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Silkworm Diseases and Pests

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Silkworm diseases are a major challenge in sericulture because they directly reduce cocoon quality and silk production. The most common diseases affecting silkworms include Pebrine, Flacherie, Septicemia, Sotto, Court, Grasserie, Infectious Flacherie Virus (IFV), Gattine and Muscardine. These diseases are caused by pathogens such as protozoa, bacteria, viruses, and fungi. In addition to the disease several pests also attack silkworms and their rearing environment. Important pests include the Uzi Fly, Dermestid Beetle and ants which harm the silkworm larvae or damage cocoons. In conclusion, maintaining proper hygiene in rearing houses, using disease-free layings (DFL eggs), controlling temperature and humidity, and regular monitoring of silkworm health are essential to prevent and manage these diseases. Effective disease control not only protects the silkworm population but also ensures higher cocoon yield and better quality silk, which is important for the sustainability and profitability of the sericulture industry.

Keywords: *Bacillus bombycis*, *Bombyx mori*, *Exorista sorbillans*, *Nosema bombycis* and *Serratia marcescens*

Introduction

Diseases of silkworm are a big challenge for the rearers or sericulturist. Due to prolong domestication, silkworm develops less immunity and less adaptability for which they are often attacked by different agents. Although some attempt has been made to develop disease resistant silkworm variety, but only a limited success is obtained till date. Silkworm (*Bombyx mori* L.) has very weak immune system to combat pathogens causing various diseases (Govindhan *et al.* 1998). Domestication of this insect for thousands of years might have caused reduction or even loss of natural resistance/tolerance to certain pathogens. Tropical races of *Bombyx mori* have higher degree of tolerance to pathogens than bivoltine and univoltine races. The higher incidence of diseases in *Bombyx mori* during autumn than in spring crop. The extent of cocoon crop loss during autumn is reported to the tune of 35–47 %, while it is 15–20 % in spring season in north India. There is no race of *Bombyx mori* complete by resistance to diseases and pests. There are two ways to control infection of diseases in silkworms (Watanabe 2002). In spite of taking many efforts on the rearing environment, silkworms are vulnerable for infection of the following agents or pathogens-

1. Pebrine disease ⇒ Protozoal Disease
 2. Flacherie disease
 3. Septicemia disease
 4. Sotto disease
 5. Court disease
 6. Grasserie disease
 7. Infectious Flacherie Virus (IFV)
 8. Gattine disease
 9. Muscardine disease ⇒ Fungal Disease
- } Bacterial Disease
- } Viral Disease

1. Pebrine Disease: This is one of the most virulent protozoan diseases. The disease is caused by protozoa- *Nosema bombycis*. NIK-2r, NIK-3h and NIK – 4m are the three most virulent strain of this pathogen found in India. The protozoa complete its life cycle through two stages- infective spore stage and vegetative stage.

Symptoms: It affects all stage of the silkworm species viz., Egg, Larva, Pupa and Adult. Hence symptoms may visible on all the stage of silkworm

1. Infected egg exhibit less attachment with the egg cards due to improper deposition of glue.
2. Eggs turn pale yellow and may fail to hatch.
3. Primarily infected larvae normally die before exhibiting any prominent symptoms, while secondary and tertiary infected larvae shows symptoms like loss of appetite, unequal body growth, and clean worm symptom due to irregular and incomplete moulting.
4. Infected worm also shows some piper like black spots on the body, irregular brown patches resulted due to dead hypodermal cells, spitting or wasting of silk instead of spinning cocoon, passing of soft faeces and generally die after spinning pupating.
5. Live infected pupa if present inside cocoon or if they infected at the pupal stage only they show black colour, swollen body with black spote on either sides of the abdomen.
6. Infected adult moth show black spots on the abdomen, deformed antennae, unstretched and discoloured wing.
7. Adult female usually laid eggs in irregular loose heaps. Body scales also fall off easily.

Management:

1. Only disease free layings are allowed for rearing in the grainages.
2. If diseased larvae detected in the rearing bed they should be removed immediately and burnt.
3. All rearing appliances including the rearing room should be disinfected with 4-5% formalin or bleaching powder. For rearing accessories instead of routine formalin benomy/ Bavistin/Bengard etc. can be used.
4. Disease resistant races (e.g. Nistari) can be considered for rearing.

2. Flacherie disease: Silkworm suffering from this disease exhibit diarrhea and vomiting. It is caused by *Bacillus bombycis*, *Bacillus sotto*, *Streptococcus bombycis*, and *Pseudomonas aeruginosa*.

Symptoms:

1. Lack of appetite. Diarrhoea and vomiting occur as common symptoms.
2. Growth stunted and shrinkage of the body observed after moulting.
3. Skin become loose and soft and exhibit sluggish movement.
4. Body colour become dull to black-brown and emits foul smell.
5. The larvae show signs of pain and convulsions and ultimately die.

Management:

1. Through maintaining optimum humidity and temperature in the rearing room.
2. Providing healthy and disease free leaves to the rearing bed.
3. Disinfection of the rearing room and the rearing appliances with 2% formalin should be done regularly

3. Septicemia disease: It occurs due to infection of haemolymph by bacteria. It mainly causes by the infection of *Bacillus*, *Streptococcus* and *Staphylococcus* bacteria. Transmission of the disease occurs through intake of contaminated leaves and wounds in the skin.

Symptoms:

1. Larval body exhibit softening and colour changes to brown.
2. Larvae release liquid excreta.
3. Loss of clasping power and death occurs frequently.

Management:

1. Proper sanitation hygiene should be maintained in the rearing room.

2. Infected larvae should be immediately removed from the bed to prevent spreading of the disease.
3. Handling of larvae should be done carefully to reduce skin wounds.

4. Sotto disease: This disease is caused by some bio-insecticidal bacteria. For e.g., *Bacillus thuringiensis*, which is widely used as a bio-insecticide releases some endotoxin thuricide. When the larva consumes the toxin two types of effects occur. In one type the larvae of *Bombyx mori* stop feeding, haemolymph turns alkaline and paralysis occurs within 60-80 minutes of contact. In another type lepidopteran larva only shows rapid inhibition of feeding.

Symptoms:

1. Loss of appetite, sluggish movement, shrinkage of skin and diarrhea.
2. Loss of clasping power of prolegs, Body turns black after death and foul smell emits from the body.

Management:

1. Cleaning of rearing room with hot water to inactivate the toxins.
2. Immediate removal of the infected or dead larvae from the rearing bed, bacterial spores should be destroyed by exposing to 2% formaldehyde for 3hrs or 100°C for 5 minutes.

5. Court Disease: It is caused by the infection of bacteria *Serratia marcescens* and *Serratia piscivora*.

Symptoms:

1. Dead larvae turn flaccid and the colour changes to crimson red.
2. This disease is also commonly known as Rangi due to this formation of colour.

Management:

1. Maintenance of the hygienic rearing room.
2. Removal of dead or infected larvae.
3. Cleaning of appliances with 2% formaldehyde are the measures for the diseases.

6. Grasserie disease: It is caused by Virus viz., **Bm NPV (*Borrelina virus*)** Nuclear Polyhedrosis Virus and infects only larval stage. This disease is characterized by the jaundice like symptoms which are collectively known as Grasserie- or Polyhedrosis.

Symptoms:

1. Formation of loose and shiny white skin with swellings in the inter segmental zones.
2. Release of milky white or yellowish fluid from the body containing polyhedra. Infected larvae turn restless and do not undergo moulting.
3. Translucent cephalothorax and opaque mid gut observed due to accumulation of polyhedra in the cytoplasm.

Management:

1. Maintenance of hygienic environment, proper ventilation in the rearing room.
2. Sterilization of the rearing room with 2% formaldehyde or Bleaching powder or Resham Keed Oushadh (RKO) or Labex.
3. Immediate removal of dead or infected larvae from the rearing bed.
4. Oral administration of nalidixic acid, P- aminobutyric acid etc. or topical application of imanin can control NPV to some extent.

7. Infectious Flacherie virus: - Infectious Flacherie Virus (IFV or BmIFV) is a highly contagious, positive-sense single-stranded RNA virus in the genus Iflavirus.

Symptoms:

1. It infects the midgut epithelium; causing sluggishness.
2. Vomiting, swollen, translucent thoraxes of larva.

Management:

1. Feeding the larvae with healthy and hygienic leaves.
2. Maintenance of proper hygiene of the rearing room.
3. Disinfection of rearing appliances with formalin.

8. Gattine disease: Gattine is a severe, often fatal, infectious disease in silkworms caused by a combined infection of a sub microscopic virus and secondary bacteria (*Streptococcus bombycina*), typically occurring in summer/rainy seasons. It presents as "clear head" or "translucent" disease. This disease is also known as **Clear head disease**.

Symptoms: Vomiting, diarrhea, sluggishness, and reduced appetite.

Management: Supplying of proper healthy leaves hygiene in the rearing room and avoids excessive moisture in the Rearing room.

9. Muscardine disease: It is highly contagious fungal disease of silkworms primarily caused by *Beauveria bassiana* (White Muscardine), *Spicaria prasina* (Green Muscardine) and *Iscaria farinosei* (Yellow muscardine). It affects the larva, pupa and Adult stage of the silkworm. It prevails during rainy/winter season < 23°C temperature and Humidity >80% are suitable for fungal growth. In muscardine the body of the larvae get mummified due to deposition of calcium oxalate. Hence the disease is also called as 'calcino'.

Symptoms:

1. Sluggish movement of the larvae, loss of appetite, vomiting, shrinkage of body with loose cuticle are observed.
2. Larvae infected at the early stage do not spin, but those infected late may spin cocoon where the pupa die inside.
3. Dead larvae generally covered with the spores of the infected fungi or may be mummified with white powdery material.

Management:

1. Proper light, humidity and aeration should be maintained in the rearing room.
2. Any factors that may help the growth of fungi should be avoided.
3. Temperature should be kept above 20°C.
4. Infected larvae should be removed immediately and buried in a deep pits.
5. For the preparation of bed 0.45 formalin seed husk can be used for 1st and 2nd instars, 0.5% for 2nd and 3rd instars. 0.6% for 4th instars and 0.8% for 5th instars.
6. During moulting after every cleaning operation dithane-M45 and kaoline can be applied to prevent the germination of fungal spores if any.
7. For every 100 layings, 3-4kg of Resham Keed Oushadh (RKO) can be spread after each moulting and 30 minutes before the larvae resume feeding.

Enemies or Pest of Silkworm

The various enemies that attack silkworms are

1. Uzi fly
2. Beetles
3. Ants
4. Lizards, birds, rats and squirrels

1. Uzi fly (Tachinidae: Diptera): The flies lay eggs on grown up larvae of silkworm and maggots on hatching eat away the body contents of caterpillar as well as hole in cocoons. Two well known Indian variety of this fly are *Tricholyga bombycis* and *Exorista sorbillans*. Legless maggot penetrates into the body of the silkworm larvae by making a hole in the cuticle. The maggot then consumes the larval tissues and completes the instars and come out from the body of the host for pupation. The host larvae die in the process.

Symptoms:

1. Infected larvae show black spots on the body, which are actually the entry points of maggot.
2. Larvae lose body weight due to loss of tissue.
3. Exhibit sluggish movement and stop feeding.

Management:

1. Uzinet (A nylon net of fine mesh) can be used to prevent the entry of Uzi fly to the rearing room.

2. Uzicide or Vijeta can be spread on rearing tray to kill the uzi eggs without hampering the normal growth of the silkworm larvae.
3. Biological control can be applied by introducing natural predators like *Neolynx thymus* (Eulophidae:Hymenoptera).

2. Beetles (Dermestidae: Coleoptera): The adults and grubs of *Dermestes cadaverinus* (Coleoptera) and other demestid beetles are attracted to smell of the cocoons. They eat the cocoons, enclosed pupae and often the eggs of silkworms. The females lay eggs in the crevices, organic matter and wooden boards.

Management:

1. Closure of cracks and crevices.
2. Thorough cleaning of rearing room.
3. Fumigation of rooms with methyl bromide.

3. Ants: Ants are major predators of silkworm larvae, particularly in outdoor and indoor rearing systems like Weaver Ant (*Oecophylla smaragdina*), *Myrmecaria brunnea* (Saunders) and *Monomorium* species (e.g., *Monomorium destructor* and *Monomorium minimum*) infest the larva of silkworm.

Management:

1. Legs of the rearing stands should be dipped in ant wells (water + kerosene).
2. Use of ash or kerosene at the handles of the mountages at the time of spinning

4. Lizards, birds, rats and squirrels: These are directly feed on silkworms' larva.

Management:

1. Rearing rooms should be kept free from lizards.
2. Setting of traps for rat and squirrel control.
3. Scaring of birds (Use Bio acoustic or reflective ribbons) from the vicinity

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