and tender leaves of *Morus alba* were provided at regular feeding intervals to ensure continuous nutrition and to support optimal larval growth, following established feeding practices. Strict hygienic and sanitation measures were maintained throughout the rearing period to minimize disease incidence and to ensure larval health.

2.4. Monitoring of Environmental Factors

Each batch was exposed to a specific combination of temperature and relative humidity. The environmental parameters were regularly monitored and recorded using a thermo-hygrometer. Controlled variations in climatic conditions were systematically implemented to evaluate their effects on silkworm growth and cocoon characteristics.

2.5. Measurement of Economic Parameters

At the end of the rearing period, fully formed cocoons of *Bombyx mori* were harvested and subjected to further analysis to determine important economic parameters.

Cocoon Weight: The total weight of individual cocoons was measured using a digital weighing balance and recorded in grams (g).

Pupal Weight: After recording cocoon weight, the cocoons were carefully cut open, and the pupae were removed. The pupae were weighed individually using a digital balance, and the values were expressed in grams (g).

Shell Weight: Following removal of the pupae, the empty cocoon shells were dried and weighed using a digital weighing balance. The shell weight was recorded in grams (g), which represents the actual silk content of the cocoon.

Shell Ratio: The shell ratio was calculated to determine the proportion of silk content in each cocoon using the following formula:

$$\text{Shell Ratio (\%)} = (\text{shell weight}) / (\text{cocoon weight}) \times 100$$

3. Results and Discussion

The influence of temperature and relative humidity on the economic parameters of the mulberry silkworm, *Bombyx mori*, was analysed under normal rearing conditions. The observations obtained from the experiment are presented in [Tables 1–4](#).

3.1. Cocoon Weight

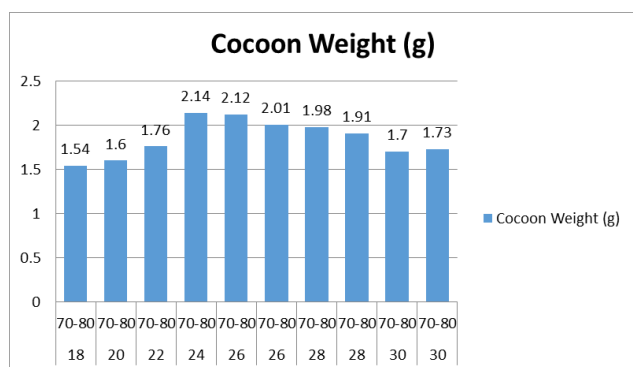
The cocoon weight of silkworms showed noticeable variation under different temperature and humidity conditions (Table 1).

The recorded cocoon weight ranged from 1.54 g to 2.14 g. The highest cocoon weight (2.14 g) was observed at 24°C temperature and 70-80% relative humidity, while the lowest cocoon weight (1.54 g) was recorded at 18°C and 70-80% relative humidity. These results indicate that moderate temperature and humidity conditions favour better cocoon development.

Table 1. Cocoon Weight of Silkworm under Different Temperature and Humidity Condition.

S.No	No.of cocoons	Temperature (°C)	R.H(%)	Cocoon weight(g)
1	10	18	70-80	1.54
2	10	20	70-80	1.60
3	10	22	70-80	1.76
4	10	24	70-80	2.14
5	10	26	70-80	2.12
6	10	26	70-80	2.01
7	10	28	70-80	1.98
8	10	28	70-80	1.91
9	10	30	70-80	1.70
10	10	30	70-80	1.73

Fig.1. Graphical representation of cocoon weight(g)



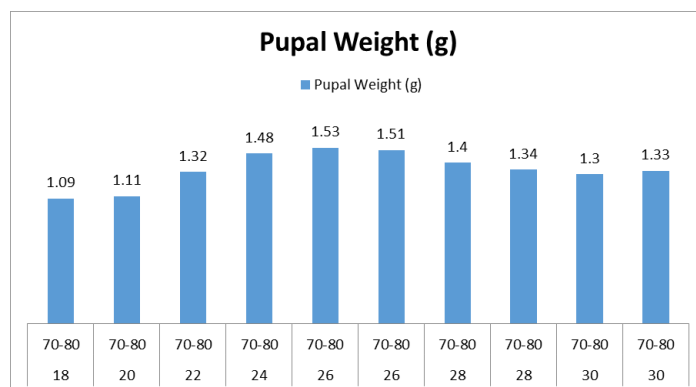
3.2. Pupal Weight :

The pupal weight of silkworms ranged between 1.51 g and 1.09 g under the experimental conditions (Table 2). The maximum pupal weight (1.51 g) was observed at 26°C temperature and 70-80% relative humidity, whereas the minimum pupal weight (1.09 g) was recorded at 18°C temperature and 70% humidity level but may be influenced by biological variation among larvae. These results indicate that favourable environmental conditions support proper larval growth and development.

Table-2 Pupal Weight of Silkworm under Different Temperature and Relative Humidity Conditions

S.No	No.of cocoons	Temperature (°C)	R.H(%)	pupal weight(g)
1	10	18	70-80	1.09
2	10	20	70-80	1.11
3	10	22	70-80	1.32
4	10	24	70-80	1.48
5	10	26	70-80	1.53
6	10	26	70-80	1.51
7	10	28	70-80	1.40
8	10	28	70-80	1.34
9	10	30	70-80	1.30
10	10	30	70-80	1.33

Figure-2. Graphical representation of pupal weight (g)



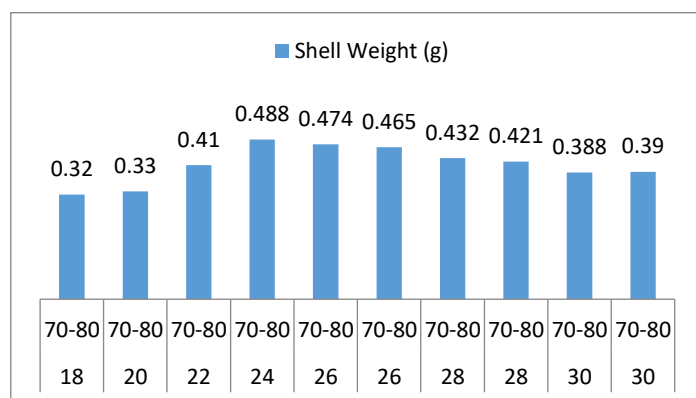
3.3. Shell Weight:

The shell weight of cocoons also varied under different environmental conditions (Table 3). The shell weight ranged between 0.320 g and 0.488 g. The maximum shell weight (0.488 g) was recorded at 24°C temperature and 70-80% relative humidity, while the minimum shell weight (0.320g) was observed at 18°C and 70-80% relative humidity. Higher shell weight indicates better silk content and improved cocoon quality.

Table-3. Shell Weight of Silkworm under Different Temperature and Relative Humidity Conditions

S.No	No.of cocoons	Temperature (°C)	R.H(%)	shell weight(g)
1	10	18	70-80	0.320
2	10	20	70-80	0.330
3	10	22	70-80	0.410
4	10	24	70-80	0.488
5	10	26	70-80	0.474
6	10	26	70-80	0.465
7	10	28	70-80	0.432
8	10	28	70-80	0.421
9	10	30	70-80	0.388
10	10	30	70-80	0.390

Figure-3. Graphical representations of shell weight



3.4. Shell Ratio:

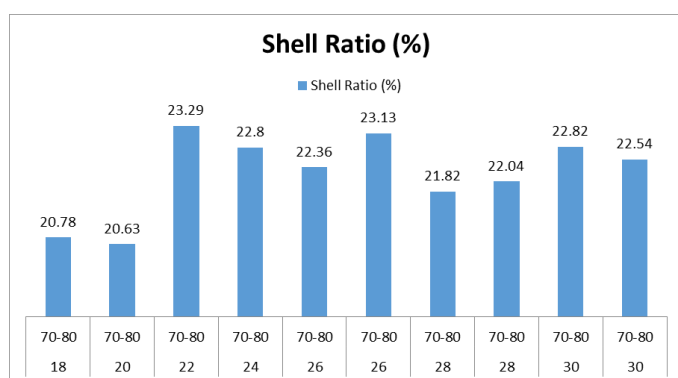
Shell ratio is an important economic parameter indicating silk productivity. In the present study, the shell ratio ranged from 20.51% to 26.13% (Table 4). The highest shell ratio (26.13%) was recorded at 24°C temperature and 70-80% relative humidity, while the lowest shell ratio (20.51%) was observed at 20°C and

70-80% relative humidity. Higher shell ratio values indicate improved cocoon quality and greater silk yield.

Table-4. Shell Ratio of Silkworm Cocoons under Different Temperature and Relative Humidity Conditions

S.No	No.of cocoons	Temperature (°C)	R.H(%)	Shell ratio
1	10	18	70-80	20.78
2	10	20	70-80	20.63
3	10	22	70-80	23.29
4	10	24	70-80	22.80
5	10	26	70-80	22.36
6	10	26	70-80	23.13
7	10	28	70-80	21.82
8	10	28	70-80	22.04
9	10	30	70-80	22.82
10	10	30	70-80	22.54

Figure-4. Graphical representation of shell ratio



4. Conclusion

The present study demonstrates that temperature and humidity play a significant role in determining the growth and cocoon characteristics of *Bombyx mori*. The best results were obtained at temperatures between 24°C and 26°C, where cocoon weight, shell weight, and pupal weight were highest. Both lower and higher temperatures adversely affected silkworm performance, indicating that extreme conditions are unsuitable for optimal production. Therefore, maintaining appropriate environmental conditions is essential for improving silk yield and ensuring sustainable sericulture practices.

Declarations

Ethics approval and consent to participate: Not applicable

Competing interests:

The authors declare that they have no competing interests

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