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Prevalence of Silkworm Disease and its Impact on Cocoon Productivity in Jammu Region.

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Abstract
Jammu and Kashmir have two different sericulture zones mainly temperate and subtropical based on their agro-climate conditions. Due to prolong domestication, silkworm developed less immunity and less adaptability and hence often suffered from infection and resulted in the outbreak of disease. The factor responsible for disease prevalence was the wider fluctuation of temperature and humidity conditions. In current investigation, survey was carried out in sericulture potential district of Jammu division during 2022-2023 to find out the prevalence of silkworm disease and its impact on cocoon productivity during spring and autumn season. The average data was recorded in autumn and spring rearing season with 50-70% and 15-30% percent grasserie, whereas no other disease throughout the period was found. Outbreak of disease in turn affected the cocoon yield and it was observed that with respect to the prevalence of grasserie during autumn season among the various abiotic factors, temperature was positively correlated (pooled r=0.65) and was highly significant with respect to humidity (r=0.56) which was significant and positively correlated. Highly significant F- value of 1.41 was obtained for the interaction of various independent factors and overall variation predicted in the data was highly significant. The temperature and humidity have directly affected the overall growth and development of silkworm and also played role in incidence and prevalence of the disease. Any fluctuation in temperature and humidity condition caused physiological changes in each instar of silkworm larvae and caused emergence of disease (grasserie). The current study revealed that the main cause of prevalence of grasserie was the change in temperature and humidity abruptly, causing great threat to sericulture industry of J&K

Keywords : Sericulture, Grasserie, disease prevalence, Abiotic factors

Introduction
Sericulture industry is agro-bussiness labour cum cottage industry under minor scale sector acting as a pillar of rural economy that contribute a lot for economical development and sustainable livelihood by providing job opportunity to many people (Ramesha *et al*., 2010). Jammu and Kashmir has eminent potential and prospectus for the production of silk which inturn empowered the farmers of J&K by providing them huge income and employment (Dar *et al*., 2021). The suitable climate and availability of skilled labour in the valley of Jammu and Kashmir are one of the favorable factors for silk production. Success of sericulture mainly depend upon mulberry leaves, silkworm seed (best quality), optimum temperature and humidity conditions. Silkworm rearing is very sensitive process with huge risk of loss due to diseases as silkworm disease are very contagious and spread very fast (Rahmathulla, 2012). There are various diseases of silkworm which have a huge impact on the cocoon yield (Sharma *et al*., 2020). The success of silkworm rearing largely depends on the quality of silkworm rearing. The optimum temperature required for silkworm during young age varied from 28±2˚C and for late age 24-25˚C is recommended (Sharma *et al.,* 2023; Sharma *et al.,* 2024). Lack of skill and rearing technicalities pose a threat of higher disease incidence at farmer level. Hence, it forms a major obstacle for an average farmer to rear silkworms from early age. Different investigations on temperature variances and their impact on cocoon production elucidate the challenges at farming level in successful management of early age silkworm rearing (Madhusudan *et al*., 2017), which may be the reason for disease spread and can pose threat to industry. Keeping this view as background, a study was conducted to understand the prevalence of silkworm diseases with respect to Jammu & Kashmir district.

Materials and methods
The present survey was carried out in two districts of Jammu i.e.Udhampur and Kathua having maximum growers. A total of 200 silkworm rearers, 100 from each district were randomly selected and the primary data was collected from silkworm rearers using questionnaire/personal interview during the year 2022-2023. Other than survey, an experimental study was also performed to evaluate the prevalence of silkworms disease.

Strain used
For experiment, silkworms hybrid stain FC1 X FC2 was procured from Sericulture Development Department, Kamsar (Poonch).

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Rearing room disinfection
First of all the disinfection of the rearing room and equipments was done with the help of disinfectant solution (Serichlor-20).Rearing was carried in special rearing houses which were isolated from free access of people with hygienic conditions and proper maintenance of environmental conditions.

Silk worm rearing
The silk worms were reared (in triplicate) after disinfection of the room. Rearing was carried out in acclimatized room where temperature and relative humidity along with pests was controlled. Silkworm was reared in plastic trays which were arranged one over the another in tiers on rearing stands. The silkworm breeds was reared following shelf rearing technique starting from brushing till cocoon spinning. After brushing, tender mulberry leaves of suitable quality was selected, chopped at a size of 0.5 cm^2 and sprinkled in a thin layer on the newly hatched larvae.

Leaf selection and chopping of leaves
During first and second instar, larvae was fed with 1st and 2nd leaves starting from the tops of the branches and were chopped double in size of larvae. 3rd instar was fed on chopped hard leaves while 4th and 5th instar were fed with full leaves. Mulberry leaves for young silkworms has a great effect on the growth and health of silkworm. The leaves selected were soft tender and rich in water content. Leaf moisture was restrained by sprinkling water over the leaves and preserving under wet gummy cloth.

Feeding schedules, Cleaning and bed spacing
1st, 2nd, 3rd and 4th instars were fed three times a day, bed changing was done twice in 2nd instar and thrice in 3rd instar and daily in 4th and 5th instars. Proper spacing and timely cleaning was done for proper growth and developments of worms.

Temperature and humidity
Three different temperature and humidity conditions were given as given in table 1

S. No.	Instar	Tc (°C)/Hc (%)	T_L (°C)/H_L (%)	T_H (°C)/H_H (%)
1	1st	27±1/85	26±1/80	29±1/86
2	2nd	28±1/85	24±1/75	30±1/87
3	3rd	27±1/80	22±1/70	31±1/88
4	4th	24±1/70	20±1/65	32±1/89
5	5th	25±1/70	18±1/60	33±1/90

Tc/Hc: Control temperature/control humidity; T_L/H_L: Low temperature/low humidity; T_H/H_H:High temperature/High humidity

Identification of mature worm
Full grown instar stopped feeding, slowly got shrinked, and their body became translucent. Due to reduction in eating, mature larvae raised its head, undergo pupation and settled to a corner among the mulberry leaves and passed soft litter on the very 8th day.
The primary was analyzed by using SPSS package.

Detection of the disease
Whole larva method
Live diseased larva was taken and crushed in an autoclaved mortar and pestle by applying gentle force to a fine homogenous paste of uniform thickness by addition of small amount of double distilled water. Fresh glass slide was taken and uniform smear was made with the help of another fresh slide. After putting coverslip, slide was observed under light microscope.

Haemolymph method
Live diseased larva was taken, sharp prick on its abdominal segment or appendages was given to collect body fluid i.e. haemolymph. 1or 2 drops of haemolymph were placed directly on the surface of a fresh glass slide and observed under light microscope.

Result
The results obtained from both field-level surveys and laboratory experiments were compiled, processed, and analyzed to provide a comprehensive understanding of the data.
The studies revealed that environmental factors showed their major role in prevalence of silkworm diseases It was observed in Kathua district that with respect to the prevalence of grasserie during autumn season, among the various abiotic factors temperature was highly significant and positively correlated factor (r=0.64) followed by humidity (r=0.51) which was significant and positively correlated (Table 2). Cocoon yield was positively correlated to temperature (r=0.10

and 0.08) with a polled r value of 0.09 and non-significant during spring season but significant and negatively correlated (r=-0.24 and -0.38) with a pooled r value of -0.31 during autumn rearing season. Humidity was positively correlated and non-significant to the prevalence of grasserie (r=0.23 and 0.15) with a pooled r- value of 0.19 during spring season and was found positive and significantly correlated (r=0.54 and 0.48) during autumn season (pooled =0.51). Cocoon yield was negatively and significantly correlared to humidity during autumn season (r=0.38) and non-significant in spring rearing (r=0.10).In Udhampur, it was observed that with respect to the prevalence of grasserie during autumn season among the various abiotic factors, temperature was positively correlated (pooled r=0.65) and was highly significant with respect to humidity (r=0.56) which was significant and positively correlated. Cocoon yield was positively correlated to temperature (r=0.06 and 0.22) with a pooled r value 0.14 and significant during spring season but significant and negatively correlated (r=0.40 and -0.36) with a pooled r value of -0.38 during rearing season (Table 2). Humidity was positively correlated and non-significant to the incidence of grasserie (0.12 and 0.08) with a pooled r=value of 0.10 during spring season and was positive and significantly correlated (r=0.65 and 0.47) during autumn season (pooled r=0.56). coccon yield was negatively and significantly correlared to huminity during autumn season (r=0.21) and non- significant in spring rearing (r=0.11).

Table 2 Disease incidence during spring and autumn (2022-2023) in Kathua & Udhampur

			Kathua				Udhampur			
S.No.	Environmental factors		Disease incidence				Disease incidence			
			Grasserie		Cocoon yield		Grasserie		Cocoon yield	
1	Temperature	Year	Seasons				Seasons			
			Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn
		2022	0.05	0.59**	0.10	-0.24*	0.09	0.46*	0.06	-0.40*
		2023	0.25	0.69**	0.08	-0.38*	0.11	0.52**	0.22*	-0.36*
		Pooled	0.15	0.64**	0.09	-0.31*	0.10	0.49*	0.14	-0.38*
2	Humidity	2022	0.23	0.54**	-0.08	-0.45*	0.12	0.65**	0.09	-0.18*
		2023	0.15	0.48*	-0.16	-0.35*	0.08	0.47*	0.13	-0.24*
		Pooled	0.19	0.51**	-0.12	-0.40*	0.10	0.56**	-0.11	-0.21*

Experimental data revealed that change in optimum climatic conditions resulted in the outbreak of disease (grasserie) which lead to the decreased in production of cocoon. Polyhedral bodies were observed under light microscope which showed the presence of grasserie (Figure 1). The diseased worms affected the productivity and quality of cocoon.

FIGURE 1 Normal larvae vs abnormal larvae with grasserie and larva infected with grasserie

During early stages of disease no symptoms were noticed except the worm being slightly sluggish, initially skin showed oily and shining appearance. But as the disease advances, the skin become thin and fragile, the body becomes milky white with inter segmental swelling, larva become restless crawled aimlessly and died (4-5 days in young larva, 5-7 days in the grown up larva).

Discussion

Sericulture constitutes a vital sector in the economic development of various districts in Jammu and Kashmir, leveraging the region's favorable environmental conditions. The region exhibits immense potential for bivoltine cocoon production, with reported yields of 50-60 kg of cocoons per ounce under optimal conditions. However, the average cocoon production in the studied districts remains suboptimal, ranging from 20-30 kg, indicating a significant gap between potential and actual yields. Indeed, a substantial yield gap exists in cocoon production, necessitating a comprehensive evaluation to identify the underlying causes and bridge this gap. In current investigation, A huge bridge gap of cocoon yield was

evaluated for season (spring/autumn). This gap may resulted due to various abiotic factors such as temperature & humidity, and biotic factors in terms of prevalence of disease. Disease prevalence mostly took place in autumn season. Also, those who use traditional methods has more prevalence of disease as compared to those who use improved technology. These observations were very similar with the studies of Sharma *et al*. (2019). Grasserie incidence was significantly high in autumn season as compared to spring in both the districts (Kathua-64% and Udhampur-49%). The result of present study revealed the high prevalence of grasserie in both districts were abundantly founded in autumn season, resulted in the decline in cocoon yield these findings were very closely related to Illahi *et al.* (2007).

Fluctuations in temperature and humidity during the rearing period disrupted the physiological balance of the silkworms, potentially compromising their health and development. Failure to maintain optimal temperature and humidity levels led to an increased susceptibility to disease outbreaks among the silkworm population which was accordance to the studies of Kant *et al*. (2024). Prevalence of disease was the foremost problem in the rearing, high wages of labor, inadequate technical guidance from extension workers, improper use of rearing equipment, resulted in outbreak of disease which in turn resulted in decline of yield which was close to the results of Balavenkatasabbaiah *et al*. (2014). This study experimentally investigated the impact of abiotic and biotic factors on the growth and development of silkworms, with a concurrent examination of the prevalence and incidence of diseases affecting silkworm populations. A significant correlation between fluctuations in temperature and humidity and the incidence of disease (grasserie) outbreaks among silkworms, ultimately leading to a decline in cocoon productivity was observed which was validated by the findings of Islam *et al.* (2018).

Conclusion

Climate played a significant and foremost role in the rearing of silkworms. Silkworm diseases were very common and can have a huge impact on farmers. The prevalence of diseases (grasserie) in silk farming was influenced by weather, rearing practices and hygiene. Disease incidence was a major factor in declined cocoon yield. Harsh climatic conditions in autumn leads to higher incidence of disease which on the other hand decrease income generation.

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