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Eco-Friendly Insect Pest Management of Mustard Plant: A Review

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Abstract— *Mustard (Brassica juncea) is an essential oilseed crop among brassicas, primarily cultivated during the Rabi season in tropical regions worldwide. Like other crops of Brassicaceae family, mustard is attacked by various insect pests. Among these pests, mustard aphid, mustard sawfly, painted bug, diamondback moth, green peach aphid, cabbage butterfly, and leaf webber are major pests of mustard plant that affect the economic value of mustard and related crops by causing severe yield losses and decreasing market value. These pests majorly affect multiple parts of plant including leaves, flowers, flower buds, stems, pods, and twigs. Major physiological effects include curling of leaves, reduced photosynthetic efficacy due to secretions of sticky honeydew that facilitates sooty mold development, and failure of young pods to mature properly. Mustard is susceptible to attack by the mustard aphid Lipaphis erysimi (Kalt.), a significant sucking pest affecting mustard and other Brassicaceae crops. Both nymphs and adults of this pest suck the cell-sap from plant parts, leading to stunted plant growth, wilting flowers, and impaired pod development. Additionally, their feeding activity introduces toxic substances into the plants, causing chlorosis at feeding sites, yellowing of veins, and leaf curling. Yield losses up to 73.3% and oil content reductions up to 66.9% have been reported. Numerous cost-effective control methods, including cultural, mechanical, biological, and botanical approaches have been identified to manage mustard pests effectively within an Integrated Pest Management (IPM) framework. IPM aids in minimizing ecological damage and reliance on chemical pesticides by utilizing natural enemies, entomopathogenic organisms, and botanical insecticides. This review synthesizes information on major insect pests of mustard and their eco-friendly management strategies.*

Keywords— Mustard, Aphids, Eco-friendly management, Lipaphis erysimi, Insect pest management, IPM.

I. INTRODUCTION

1.1 Importance of Mustard in India:

Mustard is the major Rabi season oilseed crop grown throughout India (Dhaliwal, 2022). Mustard crop belongs to the family Brassicaceae/Cruciferae (de Jussieu, 1789). This oilseed crop plays an important role in the agricultural economy of India (Sharma, 2015). India is one of the largest mustard growing countries in the world, occupying the third position in area and production after China and Canada, contributing 12% of the world's total production (Singh and Patel, 2023). *Brassica juncea* is the second most important oilseed crop in the country after groundnut and accounts for nearly 30.7% of the total oilseed production (Singh et al., 2016).

In India, mustard is predominantly cultivated in Rajasthan (50%), Uttar Pradesh (12.3%), Haryana (11.2%), Madhya Pradesh (9.8%), Gujarat (6.5%), and West Bengal (5.1%) (Sharma et al., 2011). Among these states, Rajasthan, Uttar Pradesh, and Madhya Pradesh are the major rapeseed-mustard growing states, covering 70% of the total national acreage and contributing around 72% of production (Grant Thornton, 2014-2015). Uttar Pradesh is a leading mustard producing state of India (Kumar

and Singh, 2023), with 60% of total mustard production coming from this state. In Uttar Pradesh, the area under mustard cultivation is 759 hectares with production of 956.72 tonnes and yield of 1260 kg/ha.

1.2 Pest Problem in Mustard:

Mustard crops are vulnerable to attack by a range of insect pests, including the painted bug, mustard sawfly, mustard aphid, potato aphid, leaf miner, flea beetle, diamondback moth, Bihar hairy caterpillar, cabbage butterfly, and tobacco caterpillar (Verma et al., 2023). Among these, the mustard aphid *Lipaphis erysimi* (Kaltenbach) is considered the most destructive pest (Verma, 2023). This aphid species not only causes substantial seed yield losses—reported to be as high as 73.3%—but also significantly reduces oil content in the seeds, with recorded losses up to 66.9% (Bakhetia and Sekhon, 1989). Mustard is a major oilseed crop in the north-western region of Madhya Pradesh, and *L. erysimi* (Hemiptera: Aphididae) is recognized as a key pest that inflicts severe damage (Verma et al., 2023).

The aphids feed by sucking sap from tender shoots and floral parts during the early growth stages and later from the immature pods (Gurung and Tamang, 2023). Infested plants exhibit symptoms such as stunted growth and weakened structural integrity (Verma et al., 2023). In addition, the pest secretes large quantities of honeydew, promoting the development of black sooty mould on the leaves, which further hampers photosynthetic efficiency (Shubham, 2024).

1.3 Limitations of Chemical Control:

While the use of systemic insecticides has proven effective in managing this pest, their application can negatively impact natural enemies, including predators and parasitoids (Rhoilla et al., 2020). Moreover, chemical control presents several limitations, including the development of insecticide resistance, pest resurgence, outbreaks of secondary pests, and the accumulation of pesticide residues in oil and oilseed cake beyond permissible limits (Ramana et al., 2018). Environmental degradation is also a significant concern (Singh and Sharma, 2009).

The sustainable management of mustard aphids presents a significant challenge due to their complex life cycle, broad geographic distribution, and increasing resistance to a wide range of insecticides (Bhattacharya, 2019). In Bangladesh, the conventional method of pest control largely depends on the use of synthetic chemical insecticides (Akhter et al., 2022). However, farmers frequently apply these pesticides without adequate consideration of their efficacy, specificity to the target pests, or potential adverse impacts (Dasgopta et al., 2005). It is a common practice to use excessive doses and apply them at high frequencies, particularly during severe aphid infestations (Khatun et al., 2023).

Such indiscriminate and improper use of chemical insecticides can have serious ecological consequences (Barmon and Chaki, 2021). These include the destruction of beneficial insect populations, adverse effects on non-target organisms, the resurgence of primary pests, outbreaks of secondary pests, and the accelerated development of pesticide resistance (Sekhon and Ahman, 1993). Moreover, synthetic insecticides pose significant threats to both environmental health and human safety (Aktar et al., 2009).

1.4 Need for Eco-Friendly Management:

Alternatively, plant-based extracts and botanical insecticides are considered to be more environmentally benign (Khursheed and Malik, 2022). These substances are generally less toxic to non-target organisms, more biodegradable, and therefore pose fewer risks to ecosystems and human health (Pathak et al., 2022). In recent studies, short persistent pesticides and non-chemical control options have been evaluated in field trials for efficient management of mustard aphids (Dhillon et al., 2022).

1.5 Objectives of the Review:

This review aims to: (1) document the major insect pests affecting mustard (*Brassica juncea*) in India, (2) describe their biology, damage symptoms, and economic impact, and (3) synthesize eco-friendly management strategies within an Integrated Pest Management (IPM) framework.

II. MAJOR INSECT PESTS OF MUSTARD

2.1 Mustard Aphid: *Lipaphis erysimi* (Kaltenbach, 1843) (Hemiptera: Aphididae):

Lipaphis erysimi, known as mustard aphid, is a prevalent pest affecting cruciferous crops like mustard and rapeseed, particularly from December to March. These pale-green aphids feed on plant sap, causing stunted growth, leaf yellowing, and significant crop damage, especially under cold, cloudy conditions below 20°C. Reproducing parthenogenetically, they can produce 26-133 nymphs that mature in 7-10 days, leading to up to 45 generations annually. Both nymphs and adults extract

sap from leaves, stems, and pods, resulting in curled leaves, wilting, and impaired pod formation, which can reduce crop yields by 75-80%. Affected fields often appear blighted due to sooty mold growth on the honeydew excreted by the aphids.

2.2 Painted Bug: *Bagrada cruciferarum* (Burmeister, 1835) (Hemiptera: Pentatomidae):

This species is found in Myanmar, Sri Lanka, India, Arabia, and East Africa. It has a 19-54-day life cycle with 9 generations annually. Nymphs reach 4 mm, adults 3.71 mm, with black bodies and orange/brown spots. Active from March to December, they overwinter in dried oilseed debris. Females lay 37-102 pale-yellow eggs, hatching in 3-20 days, with nymphs maturing in 22-34 days. Both nymphs and adults feed on leaf and pod sap, causing wilting and plant weakening. Their resinous secretions contaminate pods, reducing seed quality and promoting secondary infections.

2.3 Mustard Sawfly: *Athalia lugens proxima* (Klug, 1815) (Hymenoptera: Tenthredinidae):

This species is common in Indonesia, Formosa, Myanmar, and the Indian subcontinent. Larvae are dark green with five black stripes, reaching 16-18 mm. Adults are small and orange-yellow with black markings. They breed from October to March, living 2-8 days and laying 30-35 eggs on leaf margins. Eggs hatch in 4-8 days, with larvae maturing in 16-35 days through seven instars. The larvae, the primary destructive stage, skeletonize leaves and occasionally consume shoot epidermis, compromising photosynthesis and plant growth. Pupation occurs in soil for 11-31 days, completing the life cycle in 31-34 days with 2-3 generations per season. This feeding behavior leads to substantial yield losses, especially in seedlings and seed production in older plants.

2.4 Green Peach Aphid: *Myzus persicae* (Sulzer, 1776) (Hemiptera: Aphididae):

These aphids, 2.0-2.5 mm and yellowish-green, are active across India from December to March, peaking in February. Nymphs mature in 4-8 days, with adults living 10-27 days and producing up to 92 offspring. Both nymphs and adults extract sap, leading to flower drop, poor pod formation, and grain shriveling. They also transmit viral diseases and excrete honeydew, promoting sooty mold, which further reduces photosynthesis and plant health.

2.5 Cabbage Butterfly: *Pieris brassicae* (Linnaeus, 1758) (Lepidoptera: Pieridae):

This widespread pest in India primarily targets cabbage, cauliflower, and other cruciferous plants. The larvae are pale yellow to green, growing up to 40-50 mm. Adult butterflies have pale white wings with black patches. Active from October to April in plains and breeding in mountains from May to September, females lay 50-90 eggs that hatch in 3-17 days. Caterpillars initially feed in groups, dispersing as they mature over 15-40 days. They cause significant damage by feeding on leaves, young shoots, and pods, often leading to severe defoliation, with only the main veins left intact, and stunted plant growth. Pupation occurs away from food plants for 7-28 days, with adults living 3-12 days and completing four generations annually.

2.6 Diamondback Moth: *Plutella xylostella* (Linnaeus, 1758) (Lepidoptera: Plutellidae):

This globally prevalent pest primarily affects cabbage, cauliflower, and other cruciferous and solanaceous plants. Females lay 18-356 yellowish eggs on leaf undersides, hatching in 2-9 days. Pale yellow-green larvae, 8-12 mm long with fine black hairs, complete their larval stage in 8-16 days. Pupation in a silken cocoon lasts 4-5 days, with adult moths living about 20 days. The life cycle completes in 15-18 days, with multiple generations per year. First instar larvae mine leaves, creating white patches; later instars perforate leaves, often leaving only veins intact in severe infestations.

2.7 Cabbage Leaf Webber: *Crocidolomia pavonana* (Zeller, 1852) (Lepidoptera: Pyralidae):

This pest targets cabbage, radish, mustard, and other cruciferous plants. The adult moth is small with light brown forewings. Females deposit eggs in clusters of 40-100 on the underside of leaves, which hatch within 5-15 days. The caterpillar features a red head, brown longitudinal stripes, and rows of tubercles along its body, with a larval stage lasting 24-27 days. Pupation occurs inside a cocoon within the webbed leaves, taking 14-40 days. The caterpillar webs together foliage, consuming leaves, flowers, and pods (in mustard), or flower heads (in cabbage and cauliflower), causing skeletonization of leaves and leaving faecal matter within the webbed areas.

2.8 Ladybird Beetle: *Coccinella septempunctata* (Linnaeus, 1758) (Coleoptera: Coccinellidae) - Beneficial Predator:

Coccinellidae, commonly known as ladybird beetles or lady beetles, are small, dome-shaped insects ranging from 0.8 to 18 mm in size, with females typically larger than males. Their hardened forewings (elytra) come in a variety of colors including red, orange, yellow, and pink, often with distinctive spots. Ladybugs use their antennae for both olfaction and gustation.

They undergo complete metamorphosis, transitioning through egg, larval, pupal, and adult stages. Larvae are voracious predators, and adults continue this feeding behavior. Most species are beneficial predators, feeding primarily on soft-bodied pests such as aphids, scale insects, and mites, making them valuable for biological pest control.

TABLE 1
MAJOR INSECT PESTS OF MUSTARD (*BRASSICA JUNCEA*) IN INDIA

Common Name	Scientific Name	Family	Order	Plant Parts Attacked	Peak Activity	Nature
Mustard aphid	*Lipaphis erysimi*	Aphididae	Hemiptera	Leaves, stems, pods	Dec-Mar	Pest
Painted bug	*Bagrada cruciferarum*	Pentatomidae	Hemiptera	Leaves, pods	Mar-Dec	Pest
Mustard sawfly	*Athalia lugens proxima*	Tenthredinidae	Hymenoptera	Leaves	Oct-Mar	Pest
Green peach aphid	*Myzus persicae*	Aphididae	Hemiptera	Leaves, flowers	Dec-Mar	Pest
Cabbage butterfly	*Pieris brassicae*	Pieridae	Lepidoptera	Leaves, pods	Oct-Apr	Pest
Diamondback moth	*Plutella xylostella*	Plutellidae	Lepidoptera	Leaves	Year-round	Pest
Cabbage leaf webber	*Crocidolomia pavonana*	Pyralidae	Lepidoptera	Leaves, flowers, pods	-	Pest
Ladybird beetle	*Coccinella septempunctata*	Coccinellidae	Coleoptera	Feeds on aphids	-	Beneficial

III. ECO-FRIENDLY MANAGEMENT STRATEGIES FOR MUSTARD PESTS

Effective pest management in mustard involves a combination of cultural, mechanical, biological, and need-based chemical controls within an Integrated Pest Management (IPM) framework.

3.1 Field Monitoring and Scouting:

Monitoring and scouting are key parts of effective pest control (Schneider and Rebek, 2016). They should begin right after planting or transplanting the crop (Edward et al., 1986). Fields need to be checked regularly, about once a week, during the entire growing season to find pests early and understand their population levels (Werling, 2015).

Pest Monitoring Protocol: In each field, choose several spots carefully to check for pests (Pedigo and Rice, 2014). Record what kinds of pests are present and how many there are, following specific guidelines for each pest type. This focused method helps understand pest behavior and allows for quick and appropriate control actions.

- **Aphids and Painted Bugs:** Check both nymphs and adults by counting how many are on five randomly chosen leaves of each plant. Regular monitoring helps track population changes and decide the best time for control measures.
- **Leaf Miners:** To check for leaf miner attacks, count the number of active tunnels on five randomly chosen leaves of each plant. This indicates infestation severity and whether control measures are needed.

Mustard aphid
(*Lipaphis erysimi*)

Painted bug
(Bagrada cruciferarum)

Mustard sawfly
(Athalia lugens proxima)

Green peach aphid
(*Myzus persicae*)

Cabbage butterfly
(*Pieris brassicae*)

Dimond black moth
(*Plutella xylostella*)

Cabbage leaf wehber
(*Crocidolomia pavonana)*

Ladybird
(*Coccinellidae septmpunctata*)

FIGURE 1: Major insect, pest of mustard plant

3.2 Cultural Control Methods:

Cultural practices play a vital role in the sustainable management of insect pests in mustard cultivation (Roy, 2023). Clean cultivation and regular weeding help create unfavorable conditions for pest development by eliminating alternate hosts and reducing pest survival chances (Kumar et al., 2025). Such practices are also effective in managing dormant stages of pests, either by burying them deep within the soil or by exposing them to adverse environmental conditions (FAO, 2008).

Several cultural control measures have been identified as effective for mustard pest management (Mishra et al., 2023):

- **Early sowing** of the crop minimizes damage caused by mustard aphid (*Lipaphis erysimi*)
- **Adoption of tolerant varieties** contributes to aphid control
- **Judicious use of nitrogenous fertilizers** helps reduce pest incidence
- **Deep ploughing of soil** is recommended to destroy the eggs of the painted bug (*Bagrada hilaris*) (Agricultural University Agriculture Technology Portal, 2014)
- **Irrigating the crop** during the fourth week after sowing helps reduce pest infestation
- **Timely threshing** of the harvested crop prevents further damage by the painted bug (Tamil Nadu Agricultural University, 2014)

Among the various cultural control measures, early sowing is considered the most critical practice for minimizing losses from major pests such as mustard aphid, painted bug, and mustard sawfly (*Athalia proxima*) (Tamil Nadu Agricultural University, 2014). The integration of these practices forms an essential component of an eco-friendly and sustainable pest management strategy in mustard cultivation.

3.3 Mechanical and Physical Control Methods:

Mechanical and physical methods are important components of IPM strategies for mustard crops (Roy, 2025). These approaches primarily involve the removal or destruction of infested plant parts and the manual collection and elimination of

larger insect pests, generally through the use of human labor (Penn State Extension, 2011). Various mechanical devices may also be installed in the field for monitoring and controlling specific pest populations (Cardim Ferreira Lima et al., 2020).

Specific mechanical control measures include:

- At the initial stage of aphid infestation, the affected plant parts along with the aphid colonies are **removed and destroyed** to prevent further spread
- **Yellow sticky traps** are installed in the field to monitor and reduce the aphid population (Singh and Lal, 2012)
- For management of painted bugs, the leaves and stems of plants are **shaken or jerked** to dislodge the insects, which are subsequently destroyed using a kerosene oil solution (Tamil Nadu Agricultural University, 2014)
- **Manual collection and destruction of larvae**, particularly during early morning and evening hours, are practiced to manage mustard sawfly, Bihar hairy caterpillar, and diamondback moth populations (Tamil Nadu Agricultural University, 2014)
- **Pheromone traps** installed at a density of four traps per hectare are employed for the monitoring and control of diamondback moth infestations (Fredon, 2009; Laore, 2010; Ben Husin, 2017)

These mechanical and physical measures help maintain pest populations below the Economic Threshold Level (ETL) and reduce dependence on chemical control methods, thereby contributing to sustainable mustard production (Roy, 2025).

3.4 Biological Control Methods:

Farmers often use chemical pesticides to protect their vegetable crops from insects (Shah et al., 2019). However, using too many of these chemicals can cause several problems, such as harming human health, making pests resistant to the chemicals, and polluting the environment (Aktar et al., 2009). As pests become more resistant and environmental damage increases, it is important to find safer and more effective ways to control them (Couto et al., 2019).

One such method is biological control, which uses natural enemies like predators, parasitoids, or disease-causing microorganisms to reduce pest populations. This approach is a key part of sustainable farming, which aims to produce food in the long term without harming nature. Another option is using botanical pesticides made from plants. These products are effective against insects, break down easily in the environment, and cause little harm to other animals (Lengai et al., 2020).

TABLE 2
MAJOR BIOLOGICAL CONTROL AGENTS FOR MUSTARD PESTS

Type	Examples	Target Pests
Predators	Ladybird beetles (*Coccinella septempunctata*), syrphid flies, lacewings, spiders	Aphids, soft-bodied insects
Parasitoids	*Diaeretiella rapae* (aphid parasitoid), *Trichogramma* spp., *Apanteles* spp., *Bracon* spp.	Aphids, lepidopteran larvae
Entomopathogens	*Beauveria bassiana*, *Metarhizium anisopliae*, *Verticillium lecanii*, *Bacillus thuringiensis* (Bt)	Aphids, caterpillars, various insects
Botanical insecticides	Neem (*Azadirachta indica*), karanj (*Pongamia pinnata*), mahua (*Madhuca indica*), *Annona squamosa*	Multiple pests

Biological control is cost-effective, eco-friendly, and long-lasting. It offers many benefits for the environment, economy, and society (Saleh et al., 2017).

3.5 Chemical Control (as Last Resort):

Chemical control becomes necessary when aphid populations exceed established action thresholds or when natural enemies are unable to regulate rapidly increasing populations (Jain and Tiwari, 2017). However, indiscriminate use of chemical insecticides poses a significant threat to the agro-ecosystem, raising concerns about their sustainability. Therefore, selective insecticidal applications have been evaluated and recommended by several researchers for the management of mustard aphid in different regions globally.

Chemical insecticides are generally classified into two types: contact and systemic. Since aphids typically colonize the abaxial surface of leaves and feed by inserting their stylets directly into the phloem, contact insecticides are often ineffective. In contrast, systemic insecticides are absorbed by the plant and translocated through the phloem, allowing them to effectively control aphids irrespective of their feeding sites, including those under the leaves. The major groups of insecticides used against aphids include carbamates, organophosphates, pyrethroids, and neonicotinoids (Bahlai et al., 2010; Cameron et al., 2005).

Important Considerations for Chemical Control:

- Apply only when pest populations exceed Economic Threshold Level (ETL)
- Select insecticides with low toxicity to natural enemies
- Rotate insecticides from different groups to prevent resistance development
- Follow recommended doses and application timings
- Observe pre-harvest intervals to minimize residues

Continuous use of organophosphate insecticides has led to the development of resistance in aphid populations (Gould, 1996), emphasizing the need for integrated approaches.

3.6 Integrated Pest Management (IPM) Framework:

IPM is a sustainable approach that combines all available pest control methods to keep pest populations below damaging levels while minimizing environmental impact. For mustard crops, an effective IPM strategy includes:

1. **Regular monitoring and scouting** to assess pest populations and natural enemy activity
2. **Cultural practices** (early sowing, tolerant varieties, clean cultivation, balanced fertilization)
3. **Mechanical controls** (sticky traps, pheromone traps, manual removal)
4. **Biological controls** (conservation of natural enemies, augmentation, botanicals)
5. **Need-based chemical control** using selective, safer insecticides when thresholds are crossed

IV. SUMMARY AND CONCLUSION

Mustard (*Brassica juncea*) is a vital Rabi oilseed crop in India, playing a crucial role in the agricultural economy. However, its productivity is severely constrained by insect pest attacks, particularly from the mustard aphid (*Lipaphis erysimi*), which can cause up to 73.3% yield loss and 66.9% reduction in oil content. Other significant pests including painted bug (*Bagrada cruciferarum*), mustard sawfly (*Athalia lugens proxima*), green peach aphid (*Myzus persicae*), cabbage butterfly (*Pieris brassicae*), diamondback moth (*Plutella xylostyla*), and cabbage leaf webber (*Crocidolomia pavonana*) compound the damage across leaves, stems, flowers, and pods.

The over-reliance on synthetic chemical insecticides has led to numerous problems including pest resistance, resurgence of secondary pests, destruction of natural enemies, environmental pollution, and health hazards. These challenges necessitate the adoption of eco-friendly pest management approaches.

Integrated Pest Management (IPM) offers the most sustainable solution by integrating multiple tactics:

- **Cultural methods:** early sowing, deep plowing, clean tillage, tolerant varieties, balanced fertilization
- **Mechanical controls:** sticky traps, pheromone traps, manual collection and destruction of pests
- **Biological agents:** predators (ladybird beetles, syrphid flies), parasitoids (*Diaeretiella rapae*, *Trichogramma* spp.), entomopathogens (*Beauveria bassiana*, *Metarhizium anisopliae*, *Verticillium lecanii*, *Bacillus thuringiensis*)
- **Botanical insecticides:** neem, karanj, mahua, and other plant-based products
- **Need-based chemical interventions** using selective, safer insecticides only when economic thresholds are crossed

Regular field monitoring and scouting enable timely action, curbing resistance development, pesticide residues, and ecological harm while protecting natural enemy populations. The adoption of eco-friendly management strategies is

particularly important in major mustard-growing states including Rajasthan, Uttar Pradesh, and Madhya Pradesh, which together account for over 70% of national production.

Future research should prioritize:

1. Development of pest-resistant mustard varieties through conventional and molecular breeding approaches
2. Evaluation of novel biopesticides and botanical formulations for field efficacy
3. Refinement of economic threshold levels for different pests and regions
4. Understanding pest-natural enemy dynamics under changing climate scenarios
5. Documentation and validation of traditional pest management practices
6. Capacity building of farmers through extension programs on IPM adoption

The integration of these eco-friendly approaches will contribute to resilient and sustainable mustard production systems, ensuring food and oil security while protecting environmental health and farmer livelihoods.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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