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RESEARCH ARTICLE

CLIMATIC VARIABILITY AND ITS IMPACT ON THE GROWTH AND DEVELOPMENTOF SILK WORM BOMBYX MORI IN UTTARAKHAND, INDIA.

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Abstract

India has a rich and complex history in silk production and its silk trade dates back to 2nd century B.C. India's silks are known for their finery and artistic designs and distinct colours. India holds distinction of being the world's largest consumer of pure silk in the world and is the second largest producer of raw silk after china.Many states in India such as Assam, Karnataka, Tamil Nadu, Kerela, Uttar Pradesh, Jammu & Kashmir, and Uttarakhand are producer of raw silk. In currentscenario changing global climateseems to be one of the major hindrance in the growth and development of silk wormBombyx Mori. Various climatic factors such as temperature,humidity,precipitation,light, airetc. bearsinfluence on the developmental process,any change in the ratio of these climatic factors may lead to pessimistic result. The present experimental analysis conducted in laboratory contemplates the role and influence of temperature and humidity on the growth of pupa from larvae of silkworm Bombyxmori.It is observed that mortality rate is leastat temperature 22 - 26 ºC and 80-85% of relative humidity. It is also observed that weight of pupa and shell reared at temperature 22 to 26ºCand 80-85 %relative humidity are more. In addition to this, the study accentuates the character of different environmental factors on embryonic development of silkworm and highlights the precision required during the silkworm life cycle. The study includes the steps to be taken for the management of climatic condition and to improved quantity and quality of silk production in future.

Introduction:-

India is home to some of the most exotic and wide-ranging silks in the world. In fact, each silk producing cluster is unique in its patterns, designs and colour combinations. Traditional as well as modern methods of production co-exist in perfect harmony. India is the only country in the world producing all the four commercially known varieties of silk; Mulberry, Eri, Tasar and Muga.(1).The primary producer of silk is silk worm. It is well known that the environmental conditions during embryonic development not only affect the diapause nature of eggs but also larval/pupal duration, cocoon weight, and egg production (2). Among the abiotic factors, temperature and humidity play major role on growth and productivity of silkworms(3, 4)**.** The productivity and quality of silk is dependent on

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the healthiness of larvae, growth of larvaeand the environmental condition (5).The growth of silkworm and their host plants are largely controlled by the surrounding climate. The temperature bears direct correlation with growth of silkworm as wide fluctuation of temperature is harmful to the development of silkworm. (6)**Muniraju et al. (2001)** described the influence of temperature on the growth of silkworm. Higher ambient temperature increases thebasal metabolic rate andinner body temperature insmall bodied insect (6).The variability in temperature and relative humidity has been experienced in the state as a result of global warming, as indicated by (7)**Zhou, (1996).**Temperature and humidity plays a vital role on the growth of the silkworms.Assilkwormsarecold-bloodedanimals,silkworm's preferred food is mulberry leaves (8).Silkworm larvae are fed by mulberry leaves and after the fourth molt, climb a twig placed near them and spin their silken cocoons. A dense fluid secreted from its gland results in the fiber of the cocoon (9). Silk is acontinuous-filament fiber consisting of fibroin protein, secreted from two salivary glands and a gum called sericin, which cements the two filaments together. The sericin is removed by placing the cocoons in hot water, and frees silk filaments and make it ready for reeling. This process is known as degumming process. The silk extraction process in hot water also kills the silkworm pupae. (10)**Jordan (2002)** studied effect of varied temperature on various stages of silkworm. Silk gland of Bombyxmori is a typical exocrine gland secreting large amount of silk proteins. It is consisting of modified labial/salivary glands located at the two lateral sides under the alimentary canal. Each gland is basically a tube made of glandular epithelium with two rows of cells surrounding the lumen. (11)**Kremky and michalska (2004)** studied effect of temporary reduced temperature on some characters during silkworm rearing. The silk fiber protein is synthesized by silk gland cells and stored in the lumen of the silk glands. Subsequently, it is converted into silk fibers. Quantity and nature of sericin are fundamental characteristics in conferring distinctive traits to the cocoon.

Life cycle of silk worm is greatly influenced by factors of environment.Temperature bears direct effect on various physiological activities. Temperature and relative humidity are one of the most important physical environmental factors. (11)**Kremky and Michalska(2004)** reported silk worm larvae spun best cocoon at 25°C and 75 % RH. Many other researchers highlights that good quality cocoons are produced within 25 - 30° C and higher levels than these degrades the quality. (10)**(Jordan 2002).**(12)**Ahsan (1995)** gave variability of some quantitative traits in the hybrids of silkworm Bombyxmori. (13)**Mishra and Upadhayay (2006)** studied effect of temperature on nutritional efficiency of food in mulberry silkworm larvae. (6)**Muniraju et al. (2006)** described influence of temperature on the growth of silkworm. (14)**Ueda and Lizuka (2013)** studied effect of rearing temperature on health of silkworm larvae and quality of cocoons.**(15)Singh et al (2013)** studied insect adaptations to changing environment of temperature and humidity. The global temperature is rising every year and a series of record-breaking weather events are causing havoc world over**(16)(Anon, 1996**).A joint research programme undertaken by the Ministry of Environment and Forests (MoEF) Govt of India and the UK's Department for Environment, Food and Rural Affairs (DEFRA) found that India is particularly vulnerable to the impact of climate change, which could have an adverse impact the development of silk worm. Among the developmentstageofsilkworm,Bombyxmori, lowest tolerance to high temperature.This paper deals with the attempt to study and analyze the effect of temperature and relative humidity on development of silk worm and suggesting measures to be taken for the better development of silk wormBombyx Mori.

Aim of Study:-

The aim of current study is to see the effect of changing environmental condition (Temperature & Relative humidity) on the growth and development of silk worm Bombyx Mori and in its influence on weight of pupa.

Research Methodology:-

The current experimental study is performed to examine the influence of sudden change in temperature and Relative Humidity on Bombyxmori larvae growth and development and increase in silk production. Research work was carried out at Department of Zoology and Environmental science,GurukulaKangri University,Haridwar(Uttarakhand).Productive bivoltine silk worm hybrid(CSR2 × CSR4)was preferred because of high survivability,yield and silk ratio for rear during favorable season (August–February) were used as study material. Rearing was performed by using fresh leaves of mulberry variety with moisture content 75-90%. Temperature 18°,20°,22°,24°,26°,28°,30°C and relative humidity 65-90% was maintained during the experimental process. Sample of 50 larvae of silk worm were placed in different temperature and relative humidity treatment condition in sericatron. With automatic control of temperature and humidity, constant quantity of fresh mulberry leaves were provided three times a day and care was taken to maintain the moisture content of leaf to the maximum

possible extent. Mortality rate,weight of pupa and shell were recorded.The statistical analysis of data is conducted on Microsoft Advanced Excel 2013 and SPSS 16.

Result and discussion:-

Fifty larvae of silk worm were kept in sericatron at different temperature, relative humidity and fed with pre-determine quantity of fresh mulberry leaves. Periodic reading mortality rate of larvae were obtained with required care .Table 1 shows the effect of temperature and relative humidity on pupa development from larvae of Bombyxmori. Larvae were reared at varied temperature and relative humidity.The mortality rate of the larvae was observed to be highest when the temperature was either high(30°C) or low (18° C). Better results were obtained at temperature 24°C and 26°Cand 80-85% relative humidity where the survival rate of pupa was more than 88% (Table-1, Figure1).

S.no	Larvae	Temperature°C	R.H%	% of Pupa formed	% of Larvae Mortality
1	50	18	65	63	24
2	50	20	70	69	21
3	50	22	75	75	18
4	50	24	80	88	15
5	50	26	85	86	18
6	50	28	90	72	27
7	50	30	95	61	29

Table 1:-Percentage of pupa formed from larvae at different temperature and RH.

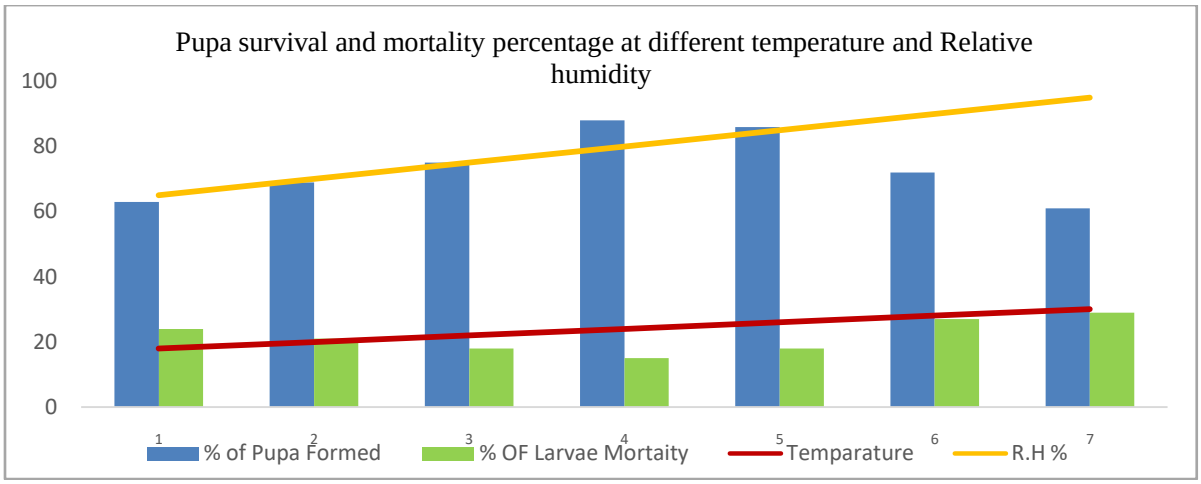

Figure: 1- Pupa survival and mortality percentage at different temperature and relative humidity.

Similarly the Average weight of the pupa formed was also observed to be 2.99 grams (healthy) at 24°C. There was constant reduction in average weight of the pupa towards the low temperature and high temperature ends(Table-2, Figure-2)

S.no	Temp°C	RH%	Avg.Weight of Pupa Formed
1	18	65	1.50
2	20	70	1.96
3	22	75	2.07
4	24	80	2.99
5	26	85	2.42
6	28	90	2.10
7	30	95	2.00

Table 2:- Effect of Temperature and RH on Weight of Pupa.

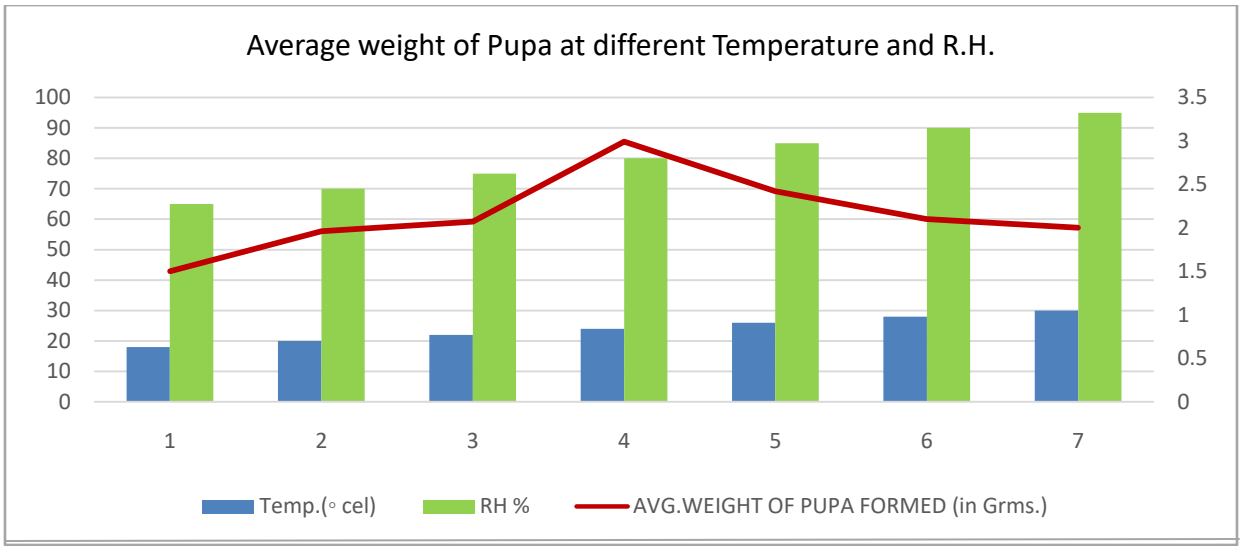

Figure 2:- Average weight of Pupa at different Temperature and R.H.

Periodic monitoring and observation also revealed that there was constant impact of temperature and relative humidity on the formation of pupa shell. Theweight of shell is 0.370 at 24ºC &80% and 0.300 at 22ºC and 75%, 0.367 at 26ºC &85%, and 0.205 at 28ºC&90% (Table-3, Figure-3). The overall observation revealed the temperature ranging between 22°C-24°C and relative humidity ranging between 70-85% to be most conducive for the growth and development of the pupa.

S.no	Temp°C	RH%	Weight Of Shell
1	18	65	0.178
2	20	70	0.230
3	22	75	0.300
4	24	80	0.370
5	26	85	0.367
6	28	90	0.205
7	30	95	0.171

Table-3:- Effect of Temperature on Weight of shell.

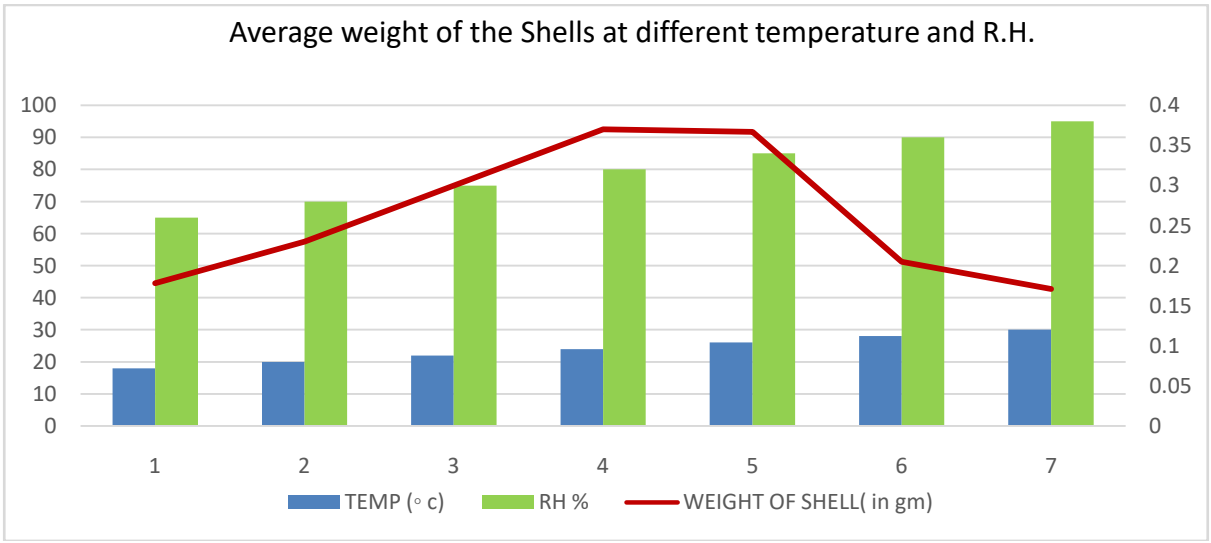

Figure: 3-Average weight of the Shell at different temperature and R.H.

Most of the strains of silkworm, due to consistent domestication, have become highly sensitive to variations in environmental conditions, especially seasonal variations in temperature and humidity in tropical parts of the Indian subcontinent. Climate change is a major prospect for the survival of species and integrity of ecosystems worldwide. Although various research has focused on changingclimate impacts, relatively little work to date has been conducted on the practical application of strategies for adaption to changing environment. While climate will have a direct impact on the performance of many species, for others impacts will be indirect resulting from changes in the spatiotemporal availability of natural resources. In addition, mutualistic and antagonistic interactions among species will mediate both the indirect and direct effects of climate change. Climatic factors have a great influence on the development and growth of silk worm temperature and relative humidity has a direct co-relation with silkworm embryonic development and growthany variation in these factors canadversely affect the natural process of silk worm. The current study indicated that temperature and RH affected both the growth and development of silkworm. The low values were obtained at 18 °C and 30 °C temperature and 65 & 95% RH. Pupa weight was recorded lower at 18 °C and 30 °C temperature and 65 & 95% RH. Variability of temperatureand RH prevents insects from attaining their potential physiological performance. The growth and development were higher when optimum temperature was maintained. Greater growth and development subsequently affects the cocoon traits.The present study indicates that greater growth and development of silkworm larva obtained under the optimum environmental conditions of 22-26°C and 75-85% RH, thus help to improve the productivity of sericulture.

Conclusion:-

Larvae were reared at different temperature and RH and pupa were formed. Mortality rate and weight of pupa were recorded at different temperature. Weight of pupa was 2.99gms reared at 24ºC & 80% the weight of shell was 0.370gms**.**The present study concludes that development of larvae were better obtained at temperature 22-24°C and 75-85% relative humidity. It is also observed that average weight of pupa and weight of shell was more at temperature 22-24°C and 80-85% relative humidity.

The present research is an attempt to highlight the conducive and optimum environmental conditions for the growth of pupa in order to provide adequate knowledge about more efficient practices/methods of silk worm rearing. These practices enable farmers to provide better care to silk worm during sericulture to enhance the quality and quantity of the product. Study can be further made using different hybrids of silkworm by providing better nutritional conditions and growth hormones. With the use of modern technology now these factors can be subsumed at laboratory conditions. Today's Biotechnological tools and molecular technologies can be used in curing various silkworm diseases and in the development of genetically modified larvae of silk worm which will remain resistant to adverse environmental conditions.

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