The American Journal of Applied sciences
(ISSN – 2689-0992)
VOLUME 05 ISSUE 06 Pages: 17-22
SJIF IMPACT FACTOR (2020: 5. 276) (2021: 5. 634) (2022: 6. 176) (2023: 7. 361)
OCLC – 1121105553

Publisher: The USA Journals

Journal Website: https://theamericanjournals.com/index.php/tajas

Research Article

THE IMPACT OF MICROCLIMATE FACTORS ON SILK THICKNESS UNIFORMITY AND OPTIMAL CONTROL THROUGH A MECHATRONIC SYSTEM

Submission Date: June 20, 2023, Accepted Date: June 25, 2023,
Published Date: June 30, 2023 |
Crossref doi: https://doi.org/10.37547/tajas/Volume05Issue06-05

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ABSTRACT

This study investigates the influence of microclimate factors on the uniformity of silk thickness and explores the application of a mechatronic system for optimal control and maintenance. As environmental conditions vary on a daily and seasonal basis, managing temperature and relative humidity becomes crucial for consistent cocoon production. The review delves into the significant role of temperature and humidity in the growth and development of silkworms, highlighting the potential of a mechatronic system for regulating the microclimate. Additionally, the research addresses the creation of an optimal microclimate during cocoon wrapping and examines the impact of temperature and humidity on the quality parameters of the resulting cocoon.

KEYWORDS

Study investigates, significant role of temperature and humidity in the growth and development of silkworms.

INTRODUCTION

Sericulture is an industry that deals with the production of silk through the cultivation of silkworm cocoons. Silk is called the queen of textiles because of its lustrous luster, softness, elegance, durability, and emollient properties for human skin and elasticity, and was discovered in China between 2600 and 2700 BC. Silk is a natural fibrous substance produced from the saliva of insects, i.e. the silk gland, and it is obtained from the fibers or cocoons spun by larvae called silkworms. Silk is preferred over all other types of fibers due to its excellent properties such as water absorption, heat resistance, dyeing efficiency and luster. Factors that mainly affect the physiology of insects are foliar nutrition and temperature and

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Crossref doi Google Scholar WorldCat MENDELEY
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humidity. The mulberry silkworm (Bombyx mori L.) is very delicate, very sensitive to environmental changes, and because it has been domesticated for many years since 5000 years, it cannot withstand extreme natural changes in temperature and humidity. Thus, the adaptation of the silkworm to environmental conditions is quite different from that of the wild silkworm and other insects.

The silkworm is one of the most important domesticated insects, feeding on mulberry leaves during the larval stage to produce a rare and valuable silk thread in the form of a cocoon. Environmental conditions greatly affect the growth and development of the silkworm. Along with cocoons, biological traits are affected by environmental temperature, season of rearing, genetic makeup of quality mulberry leaf and silkworm strains. Different seasons affect the behavior of Bombyx mori L.

Temperature plays an important role in silkworm growth. Since silkworms are cold-blooded insects, temperature directly affects various physiological activities. The success of the cocoon industry depends on several factors, but environmental conditions such as biotic and abiotic factors are of particular importance. Among the abiotic factors, temperature plays a major role in silkworm growth and productivity.

There are many reports that good quality cocoons are grown in the temperature range of 22–27◦C and that cocoon quality is lower than this. However, polyvoltine breeds grown in tropical countries are known to tolerate slightly higher temperatures and adapt to tropical climates. To use bivoltine species in a tropical country like India, it is necessary to have a stable cocoon yield in a high temperature environment. High temperatures adversely affect almost all biological processes, including the rates of biochemical and physiological reactions [6] and may ultimately affect the quality or quantity of silkworm cocoons and subsequent silk production. Several studies [7] show that silkworms are more sensitive to high temperatures in the fourth and fifth instars. It is known that most of the economically important genetic traits of silkworm are qualitative and phenotypic expression is greatly influenced by environmental factors such as temperature, relative humidity, light and nutrition. In the initial stages (I, II, III), the temperature requirements are high and the worms feed actively, grow very strongly and lead to a high growth rate. Such a strong worm can withstand even the adverse conditions of later periods.

Table 1. The optimum temperature required for rearing silkworms of different early stages is shown in

Environmental factors	I instar	II instar	III instar	IV instar	V instar
Temperature	28^0C	27^0C	26^0C	25^0C	24^0C-25^0C
Relative humidity	85-88%	85%	80%	70-75%	65-70%

Table 1: Optimum temperature and humidity requirements of silkworm at different stages.

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Post-molting 3 larvae were exposed to various heat and moisture stresses until cocoon characteristics were assessed. Comparative feeding and beating performance show that the deleterious effects of high temperature and high RH are more pronounced for most traits such as cocoon uniformity, cocoon weight, shell weight, shell percentage, regeneration, filament length and this effect was almost identical for all three silkworm hybrids studied. This study showed that the deleterious effects of high temperature and high RH had a greater effect on the rearing and spinning of silkworm larvae than other temperature and RH treatments, and similar effects o observed in all three silkworm hybrids studied. Cocoon performance can also be improved by providing ideal environmental conditions during the larval cycle, which is affected by high temperature and RH. The study shows that high temperature and low humidity have a greater effect on the growing stage than on the spinning stage.

There is limited information on the combined effects of different temperatures and humidity at different stages of silkworm rearing and spinning on different cocoon characteristics and packing parameters, which in turn improve the quality and quantity of silk to international standard levels. provides valuable information to the manufacturers of the connecting technology.

To assess cocoon size uniformity, 50 cocoons were randomly sampled from each replicate for all hybrids under all adequate temperature and environmental conditions. Cocoon length and width were measured using vernier calipers specifically designed to check cocoon uniformity. After measuring the length and width of the cocoon fiber, the ratio between length and width is calculated according to the following formula:

cocoon length to width ratio = (length / width) x 100

The obtained ratio between length and width is statistically analyzed for standard deviation (SD) and coefficient of variation (CV). Cocoons with a smaller standard deviation (SD) and coefficient of variation (CV) were considered to be uniform in cocoon shape.

The raw material for silk fiber is the cocoon. The cocoon is nothing more than a protective sheath made of a continuous long protein silk enzyme wrapped around by the mature silkworm. Cocooning takes place up to the cocoon to protect it from the climate and external environment for reliability and production of raw silk. It is composed of fibroin and siricin substances. The characteristics of a good cocoon are compact, uniform in shape and size, rich in silk content, less thread and easily regenerated. However, the quality of the cocoon depends on different feeding methods. Worms are grown using the latest technologies for cocoon and fiber quality.

MATERIALS AND METHODS

- Summarizing the above-mentioned information and skills, it can be said that cocoon production is one of the most complex and urgent issues. We can identify the most important factors in the cultivation of high-quality silk and take them as a goal for scientific research.
- Other aspects of producing quality cocoons include:
- Maintaining optimal temperature and humidity conditions during cocoon spinning.
- To maintain proper density during installation.
- Maintenance after installation.
- Provide timely quality mulberry leaf feed
- Timely harvesting of cocoons.

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We can consider the issue of creating an optimal microclimate from the mentioned factors. If the temperature during cocooning exceeds 22°–25°C, the shell becomes very loose and folds with wrinkles and knots. It also changes the properties of sericin. This causes the silk filaments to clump together and makes winding difficult. Low temperature slows down the secretion of the silk thread, resulting in a large cocoon. Also, it takes a lot of time for the cocoon to scale. Relative humidity (60-70%) promotes health, good recovery and quality cocoons. When the optimum level is exceeded, larvae and fungi stop dying. Low humidity results in double cocoons and loose cocoons. The speed of air flow should be less than one meter per second and fast or strong air flow will cause accumulation of mature silkworms, resulting in double cocoons. The brooding room requires moderate, even lighting, and strong light will cause the silkworms to gather on one side, resulting in double cocoons or cocoons of uneven thickness. Complete darkness slows down the spinning process, resulting in poor quality cocoons.

The industrial or commercial term raw silk (Grege) usually refers to raw mulberry silk. It is a compact untwisted and unrefined silk thread, which is produced by combining the required number of silk fibers from several separate cocoons using a special technique called Reeling. It involves a series of skilled operations to transform the raw material (cocoon) into long lengths of fine, continuous silk filament. Unlike other aspects of cocooning, reeling requires constant attention and care, as the process of winding the cocoon threads is constantly interrupted and the reel weaves new filaments to create a continuous filament. should be attached. If this is not the case, the silk of the spool will cause the fine lengths to appear abruptly.

The quality indicators of the cocoon play an important role in the quality of the silk raw material. Many parameters, some important for maintenance, determine the characteristics of the cocoon and some important for harvesting the cocoon. Technological indicators of cocoon are of great importance for the reeler, because they determine the quality, quantity and efficiency of the winding process. Significant changes in cocoon shape and cocoon size in hybrids lead to changes in filament size and quality of spun yarn. In addition, winding with irregular and non-uniform cocoons can lead to thread breakage, blockages due to slag, poor winding, poor ripening, reduced raw silk recovery, changes in raw silk denier, and poor it is said to lead to purity. In automatic and semi-automatic winding machines, the uniformity of the cocoon size is very important in order to have the same size of filament. Extensive studies have been carried out on changes in the shape of the cocoon in the parent silkworm breeds and their hybrids. Different temperatures during the spinning period and its effect on the cocoon and winding parameters of new bivoltine monovoltine hybrids were investigated. The researchers evaluated the effects of various nutritional and environmental stressors on the silk fiber properties of the bivoltine silkworm. Researchers [20] also showed that there is a relationship between the water content of the cocoon layers during the spinning stage and cocoon regeneration, and recommended that the water content of the cocoon layer should be below 20% to obtain high-quality cocoons. It should be noted that if the ambient humidity is high during the cocoon spinning process, the water in the spinning solution, in the cocoon, and the liquid of the silkworm gradually evaporates and affects the structure of sericin.

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RESULTS AND DISCUSSIONS

Therefore, during our research, we created an artificial microclimate through a mechatronic system in order to ensure the factors that affect the quality of silk fiber, that is, the necessary temperature and humidity. Due to the ease of use of the mechatronic microclimate system construction, it can be used in the process of feeding silkworms in any wormery. The main task of the mechatronic microclimate device is to control the climate in the worm house, to automatically provide the required temperature and humidity. Our mechatronic microclimate device measures the humidity and temperature in the air through the DHT11 sensor and outputs the data to the LCD screen. If the humidity is less than the specified amount, it starts the air humidifier. it rots.

The air temperature is also monitored in this way. Sensitive DHT11 sensors are installed on both sides of the worm house and outside the worm house. When the temperature is not the same in the worm house, the heat transfer device is activated and the hot air flows from the high temperature side to the low temperature side. After the heat in the wormery is evenly distributed, the mechatronic system turns off the heat transfer device. The advantage of our mechatronic system microclimate device is that these processes are carried out automatically by the program written on the microcontroller without the intervention of the human factor. As a result, all parts of silkworms are provided with the same humidity and heat temperature.

CONCLUSION

In conclusion, this system was developed by reviving silkworm larvae from the eggs prepared at the silkworm production enterprise of "Shandun" province of the Republic of China, and from 12.04.2022. 'hardening, increasing the metric number has been achieved. In practice, in the house of Temirov Ubaidulla, a resident of the Norin district of the Namangan region of the Republic of Uzbekistan, 40 grams of silkworms were kept, and a total of 148 kg of high-quality cocoon raw material was grown from 74 kg per box. It can be seen that this result is very significant positive according to the yields of the previous year. According to the productivity of 2020, 63.5 kg per box, 64 kg in 2021, and according to this productivity in 2022, this result increased to 74 kg. This will help to supply competitive silk fiber to the world market.

In short, it should be noted that the results of the conducted scientific research are justified and a positive conclusion can be drawn.

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