Introduction to Insect Pests of Sesame (*Sesamum indicum* L.) and Their Management: A Review

Commented [B1]: Remove all capital letters except first letter

Abstract

Sesame (*Sesamum indicum*), a valuable oilseed crop, is affected by a variety of insect pests that cause significant yield losses. The most common pests include the leaf webber and capsule borer, gall fly, whiteflies, bud fly, bihar hairy caterpillar and hawk moth *etc.* These pests can damage sesame plants at various stages of growth, leading to reduced seed quality and productivity. This review discusses the key insect pests of sesame, their life cycles, and the economic damage they cause. Additionally, it highlights various pest management strategies, including cultural, mechanical, biological, and chemical control methods, with a focus on integrated pest management (IPM) practices. The role of resistant varieties, organic products such as neem-based formulations, and biological control agents like fungal pathogens is explored. The review emphasizes the importance of eco-friendly and sustainable pest control methods to ensure higher yields and improved profitability for sesame growers.

Keywords: Integrated pest management, sesame, *Antigastra catalaunalis* and *Bemisia tabaci.*

1. Introduction

Sesame (*Sesamum indicum*), also known as "queen of oilseeds," is one of the oldest cultivated crops, valued for its high-quality oil and nutritional benefits (Parveen *et al.*, 2024a). It is grown widely in Asia, Africa, and parts of Latin America, contributing to the livelihoods of smallholder farmers. However, sesame is particularly vulnerable to a range of insect pests throughout its growth cycle, from seedling emergence to harvest. These pests can cause severe damage, leading to reduced plant vigor, loss of seed production, and diminished oil quality. Given the increasing demand for sesame oil and seeds in both domestic and international markets, effective pest management strategies are crucial for maintaining high yields and quality. India, being one of the major producers of sesame, plays a crucial role in its global production and export (Parveen *et al.*, 2024b). Sesame is one of the world's oldest oil seed crop grown mainly for its seeds that contain approximately 48 to 52% oil and 25% protein (Kiran *et al.*, 2023).

2. Insect Pests

2.1. Gall Midge, *Asphondylia sesame* Felt, Cecidomyidae, Diptera

The sesame gall midge is one of the most significant pests affecting sesame production, particularly in Africa and Asia. The larvae of this fly feed on developing flower buds, causing the formation of galls, which prevent flower opening and seed setting. Infestation by *Asphondylia sesami* can result in significant yield losses, with some fields experiencing total crop failure in severe outbreaks. The incidence of this insect pest is noticed from September to November and coincides with flowering to capsule formation stage of the crop. Even though not yet quantified, estimated yield reduction could reach more than 30% in heavy infested years (Panday *et al.*, 2021). Biology of *Dasyneura* was studied by Prasad (1967) and stated that clear humid weather is more suitable for oviposition. This pest completes two to three overlapping generations during August to October.

2.2. Leaf Webber and Capsule Borer, *Antigastra catalaunalis* Duponchel, Crambidae, Lepidoptera

The sesame leaf webber and capsule borer is a widespread pest found in many sesame-growing regions. The larvae of this moth feed on the tender leaves, flowers, and pods of sesame plants. They spin webs around the foliage and bore into the capsules, causing direct damage to seeds and reducing both yield and oil content. The pest has been observed to cause 10-70% infestation of plants, 1.0-43.5% infestation of capsules and 8.86 to 71.53% yield loss (Menon *et al.*, 1960). Severe infestations can lead to defoliation and stunted plant growth. Cheema and Singh 1987 reported that this pest is active throughout the year and did not hibernate or aestivate. The period from April to June was passed on stray plants and early sown sesame inter cropped with cotton. The larval stage lasted between 9.85 and 10.24 days, with an average duration of 9.99 days. Before adult emergence, the pupa turned brown. The pupa's length ranged from 6.87 to 7.39 mm, averaging 7.11 mm, while its width varied between 1.18 and 1.30 mm, with an average of 1.23 mm. The pre-oviposition period of the female moth ranged from 9.85 to 10.30 hours, with an average of 10.05 hours. The oviposition period for *A. catalaunalis* females was between 4.30 and 4.60 days, averaging 4.43 days. The total life cycle of *A. catalaunalis* ranged from 18 to 40 days (Athya and Panday, 2020a).

2.3. Aphids, *Aphis gossypii* Glover and *Aphis craccivora* Koch, Aphididae, Hemiptera

Commented [B2]: Arrange the insect order wise lepidoptera, Hemiptera, Mite, Diptera likewise first chewing insects and then sucking insects pests.

Commented [B3]: Remove caps

Commented [B4]: Add in second line after Africa and Asia.

Commented [B5]: Place it into a new line et al in same line

Commented [B6]:

Commented [B7]: Add reference

Aphids are sap-sucking insects that infest sesame plants, feeding on the leaves, stems, and pods. These pests ~~not only~~ cause direct damage by extracting plant sap, which leads to stunted growth, yellowing of leaves, and reduced photosynthesis, ~~but~~ they also act as vectors for viral diseases such as sesame leaf curl virus (SLCV). Aphid infestations are common in warm, humid conditions and can lead to substantial losses if not managed early (Langham, 2019).

2.4. Whiteflies, *Bemisia tabaci* Gennadius, Aleyrodidae, Hemiptera

Whiteflies, particularly *Bemisia tabaci*, are another significant pest of sesame. Like aphids, whiteflies suck sap from the plant and transmit viral diseases. Their feeding weakens the plant, causing yellowing, premature leaf drop, and a reduction in seed and oil yield. Whiteflies also excrete honeydew, which encourages the growth of sooty mold on plant surfaces, further diminishing the plant's ability to photosynthesize. The maximum population of whitefly (2.94 whitefly/six leaves/plant) was recorded in 19th standard week when the maximum and minimum temperature was 40°C and 24°C, respectively with morning and evening relative humidity 59 per cent and 30 respectively (Kiran *et al.*, 2023).

2.5. Red Spider Mites, *Tetranychus urticae* Koch, Tetranychidae, Trombidiformes

Red spider mites are a major concern in dry conditions where sesame is grown. These tiny pests feed on the underside of sesame leaves, piercing cells and sucking out the plant's juices. This leads to speckling, bronzing, and premature leaf drop, which significantly reduces the plant's photosynthetic ability. Severe infestations result in reduced seed yield and poor oil quality. The activity of spider was noticed in 9th standard week (0.02 spider/plant) and continued till maturity of the crop (0.34 spider /plant) (Kiran *et al.*, 2023).

2.6 Linseed Bud Fly, *Dasineura sesame* Glover & Prasad, Cecidomyiidae, Diptera

The infestation of sesame crops by this pest is typically observed from August to October, with peak activity occurring from late August through September. Recently, this pest has also been found damaging sesame crops in Madhya Pradesh. The biology of *Dasyneura* was studied by Prasad (1967), who noted that clear, humid weather is ideal for oviposition. Mating generally takes place in the morning, lasting about 0.34 minutes, and the oviposition period ranges from 2 to 3 days. Eggs are laid in clusters of 3 to 7 in newly formed flower buds, with up to 20 eggs per bud observed in some cases. The incubation period is between 28 and 36 hours, with hatching typically occurring between 2 and 6 PM. The larvae go through four instars, and when fully grown, they create a hole in the bud, exit, and pupate 5 to 7 cm deep in the soil. The

Commented [B8]: remove

Commented [B9]: remove and start new sentence from They

Commented [B10]:

Commented [B11R10]: Add details of life cycle if latest review avaiable

Commented [B12]: check spelling

Commented [B13]: superscript

Commented [B14]: add reference

Commented [B15]: add reference if avaiable

Commented [B16]: Start with Prasad also noticed that

pupae are cylindrical and may either form a silken cocoon or pupate without one. The pupal stage lasts 4 to 6 days. As the sesame flowering season concludes, the larvae enter the soil and undergo diapause within cocoons. Adult emergence occurs in the morning, between 6 AM and 8:30 AM. This pest completes two to three overlapping generations between August and October.

2.7 Leaf Hoppers, *Orosius albicinctus* Distant, Cicadellidae, Hemiptera

Leafhopper is a major pest affecting sesame and is known to transmit phyllody disease, which is observed throughout the year. This insect has been recorded to infest seventeen different plant species. In addition to sesame, some wild host plants include chicory (*Chicorium intybus* L.), datura (*Datura metel* L.), and dhaincha (*Sesbania bispinosa*). Cultivated host plants include Bengal gram (*Cicer arietinum*), lucerne (*Medicago sativa*), sunhemp (*Crotalaria juncea*), and Indian mustard (*Brassica campestris*). Phyllody-infected sesame plants show stunted growth, with their floral parts turning into leafy structures that do not produce fruits or seeds, potentially causing up to 100% yield loss (Selvanarayanan and Selvamuthukumaran, 2000). According to Murugesan *et al.,* (1978), a 1% increase in phyllody incidence can reduce sesame yield by 8.4 kg/ha. The incubation period of the disease is approximately 30 to 35 days after sowing, coinciding with the initiation of flowering. Once the pathogen, a phytoplasma-like organism, is transmitted, the disease spreads rapidly, leading to flower malformation. Infected plants resemble bunches of leaves, fail to form pods, and ultimately suffer from severe yield loss. The incidence of leafhopper was noticed from 9th standard week (1.30 leafhopper/six leaves/plant) and continued till maturity of the crop (Kiran *et al.,* 2023).

Commented [B17]: Add reference

2.8 Hairy Caterpillar, *Spilosoma obliqua* Walk, F-Erebidae;SF-Arctiinae, Lepidoptera

Two species of hairy caterpillars, *Spilosoma obliqua* and *Amsacta moorei*, are known to damage sesame crops. Their activity typically begins with the onset of the monsoon and continues from July to October. Both species are polyphagous, meaning they feed on a wide range of host plants. As their name suggests, the caterpillars' bodies are covered with hairs, which can be reddish, orange, brownish-orange, or black in color. Newly hatched larvae tend to stay in groups on leaves, where they defoliate the plants, leaving behind a papery white, skeletonized appearance. Mature caterpillars migrate to other plants, consuming large amounts of foliage and often leaving only the stem. As a result, affected plants become weakened, producing fewer capsules. Fully grown larvae continue migrating from one plant to another, further

damaging the crop. *S. obliqua* lays its eggs on the undersides of leaves, with an incubation period of 3-4 days. The larvae grow to full size in 2-3 weeks. Pupation occurs in the soil, under dry leaves or debris. This insect species can have 6-8 generations annually (Langham, 2019).

2.9 Hawk Moth, *Acherontia styx* Westwood, Sphingidae, Lepidoptera

This insect, commonly referred to as the hawk moth, sphinx moth, or death's head moth, is a well-known pest of sesame in India. It is also found in Indonesia, the Philippines, China, Myanmar, Bangladesh, and Sri Lanka. Being polyphagous, it feeds on a variety of crops in addition to sesame, such as potato, brinjal, lablab and some ornamental plants. The adult moth is notorious for robbing honey from honeycombs in apiaries, earning the nickname “honey robber”. It is a large, robust moth with a reddish-brown body and thick-set build. Its wings, which span about 10 cm, are marked with a combination of dark brown and gray patterns, featuring dark or black wavy lines and a distinctive yellow spot on each forewing (Langham, 2019).

2.10 Mirid bug, *Nesidiocoris tenuis* Reuter, Miridae, Hemiptera

Mirid bug is one of the most effective predatory mirid bugs, although it is associated with some negative effects due to its facultative phytophagy. This insect spontaneously colonizes agroecosystems in the presence of prey. Incidence of mirid bug was noticed from 9th standard week (1.00 mirid bug /six leaves/plant) and continued till maturity of the crop (5.98 mirid bug /six leaves/plant) (Kiran *et al.*, 2023).

3. Integrated Pest Management (IPM)

3.1. Cultural Control

Cultural practices are critical in minimizing pest populations and reducing the need for chemical inputs. Some effective cultural control measures include:

- **Crop rotation**: Rotating sesame with non-host crops helps break the life cycle of pests such as the sesame webworm and gall midge. Rotating sesame with crops like potato, groundnut, chickpea, uridbean, and cowpea is essential for sustainable sesame production. Some effective crop rotations include potato-sesame, groundnut-sesame, sesame-chickpea, sesame-uridbean, and cowpea-sesame.
- **Intercropping**: Growing sesame alongside other crops like legumes or maize can help reduce pest infestations by confusing the pests or attracting natural enemies. Intercropping sesame with green gram or black gram (in a 3:3 ratio) and sesame with

Commented [B18]: Add reference if available

Commented [B19]: Add details of life cycle

Commented [B20]: Give the citation

Commented [B21]: superscript

Commented [B22]: Webworm or webbers check properly

Commented [B23]: Check spelling uridbean or urdbean

cluster bean (also in a 3:3 ratio) has been found to reduce the occurrence of pests such as leaf webbers, capsule borers, gall flies, ~~and bud flies~~ (Panday *et al.*, 2021).

- **Field sanitation**: Removing plant debris and weeds from fields helps eliminate habitats for pests, reducing their population.
- **Early planting**: Planting early in the first week of July and selecting early-maturing varieties such as Uma, RT-46 and JT-7, which have a growth period of 80-85 days, combined with applying a balanced fertilizer mix, helps accelerate crop growth. This strategy ensures that the crop progresses beyond the vulnerable stage before the pest populations of leaf webbers, capsule borers, and gall flies reach levels that can cause significant damage (Panday *et al.*, 2021).
- **Resistant Varieties:** Using genetic resistance is one of the oldest, most efficient, and cost-effective strategies for pest control. Resistant varieties serve as the primary defense against pests and form a reliable foundation for integrated pest management (IPM) in sesame cultivation. Several pest-tolerant sesame varieties have been identified to combat major insect pests.
  - ✓ **Leaf roller/capsule borer (*Antigastra catalaunalis*):** Rama, RT-54, RT-103, RT-125, Usha, Sweta Til, Tapi, Krishna, N-32, JTS-8, MT-75, Hima and SI-250
  - ✓ **Gall fly (*Asphondylia sesame*):** RT-46, Sweta Til, RT-103, RT-125, OMT-26, RAUSS-17-4 & N-32
  - ✓ ***Antigastra* and *Asphondylia*:** RT-46, RT-103, Sweta Til, RT-127 and N-32
  - ✓ **Bud fly (*Dasynura sesami*):** MT-75
  - ✓ **Gall fly and Mites:** RT-127
  - ✓ **Hairy caterpillar:** Tilothama an Rama for Rabi/summer

3.2 Mechanical Methods: Certain mechanical methods have proven to be highly effective in controlling pests in sesame cultivation-

- ➢ Manually collecting and destroying egg masses and the gregarious stages of hairy caterpillars, along with removing damaged leaves.
- ➢ Gathering and eliminating infested leaf rolls, shoots, capsules, and buds affected by pests like *Antigastra* and *Asphondylia* to reduce pest populations.
- ➢ Clipping galls, removing and burning shed buds serve as effective preventive measures against gall fly.

Commented [B24]: Add reference if available.

Commented [B25]: Add full name or either common name of both pest

- Setting up bird perches at a rate of 40-50 per hectare.
- Installing one light trap per hectare to capture adult Bihar hairy caterpillars.

Commented [B26]: Check only hairy caterpillar or Bihar hairy caterpillar

3.3. Biological Control

Biological control involves the use of natural enemies such as predators, parasitoids, and pathogens to reduce pest populations. In the case of sesame pests, the following biological agents are commonly used:

- **Ladybird beetles** (*Coccinellidae*) and **lacewings** (*Chrysopidae*) as predators of aphids and whiteflies.
- ***Trichogramma* spp.**, egg parasitoids, are effective against the sesame webworm by parasitizing their eggs.

Commented [B27]: Check as above

- **Entomopathogenic fungi** various fungal pathogens were tested at multiple AICRP (Sesame and Niger) centers, and results showed that *Beauveria bassiana* demonstrated greater effectiveness against *Antigastra* larvae compared to *Metarhizium anisopliae*. In contrast, *Verticillium lecanii* was found to be the least effective against these larvae (Anonymous, 2011).

Commented [B28]: Add common name

Spraying neem oil at 2%, Neemgold at 0.3%, or T.N.A.U. neem formulation at 3%, twice once at 30 days after sowing (DAS) and again at 45 DAS has been shown to effectively control *Antigastra* in sesame crops. Ahirwar *et al.*, (2010) concluded that the populations of sucking pests in sesame, such as jassids, mirid bugs, and whiteflies, can be effectively, economically these include NSKE (in cow urine) at 30 ml/l or neem oil at 10 ml/l. Nath *et al.*, (2002) evaluated various neem-originated formulations for managing sesame insect pests, Nimbecidine was the most effective against the Bihar hairy caterpillar, leaf webber, capsule borer, and hawk moth. For sesame gall fly, Neemta 2100 was identified as the most effective formulation. Although biological control methods are environmentally friendly, their adoption remains limited in sesame-growing regions due to a lack of awareness, resources, and access to biological control agents.

Commented [B29]: Not clear check the proper reference and add accordingly.

3.4. Chemical Control: Chemical pesticides remain the most commonly used method for managing sesame pests. Insecticides are widely applied to control pests like aphids, whiteflies, and the sesame webworm. While effective in the short term, over-reliance on chemical control has led to issues such as pesticide resistance, resurgence of secondary pests, and negative environmental impacts, including harm to beneficial organisms and pollinators.

Commented [B30]: Write insecticides instead of pesticides

Commented [B31]: Check as above.

Commented [B32]: Write insecticides instead of pesticides

3.4.1 ETL: The ETL for pest control in sesame are as follows: for leaf webber and capsule borer, it is 1-2 larvae per plant during the vegetative and flowering stages and 1 larva per plant during the capsule formation stage. Athya and Panday (2020b) evaluated the economic injury level was found 0.74 larvae/ plant for sesame during pre-*rabi* season. For gall fly, the threshold is 2 to 5 galls per plant, while for *Antigastra* and *Asphondylia*, it is a 10% plant infestation rate.

3.4.2 Seed treatment: Imidacloprid 70WS at a rate of 7.5 g/kg seed

3.4.3 Foliar spray: Thiamethoxam + two foliar applications of profenofos 50 EC (2 ml/l), Spinosad 45 SC (0.15 ml/l), Chlorantraniliprole 18.5 SC (0.4 ml/l), Novaluron 10 EC (2 ml/l), or Flubendiamide 480 SC (0.3 ml/l) at 30 and 45 days after sowing (DAS). Athya and Panday (2020b) reported the most effective foliar spray of profenophos 50 EC 1 ml/l for the management of *Antigastra*.

4. Challenges and Future Directions

4.1. Pesticide Resistance: The indiscriminate use of insecticides has led to resistance in pests like aphids and whiteflies. Developing pest management strategies that rotate chemical classes and incorporate biological control is essential for managing resistance.

4.2. Climate Change: Climate change, with its associated shifts in temperature and rainfall patterns, is likely to affect pest populations and the dynamics of their infestations. Adaptation strategies, such as breeding climate-resilient varieties and adjusting planting times, will be critical in mitigating these effects.

4.3. Knowledge Gaps and Resource Limitations: Many ~~smallholder~~ farmers lack access to the knowledge and resources needed to implement IPM. Training programs and extension services should focus on promoting sustainable pest management practices, including biological control and cultural methods.

6. Conclusion

The management of insect pests in sesame is crucial for maintaining high yields and ensuring the sustainability of sesame production. While chemical control remains the dominant method, the adoption of integrated pest management practices is essential to address the challenges of pesticide resistance, environmental harm, and pest resurgence. By promoting IPM, fostering the use of biological control, and encouraging the development of pest-resistant sesame varieties, farmers can achieve more sustainable and profitable sesame cultivation.

Commented [B33]: Add reference

Commented [B34]: Write common name

Commented [B35]: Check proper dose in reference

Commented [B36]: Not clear

Commented [B37]: remove

Commented [B38]: Correct the number

7. References

Ahirwar RM, Gupta M P and Banerjee S. 2010. Field efficacy of natural and indigenous products on sucking pests of sesame. Indian Journal of Natural Products and Resources, 1(2), 221-226.

Anonymous, 2011. Annual Progress Report (Sesame and Niger). All India Coordinated Research Project on sesame and niger, JNKVV, Jabalpur.

Athya DP and Panday AK. 2020a. Biology of leaf webber and capsule borer, *Antigastra catalaunalis* (Dup.) in sesame. Journal of Entomology and Zoology Studies, 8(2): 55-61.

Athya DP and Panday AK. 2020b. Economic injury level of sesame leaf webber and capsule borer *Antigastra catalaunalis* (Duponchel). Indian Journal of Entomology, 82(4): 735-738.

Cheema JS and Singh G. 1987. Biology of sesame leaf webber and capsule borer, *Antigastra catalaunalis* (Dup) (Pyralidae: Lepidoptera) in Punjab. J. Res. Punjab Agric. Univ. 24: 65-74.

Langham RD. 2019. Sesame pests– a review, part 1 (*Sesamum indicum* L.) page: 1-286.

Menon M G R, Lal R and Bhattacharjee N S. 1960. Studies on *Antigastra catalaunalis* (Dup.), the til leaf roller. II. Bionomics and Biology. Indian J. Ent. 22: 1-6.

Murugesan M, Shanmugam M, Menon P P V, Arokiaraj A, Dhamu K P and Kochubabu M. 1978. Statistical assessment of yield loss of *Sesamum* due to insect pests and diseases. Madras Agricultural Journal 65: 290-295.

Nath P, Bhushan S, Singh A K. 2002 Evaluation of Neem Based Formulations and Neem Seed Kernel Extract against the Insect Pests of *Sesamum*. Annals of Plant Protection Sciences, 10(2): 207-2011.

Panday AK, Dwarka, Bisen R and Jain S. 2021. Insect pest management concept and approaches; Major Insect Pests of Sesame and Their Management. AkiNik Publications New Delhi. Vol. 1, 186-203.

Parveen S, Panday AK , Vishwakarma AK , Das SB, Sharma AK , Dwarka and Vishwakarma D. 2024a. Screening of Various Sesame Genotypes Against Leaf Webber and Capsule Borer, *Antigastra catalaunalis* Dup. Journal of Advances in Biology & Biotechnology, 27(7): 803-812.

Parveen S, Panday AK, Das SB, Sharma AK, Dwarka and Pandey R. 2024b. Study the response of different genotypes of sesame against larval population of leaf webber and capsule borer [*Antigastra catalaunalis*, Dup.]. International Journal of Advanced Biochemistry Research, 8(6): 458-462.

Prasad S N. 1967. Biology of gingelly blossom midge, *Dasineura sesami* Grover. Cecidalogia Indica 2:1-16.

Thakur K, Panday AK, Dwarka and Deepali. 2023. Study the Seasonal Incidence of Major Sucking Insect-Pests of Sesame (*Sesamum indicum*, L.) Crop. International Journal of Plant & Soil Science, (35)19: 1441-1446.

Selvanarayanan V and Selvamuthukumaran T. 2000. Field resistance of sesame cultivars against phyllody disease transmitted by *Orosius albicinctus* Distant. Sesame and Safflower Newslett., 15: 71-74.

Commented [B39]: Correct the number

Commented [B40]: Check Reference style according to the journal guidelines and write accordingly.

Commented [B41]: check