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Disease incidence of silkworm, *Bombyx mori* L. in different rearing areas and seasons of northern part of Bangladesh

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Abstract: The present investigation has concentrated to study the natural incidence of viral, bacterial and fungal diseases of silkworm, *Bombyx mori* L. in four rearing seasons *viz*. Vaduri (S-1), Agrahani (S-2), Chaita (S-3) and Jaistha (S-4) practiced in northern part of Bangladesh in four major sericulture extension areas such as, Bholahat (A-1), Chapai Nawabgonj Sadar (A-2), Mirgong (A-3) and Poba (A-4). The data were collected from the nurseries of survey areas during the years 2010-2014. Prevailing temperature (ºC) and relative humidity (%) of the rearing houses of the study areas and seasons were also recorded. The highest incidence of bacterial disease was observed in A-3 followed by A-4, A-1, and A-2. It was found that the S-3 showed the highest percentage of incidence followed by the order S-4 > S-2 > S-1. In case of viral disease the highest incidence was recorded in A-4 followed the order A-3, A-2 and A-1. The incidence of viral disease of different rearing seasons followed the order S-1 > S-4 > S-3 > S-2. But the incidence of fungal disease of different rearing areas followed the order A-3 > A-4 > A-1 > A-2 and for different rearing seasons these were S-2 > S-3 > S-4 > S-1. Environmental variations day to day, region to region and season to season emphasize the need of management of temperature and relative humidity for suppressing different diseases of silkworm.

Key words: *Bombyx mori* L., diseases incidence, rearing area, rearing season

Introduction

The silkworm, *Bombyx mori* L. is an important economic lepidopteron insect and utilized for the commercial production of the natural silk fiber. It is prone to various pests and diseases. The growth and development of silkworms are greatly influenced by environmental conditions. As a result, worms become weak and susceptible to various diseases (Rahmathulla, 2012). The incidence of different diseases differs from region to region, crop to crop, and even farmer to farmer in the same crop (Kumari *et al*., 2001). It has been found that crop losses generally more in the tropics than in the temperate region (Sengupta, 1988) which showed an annual loss due to disease at around 30% and another 5-10% due to pests. In Bangladesh, few farmers fully failed to harvest some crops, and some others, partly harvest during four rearing seasons in a year. Whereas, in temperate region, the total crop loss during a year hardly exceeds 10%. In Japan average annual loss is around 7.5% only (Sengupta, 1988). In China it was estimated that about 70-80% of the total loss of silkworms was due to viral diseases. A number of laboratory as well as field results on the incidence of bacterial and viral diseases of silkworms have been reported from India (Sidhu & Singh, 1968; Chitra *et al*., 1975; Sarat-Chandra, 1988).

The weather condition of Bangladesh and present rearing practices of silkworm greatly favour the outbreak of both bacterial and viral diseases. Most of the private farmers do not have separate and ideal rearing house; they are not trained and use the old techniques. As such 40-50% reduction of average cocoon yield at occurs during two seasons of Jaistha and Vhaduri (Barman, 1986). A laboratory investigation carried out during 1983 suffered about 21.3% larval mortality due to viral disease, 23% due to bacterial and 30% due to physiological ailments of total mortality (Barman & Pasha, 1986) accounted in a year.

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Prevention of silkworm diseases has become one of the most important aspects in the success of commercial sericulture (Biabani *et al*., 2005). In order to obtain high and stable cocoon yield it is necessary to make efforts first to decrease pathogen quantity and pathogenicity, and second to strengthen the larval health by increasing their disease resistance ability (Sidhu & Sing, 1968). The variations in the environmental conditions day to day, region to region and season to season also emphasize the need of management of temperature and relative humidity (Rahmathulla, 2012).

To date, no satisfactory reports are available on the incidence of diseases of silkworm in different rearing regions and seasons of northern part of Bangladesh. In this context, a survey was conducted. The study will hopefully be useful in understanding the role of different rearing regions and seasonal factors affecting the disease incidence in silkworm.

Materials and Methods

Collection areas and seasons: Diseased silkworm of 3rd to 5th instars were periodically collected from different silkworm rearing areas, such as Bholahat (A-1), Chapai Nawabgonj sadar (A-2), Mirgonj (A-3) and Poba (A-4) of Rajshahi division covering four rearing seasons e.g. Vaduri (S-1), Agrahani, (S-2), Chaita (S-3) and Jaistha (S-4). The recorded disease incidental data of five years' (2010-2014) for the study areas and seasons were collected from the sericulture nurseries.

Observed diseases in silkworm: Different types of silkworm diseases were observed and identified through morphological characters collected from different rearing seasons of four rearing areas. The observed diseases were bacterial, viral and fungal which were highly infectious.

Data analysis: Collected data were analyzed to calculate the percentage of incidence of bacterial, viral and fungal diseases of silkworm. Prevailing temperature (ºC) and relative humidity (%) of the rearing houses of the study areas and seasons were recorded. Data were analyzed using ANOVA.

Results

Incidence of diseases of silkworm:

Bacteria

Incidence of bacterial diseases of *B. mori* for four rearing areas of Bangladesh at different rearing seasons are shown in Table 1. The highest incidence of bacterial diseases was found in S-4 (2.70 ± 0.26) and the lowest S-1 (1.60 ± 0.13) in A-1. In A-2, the highest number was in S-4 (2.50 ± 0.79) and lowest number in S-1 (1.80 ± 0.26). In A-3, the highest number was found in S-3 (9.40 ± 3.75) and lowest in S-1 (2.70 ± 0.52). In A-4, the highest number was in S-3 (5.70 ± 1.56) and lowest in S-1 (2.40 ± 0.32). Most of the items except year and area × season showed highly significant (P<0.01).

Table 1. Incidence of bacterial diseases of silkworm, *B. mori* in different rearing seasons and areas of northern part of Bangladesh

Seasons / Areas	S-1 Mean ± SE	S-2 Mean ± SE	S-3 Mean ± SE	S-4 Mean ± SE	F-values
A-1	1.60 ± 0.13	2.30 ± 0.44	2.10 ± 0.52	2.70 ± 0.26	6.46**
A-2	1.80 ± 0.26	1.80 ± 0.39	1.90 ± 0.32	2.50 ± 0.79	1.27
A-3	2.70 ± 0.52	3.90 ± 1.05	9.40 ± 3.75	4.30 ± 1.09	10.62**
A-4	2.40 ± 0.32	3.30 ± 0.93	5.70 ± 1.56	3.90 ± 0.43	2.50

A-1= Bholahat, A-2= Chapai Nawabgonj Sadar, A-3= Mirgong, A-4= Poba; S-1= Vaduri, S-2= Agrahani, S-3 = Chaita, S-4=Jaistha, ** P < 0.01

Viral

The results of incidence of viral diseases for four rearing areas at different rearing seasons are shown in Table 2. In case of A-1 and A-3, the highest and the lowest numbers were found in S-1 and in S-2 respectively. But in A-2 the highest value was observed in S-1 (15.60 ± 3.54) and the lowest in S-4 (8.00 ± 1.95); and in A-4 the highest was in S-4 (33.90 ± 9.26) and the lowest in S-2 (13.0 ± 1.68). Analysis of variance showed highly significant differences among seasons (F= 3.60, P< 0.01) and among areas (F= 27.08 P< 0.01) at 1% level of significance but year and area × season showed insignificant results.

Table 2. Incidence of viral diseases of silkworm, *B. mori* in different rearing seasons and areas of northern part of Bangladesh

Seasons / Areas	S-1 Mean ± SE	S-2 Mean ± SE	S-3 Mean ± SE	S-4 Mean ± SE	F-values
A-1	6.80 ± 0.44	4.90 ± 0.38	5.50 ± 0.46	6.00 ± 0.46	3.60*
A-2	15.60 ± 3.54	9.20 ± 1.75	12.50 ± 2.32	8.00 ± 1.95	0.48
A-3	23.20 ± 4.42	13.20 ± 3.05	16.30 ± 4.29	19.30 ± 3.35	27.08**
A-4	33.40 ± 9.31	13.00 ± 1.68	23.00 ± 8.33	33.90 ± 9.26	1.87

A-1= Bholahat, A-2= Chapai Nawabgonj Sadar, A-3= Mirgong, A-4= Poba; S-1= Vaduri, S-2= Agrahani, S-3 = Chaita, S-4=Jaistha, *P < 0.05, ** P < 0.01

Fungal

The incidence of fungal diseases is shown in Table 3. In case of fungal diseases the highest number was found in S-2 and the lowest in S-4 (0.60 ± 0.13) in A-1 and in A-2. Season-2 showed the highest value but the lowest value was recorded in S-1 for A-3 and A-4. The items, viz. season (F=22.40) and area (F=3.98) revealed significant results (P < 0.01) but year and area × season showed insignificant results.

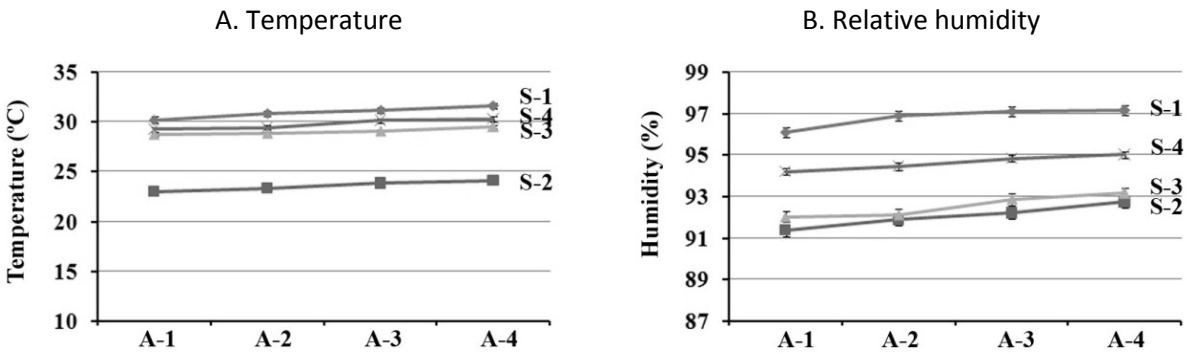
Table 3. Incidence of fungal diseases of silkworm, *B. mori* in different rearing seasons and areas of northern part of Bangladesh

Seasons / Areas	S-1 Mean ± SE	S-2 Mean ± SE	S-3 Mean ± SE	S-4 Mean ± SE	F-values
A-1	0.60 ± 0.13	3.80 ± 1.45	2.90 ± 0.56	0.60 ± 0.13	22.40**
A-2	0.70 ± 0.16	4.10 ± 1.28	3.20 ± 0.97	0.50 ± 0.00	1.58
A-3	0.70 ± 0.16	9.30 ± 3.04	3.60 ± 1.68	1.00 ± 0.20	1.58
A-4	0.60 ± 0.13	7.80 ± 2.19	4.90 ± 1.98	0.90 ± 0.13	2.08

A-1= Bholahat, A-2= Chapai Nawabgonj Sadar, A-3= Mirgong, A-4= Poba; S-1= Vaduri, S-2= Agrahani, S-3 = Chaita, S-4=Jaistha, ** P < 0.01

Temperature and humidity

Among different rearing seasons the highest temperature were recorded in S-4 followed by S-3, S-2 and S-1, and the humidity were in the orders S-1>S-4>S-3>S-2. Among different rearing areas the highest temperature and humidity were observed in A-4 followed by A-3, A-2 and A-1 for all the seasons (Fig. 1).



A-1= Bholahat, A-2= Chapai Nawabgonj Sadar, A-3= Mirgong, A-4= Poba; S-1= Vaduri, S-2= Agrahani, S-3 = Chaita, S-4=Jaistha

Fig. 1. Average room temperature and relative humidity in different rearing seasons and areas

Discussion

Disease is very common incidence in sericulture industry because *B. mori* is very sensitive insect. It affected by various types of diseases due to virus, bacteria and fungus. The incidence of these diseases was varied in different countries, regions, crops and even in farmers. Five years (2010-2014) data were collected to find out the natural incidence of viral, bacterial and fungal diseases of silkworm in four rearing seasons practiced in Bangladesh in four major sericulture extensions areas.

The highest incidence of bacterial disease was observed in A-3 followed by A-4, A-1, and A-2. It was also found that the S-3 showed the highest percentage of incidence and followed the order S-3>S-4>S-2>S-1. Among different rearing areas the highest temperature and humidity were observed in A-4 followed by A-3, A-2 and A-1 for all the seasons. Anitha *et al.* (1994) reported the bacteria as the etiological agent of flacherie in silkworms as early as 1870. The major factor responsible for bacterial flacherie was the rearing conditions. The rise in temperature and humidity in rearing place leads to dysfunction of alimentary canal which encourages flacherie (Nataraju *et al*., 2005). This is also due to poor quality of mulberry leaves. The leaves of poor nutritive value cannot provide sufficient quality of essential requirement to the larva to produce antibacterial factor, which results in high rate of multiplication of infectious bacteria and development of bacterial flacherie (Nataraju *et al*., 2005).

B. mori L. is prone to bacterial infection. The pathogen is difficult to be detected at early stage of infection, as the discernible morphological symptoms are developed at late stages of infection (Shamim *et al*., 1996). Since there are no specific preventive measures for the occurrence and spread of disease other than sanitized breeding and rearing methods, the only commercial practice is to discard large stock of worms in case of infection to avoid the spread of disease (Acharya *et al*., 2002).

In case of viral disease the highest incidence was recorded in A-4 followed the order A-3, A-2 and A-1, and the incidence of viral disease of different rearing season followed the order S-1 > S-4 > S-3 >S-2. Different parameters affect disease spread, among which environmental conditions are highly significant in the larval response to NPV (Krishnaswami *et al*., 1978). Barman (1988) reported that the seasonal effect was highly significant. Pasha & Alam (1998) surveyed at Bholahat and Mirgong extension areas under Chapai Nawabgang and Rajshahi district of Bangladesh. Highest number of diseases was found in Bholahat and the lowest in Mirgong.

Observation through different environmental conditions like high temperature (<28^{0}C) or high relative humidity (<80%) with wide range of fluctuation or a combination of both essential for the development of viral diseases which is in close agreement with the observation of Aruga (1961). This finding also corroborates the observation of Aratake *et al.* (1973) who pointed out that high temperature 30^{0}C as well as the low temperature below 15^{0}C, in nutrition overcrowding and certain chemical act as the stressor of viral diseases.

The incidence of fungal disease of different rearing areas followed the order A-4 > A-3 > A-2 >A-1 and in case of different rearing seasons they followed the order S-2 > S-3 > S-4 >S-1. During that time the temperature and humidity were in the orders A-4> A-3> A-2> A-1. The highest temperature was in A-4 of S-1 and lowest temperature was in A-1 of S-2. Pasha & Alam (1998) reported that the incidence of white muscardine disease of silkworm is very common during October-November (Agrahyoni) and February- March (Chaita) seasons in Bangladesh except in other seasons. They reported that the incidence of disease was higher at Bholahat than Mirgong.

The experimental results presented in the several promising guidelines for suppressing different diseases of silkworm. However a complete suppression was not achieved. In discussing the result one thing is clearly understood that in controlling these diseases, optimization of the rearing environment should be major factor of consideration. But in reality and practices, seasonal condition is not be avoided by any means. Therefore, control the bacterial, viral and fungal pathogens must be accompanied by the prevailing situation of weather condition, especially temperature, humidity and their fluctuation.

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