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A Comprehensive Review of *Spodoptera litura* and Helicoverpa armigera

[1]* *Sirnaik Rohan*

[1]* *Research Scholar, PG Department of Agrochemicals and Pest Management, Devchand College, Arjunnagar, (MS) India.*

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***Corresponding Author**

Email: sarnaikrohan65@gmail.com

ABSTRACT

Abstract:

Spodoptera litura (tobacco cutworm) and Helicoverpa armigera (cotton bollworm) are two of the most destructive polyphagous lepidopteran pests affecting agricultural and horticultural crops worldwide. Both species exhibit wide host ranges, attacking more than 100–150 plant species including economically important crops such as cotton, tomato, chickpea, maize, and groundnut, leading to significant yield losses and economic damage.Their high reproductive potential, adaptability to diverse agro-climatic conditions, and capacity for multiple generations per year contribute to their persistent infestation and outbreak potential. Biologically, these pests undergo complete metamorphosis with highly voracious larval stages responsible for severe defoliation, fruit boring, and destruction of reproductive plant parts. H. armigera is particularly noted for its mobility, diapause capability, and aggressive feeding behavior, while S. litura is recognized for its gregarious early larval stages and rapid defoliation ability. Their polyphagous nature and overlapping ecological niches make them major constraints in sustainable crop production, especially in tropical and subtropical regions. Management of these pests remains challenging due to the rapid development of resistance against conventional chemical insecticides and the associated environmental and ecological concerns. Excessive pesticide use has led to resistance, pest resurgence, and negative impacts on non-target organisms. Consequently, integrated pest management (IPM) strategies involving biological control agents, botanical pesticides, resistant crop varieties, and cultural practices are increasingly emphasized. Recent research highlights the potential of microbial metabolites, plant extracts, and novel insecticide molecules as eco-friendly alternatives for effective control. In conclusion, S. litura and H. armigera continue to pose serious threats to global agriculture. A comprehensive understanding of their biology, ecology, and resistance mechanisms is essential for developing sustainable and integrated management approaches to minimize crop losses and ensure food security.

1. Introduction

Insects are the main source of biotic stress on crops. The study of insect pests is an important part of Entomology especially in understanding their biology, behavior and management There are hundreds of insects that can cause serious damage to crops. Lepidoptera is second most diverse pest insect order outnumbered only by the beetles. Among the major agricultural pests, Helicoverpa armigera and Spodoptera litura are of great economic significance due to their wide host range and destructive feeding habits.. There is hardly any cultivated plant that is not attacked by the lepidopteran pest. .Helicoverpa armigera (Hubner) is most common and critical challenge for chickpea productivity around the world (luckmann and metacalf ,1975; Ujjan et al.,2019; Jai et al., 2020). In case of outbreaks, yield losses caused by chickpea pod borer range from 10-90 percent depending upon the insect population and susceptibility of genotypes.(Sharma et al., 2012). Helicoverpa armigera is highly polyphagous pest that also attacks crops such as cotton , tomato,maize etc. it causes severe damage during the larval stage by feeding on reproductive parts like buds, flowers, and fruits leading to significant yield loss. Its high reproductive capacity adaptability to different environmental conditions and resistance to many insecticides make it a challenging pest to manage..The tobacco cutworm, Spodoptera litura (Fabr.) (Lepidoptera: Noctuidae), is global agricultural pest. It is highly polyphagous, able to feed on many families of plants, including important crops such as cotton, beans, tobacco, vegetables and rice (Dhir et al., 1992 Qin et al., 2004, Zhou, 2009,Ahmad et al., 2013). The larvae feed gregariously in early stages and skeletonize leaves, while later instars disperse and consume large quantities of foliage..Heavy infestation can result in complete defoliation of crops. laboratory rearing of these insects plays a crucial role in studying their life cycle, development biology and behavior. It also provide a continous supply of test insects for evaluating insecticides biological control agents and other pest management strategies. Understanding their rearing techniques is essential for advancing research in pest control and sustainable agriculture.

2. Material:

2.1. *Spodoptera litura*

Geographical Distribution

Spodoptera litura has a wider global footprint covering Asia, Europe, Africa, Ocenia, and recently south/central America.It is widely distributed in Asia including India, Pakisthan, China, Korea, Japan and Australia .its presence is common in Pacific islands, Hawaii and parts of Africa .it is known for migratory activity and expansion in monsoon seasons, particularly in Southeast Asia and South China.

Morphology:

The morphology of Spodoptera litura can be described across its life stages. The egg is spherical and small 0.5mm in diameter. It is creamy to yellow in color. *Spodoptera litura* laid eggs in clusters on leaf surfaces. The larva is the most destructive stage .Its length is upto 35-40 mm when fully grown and greenish to dark brown in colour. Prominent longitudinal stripes along the body, dorsal side often has dark triangular or semicircular markings. The third stage is pupa and its length is 15 – 20 mm, reddish brown to dark brown. It is smooth and cylindrical in shape, found in soil. The adult (moth) is medium sized with wingspan 30-38 mm. Its forewings are brownish with complex patterns with distinct pale wavy lines and spots, hindwings are whitish with dark margin. Body is stout, covered with scales, Antennae are filiform in both sexes. Females are slightly larger and lighter in colour.

2.2. Helicoverpa armigera

Geographical Distribution

Helicoverpa armigera is extensively distributed Africa, Asia and Europe, widely established in South America and parts of Central America. It is highly migratory, enabling it to inhabit diverse climatic conditions across the old world.
The former sub-species have also recently been confirmed to have successfully invaded brazil and have since spread across much of south America and reached the Caribbean (Czepak et al., 2013).

Morphology:

Helicoverpa armigera is a holometabolous with a complete life cycle of egg, larval, pupal and adult stages. The mature *H.armigera* moth has a dull black border on its hindwings and a V shaped spot on its forewings. It is brown in colour. The insect lays one egg per host plant and it takes 4-7 days for the egg to hatch. When the larva reaches maturity, it is about 2 inches long , greenish with brown gray lines and has dark and pale stripes on its dorsal side. The sixth larval instars occur through

3. Methodology:

3.1. Mass rearing of *Spodoptera litura*

Egg mass and different larval stages of *S. litura* were collected from tobacco field located around Devchand college, Kolhapur, Maharashtra . The collected larvae were reared individually in plastic container and fed regularly with caster leaves (*Ricinus communis*) until the larve became pupae under the laboratory conditions at 27+1 and 75+5% relative humidity with natural photoperiod**.** Sterilized soil was provided for pupation. After pupation the pupa were collected from soil and placed inside the rearing cage. After adult emergence cotton soaked with 10% honey (sugar) solution mixed with a few drops of multivitamin was provided for adult feeding.

3.2. Life cycle of *Spodoptera litura*

Under favorable conditions, the pest completes its life cycle in about 25 days, enabling rapid population buildup and frequent out breaks (Kumar and Bhattacharya,2019; Kumar and Prasad, 2020). Female moths can lay around 850 - 900 eggs during their life span, often in clusters on the underside of host plant leaves. After hatching, the larvae progress through six distinct instar before pupating.

- **Eggs**
  The egg masses of *S. litura* were found on upper surface of tobacco leaves. In cluster the eggs were covered with pale brown scales from abdominal tip of gravid female which look alike hairs. The incubation period of eggs varied from 4 to 5 days.
- **Larva**
  First instar

Newly hatched neonate larvae were tiny, blackish green colour. Dark black head consist clearly visible black hairs on the body and minute black spot on first abdominal segment and which become yellowish green in colour. First instar larval period lasted for about 2-3 days.

Second instar
This instar larval found hairless, pale green in colour and red longitudinal line was visible on the thorax region of larva. This instar larval stage duration is 2-3 days.

Third instar
Third instar larva was distorted their body colour and red longitudinal black line was appeared on the thorax region of larva. Third instar larval period was 3-4 days.

Fourth instar
This instar was the shortest developmental period compare to other larval instars. This instar larva was dark also blue green in colour. This stage lasted for only 1-1.5 days.

Fifth instar
Fifth instar larva was dark blackish brown in colour. on the dorsal side of the larva three lines were appears with small spots. This instar period lasted for 2 days.

Sixth instar
Fully grown larvae were stout and smooth with scattered short setae. Head capsule was shiny black and conspicuous black tubercles. Colour of fully grown larvae was not constant it may varies from dark gray to dark brown or brown, sometimes marked with yellow dorsal lateral stripes of unequal width. Mature larvae were 40 to 50 mm long. Sixth instar larval stage takes 2.5 to 3 days. The total larval period was of 12 to 14 days.

- **Pre-pupal period**
  The pre-pupal period lasted from 1.5 to 2 days. Fully developed larvae do not feed, become sluggish and enter inside the soil layer. The larva ceased drilling hole in to soil about 3-5cm for preparation of pupation.
- **Pupa**
  Newly formed pupa was pale yellow in colour and later turn into shiny dark reddish brown colour. Sexes were easily distinguished by distance between anal pore 25 and genital pore as well as abdominal shape. Female pupae were slightly bigger than the male. Pupal period was 7-10 days.

- **Adult**
  Moths were brown with complex pattern of creamy colored crisscrossing markings on the forewings. The hind wings were silvery white in colour. Males were prominent white band on forewings and more active and fluttering followed by mating occurs generally night time longevity of female was more 8-10 days than the male 7-8 days.

4. Mass rearing of Helicoverpa armigera

Larvae of *H.armigera* were collected from infested chickpea fields located around Devchand College, Kolhapur, Maharashtra. The larvae were feed with fresh tomato leaves in the laboratory at 26 + 1 ^{0}C, 13+1 hrs photophase,11+ 1 hrs Scotophase, and 75 + 5% relative humidity. After emergence, adults were released into the oviposition chambers for egg laying and provided with 20% honey solution. Fresh tender tomato leaves were kept inside the chambers to stimulate oviposition. The eggs were kept in hatching chambers at 75^{+}_ 5% relative humidity. Newly hatched larvae were maintained on the natural diet. Third instar larvae were used for bioassay.

Life cycle of *Helicoverpa armigera*
The life cycle of helicoverpa armigera is influenced by various biotic and abiotic factors such as temperature, host availiability and environmental condition. This resilience is due to its traits such as being polyphagous, highly adaptable to enter facultative diapauses. (Yadav et al., 2022)

- **Eggs**

Spherical eggs were yellowish white in colour when laid but later turns into dark brown colour as they matured. They laid singly with 0.4 to 0.6 mm in diameter. When eggs close to hatching at that time black head capsule is visible through the egg shell. Average incubation period was 3 to 4 days.

- **Larva**

  First instar

  Newly hatched neonate larvae were very sluggish, pale and translucent. Negatively photo tactic. They consume their egg shells and after 2 to 4 hours they become active and search for suitable food. First instar larval period is about 2-3 days.

- **Second instar**

  Second instar larval head and thoracic legs were black in colour. The dermal spinulation was more prominent. This instar larval stage duration lasts 2-3 days.

- **Third instar**

  Third instar larva was with pale brown head consist two tiny lateral stripes, thoracic legs and anal shields were black. Dorsally body was convex and ventrally flat. This stage duration is about 3-4 days.

- **Fourth instar**

  This instar larva was appeared like third instar with brownish green in colour. Three lines were visible with small spots on dorsal side of the larva. This stage lasted about 4-5 days.

- **Fifth instar**

  Fifth instar larva was including brownish head. Fine pale setae were observed. This instar period lasted for 4-5 days.

- **Sixth instar**

  Sixth instar larval head thoracic and anal shields were dark brown. Fully grown larvae had reddish brown head. Pro thorax was more brownish as compared to mesothorax and meta thorax. Small white bristles were spread all over the body. Tubercles and spiracles of the larvae were brownish to blackish giving them a spotted appearance They exhibit body colour polymorphism. Mature larvae were 30 to 35 mm long. Sixth instar larval stage takes 4-6 days. Total larval period was of 18 to 20 days.

  Pre-pupal period

  The pre-pupa was appeared as light green yellowish in colour but later on it becomes dark brown, sluggish, wrinkled full grown larvae were with suspended feeding. The pre-pupal period lasted from 1-3 days.

  Pupa

  The pupa was mahogany-brown in color and object type. Body is rounded both anteriorly and posteriorly, with two tapering parallel spines at posterior tip. Pupal period was 13 to 15 days.

  Adult / Moth

  The adult moth was stout bodied with broad thorax. The male moth was pale greenish colour with V shaped speck and female appeared like pale brownish yellow snout moth. Moths were active throughout the night only and they were attracted towards light. They have yellowish margins and strongly marked veins. It was fascinatingly noticed that the females emerged earlier two days than males. .Adult males longevity takes 6-8days and 8-10 days in case of female. Entire life cycle duration is about 40-47 days.

5. Results and Discussion

The laboratory rearing of *Helicoverpa armigera* was successfully carried out under controlled conditions. He insect completed its life cycle from egg to adult stage

- Eggs hatched within 2-4 days.
- Larva passed through 5-6 instars over 2-3 weeks.
- Pupation occurred in soil or artificial medium and lasted 7-15 days.
- Adults emerged successfully and were able to mate and lay eggs, continuing the culture.

Healthy growth and survival indicated that the provided diet and environmental conditions (temperature, humidity and light) were suitable for rearing.

The successful rearing of *Helicoverpa armigera* demonstrates the importance of maintaining optimal environmental and nutritional conditions. Temperature around 25-28c and relative humidity of 60 to 70% are ideal for its development. Any deviation can slow growth or increase mortality.
Larval stage is the most active and destructive phase requiring adequate nutrition. Cannibalism is a common behavior in later instars, so individual rearing or sufficient spacing is necessary to improve survival rates. The use artificial diet helps maintain uniform growth and reduces dependency on seasonal host plants.
Pupation success depends on providing a suitable medium like moist soil or sand Improper pupation conditions may lead to deformities or failure in adult emergence.
Adult moths require a carbohydrates source like honey or sugar solution for longevity and reproduction. Proper mating conditions space, light cycle ensure continues egg production
Overall, rearing *Helicoverpa armigera* in the laboratory is essential for

- Studying life cycle and behavior
- Testing insecticides and biocontrol agents
- Supporting research in entomology and pest management.

It is important to follow recommended fertilizer dose and practice judicious water management to prevent excessive vegetative growth, which can create harborage for larvae (Patil et al., 2017; Mahmood, 2021)

Result

The laboratory rearing of *Spodoptera litura* was successfully completed under controlled conditions. The insect developed through all life stages.
Eggs hatched within 3-5 days.
Larvae passed through 5-6 instars over 2-3 weeks.
Pupation occurred in soil or rearing medium and lasted 7-12 days.
Adults emerged normally mated and laid egg masses, ensuring continuation of the culture.
The survival rate was satisfactory indicating that the environmental conditions and diet provided suitable for its growth and development.

Discussion

The successful rearing of *Spodoptera* highlights the importance of maintaining appropriate environmental factors such as temperature (25-28 C) and relative humidity 65 -75 %. These conditions favour rapid development and higher survival rates.
The larval stage is the most active feeding stage and requires a nutrient rich diet host leaves or artificial diet. Early instar larvae show gregarious behavior, feeding in groups while later instars become solitary and highly voracious. Overcrowding during later stages can lead to cannibalism, so proper spacing or individual rearing is necessary.
Pupation requires a suitable medium such as moist soil. Improper conditions can result in failed pupation or malformed adults.eg sugar or honey solution to enhance longevity and fecundity.
The rearing of *Spodoptera* is important in

- Studding insect biology and life cycle
- Screening insecticides and biocontrol agents
- Research in entomology and integrated pest management.
- Overall, the experiment confirms that *Spodoptera litura* can be efficiently mass reared in laboratory conditions with proper care making it suitable for experimental and applied research purposes.

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