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Sustainable Management of Pests Infesting Rapeseed and Mustard Crops

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ABSTRACT

Oil seed crops possess an important place in Indian Agriculture. Rapeseed (*Brassica napus* L.), Yellow Sarson (*Brassica rapa* var. *yellow sarson*) and Mustard (*Brassica juncea* L.) is produced largely in Rajasthan, Uttar Pradesh, Haryana, and West Bengal. The oil and seed are used to flavour vegetables and curries and as a condiment for making pickles. In northern India, the oil is used for frying and cooking and is consumed by humans. The oil cake is utilized as manure and as cow feed. They provide adequate nutrients and sulphur for the diet. Many phyto-chemicals, including vitamins, minerals, dietary fiber, chlorophylls, glucosinolates, polyphenols, and volatile substances are found in mustard. The oil content of mustard and rapeseed varies between 30 and 48 %.

Damage caused by several insect pests is one of the main causes of the low mustard yield; in India, rapeseed-mustard crops have been found to be infested a number of pests of which a dozen are regarded as severe pests. Major pests of mustard include the mustard aphid, mustard saw fly, painted bug, and leaf miner. To combat these threats, farmers have to depend on chemical pesticides for quick and effective pest control. Indiscriminate use has led to a host of new problems including pest resistance, resurgence, outbreak of secondary pests, environmental degradation, residual toxicity, health hazards, and the destruction of beneficial organisms such as pollinators and natural predators. These consequences have necessitated a shift towards more sustainable and ecologically sound pest control strategies. This led to the development and adoption of Integrated Pest Management (IPM)—a holistic approach of pest control.

Keywords : Insect pests, chemical pesticides, environmental degradation, control strategies, holistic approach.

Introduction

An important part of the Indian agricultural sector is oil seed crops. Domesticated oilseed crops grown during the *Rabi* season are mustard (*Brassica juncea* L.), Rapeseed (*Brassica napus* L.), Yellow Sarson (*Brassica rapa* var. *yellow sarson*) which are members of the

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Cruciferous family of plants. Despite being grown in 13 states in India, mustard is produced largely in Rajasthan, Uttar Pradesh, Haryana, and West Bengal. This crop is the main edible oilseed crop in India, producing almost one-third of the nation's oil. Due to its appropriateness for both sole and mixed cropping, as well as their versatility in both irrigated and rain-fed environments, this group of oilseed crops is becoming increasingly popular among farmers. Additionally, it has a lower manufacturing cost and uses less water while yielding a larger return (Shaila *et al.*, 2022).

The oil and seed are used to flavour vegetables and curries and as a condiment for making pickles. In northern India, the oil is used for frying and cooking and is consumed by humans. The oil cake is utilized as manure and as cow feed. Cattle can benefit from green feed made from green stems and leaves. Young plants' leaves are used as green vegetables because they provide adequate nutrients and sulphur for the diet. Many phyto-chemicals, including vitamins, minerals, dietary fiber, chlorophylls, glucosinolates (and the products of their breakdown), polyphenols, and volatile substances (such allyl isothiocyanate and 3-butyl isothiocyanate) are found in mustard. Furthermore, mustard may have numerous pharmacological properties, such as bacteriostatic, antiviral, anti-oxidant, and anti-inflammatory effect (Gharde *et al.,* 2019).

Allelochemicals produced by mustard plants have an impact on the germination, growth, survival, and reproduction of surrounding plant species. The mustard plants contain chemicals called 8-hydroxyquinoline and (±)-catechin, which are effective chelators of nutrients like phosphorus. These substances are released from the roots, which alters how nitrogen is fixed in the soil, increasing nitrogen accumulation and the soil microbiota's decomposition and release of ammonium nitrogen, which enhances nutrient uptake. The nearby plants are subsequently given extra nitrogen to increase crop output. Mustards are a great companion crop or rotating crop because of this and their advantages in controlling weeds. Furthermore, all mustards include brassinosteroids, such as brassinolide, which have the ability to enhance growth and production. Glucosinolates and other volatile sulphur compounds are antimicrobial and allelopathic metabolites that, through a process called bio-fumigation, can stop bacterial infections, fungal infestations, nematode invasions in the roots, and insect infestations. Most insect pests are repelled by glucosinolates because they are found in the volatile oils that Brassicaceae release. It has been demonstrated that plants work well as a natural insecticide against flies, red spider mites, and aphids. Mustards have insecticidal properties comparable to those of the pyrethroid, permethrin. By blocking the sodium channel current that causes the nerve cell membrane to polarize, this chemical compound affects the membranes of insects and parasites. This delays the membrane's repolarization, which eventually paralyzes and kills the pest.

The oil content of mustard and rapeseed varies between 30 and 48%. Damage caused by several insect pests is

one of the main causes of the low mustard yield in India, rapeseed-mustard crops have been found to be infested by around 43 insect pest species, of which roughly a dozen are regarded as severe pests. Major pests of mustard include the mustard aphid, mustard saw fly, painted bug, and leaf miner (Pradhan *et al.*, 2020).

Table 1. List of pest complex of rapeseed and mustard

Major pests

Common name	Scientific name	Family	Order
1. Mustard Aphid	*Lipaphis erysimi*	Aphididae	Hemiptera
2. Painted Bug	*Bagrada hilaris*	Pentatomidae	Hemiptera
3. Mustard Sawfly	*Athalia lugens*	Tenthredinidae	Hymenoptera
4. GreenPeach Aphid	*Myzus persicae*	Aphididae	Hemiptera
5. Pea leaf miner	*Chromatomyia horticola*	Agromyzidae	Diptera
6.Bihar Hairy Caterpillar	*Spilosoma obliqua*	Arctiidae	Lepidoptera
7.Cabbage Buterfly	*Pieris brassicae*	Pieridae	Lepidoptera
8.Diamondback moth	*Plutella xylostella*	Plutellidae	Lepidoptera

Minor pests

Common name	Scientific name	Family	Order
1. Flea beetles	*Phyllotreta cruferеae*	Chrysomelidae	Coleoptera
2. Leaf webber	*Crocidolomia binotallis*	Pyralidae	Lepidoptera
3. Cabbage head borer	*Hellula undalis*	Pyralidae	Lepidopter
4. Jassid	*Empoasca binotata*	Cicadellidae	Hemipter

Major pests

1. Mustard Aphid*: Lipaphis erysimi* (Aphididae : Hemiptera)

Distribution and status : In India, the mustard aphid is a notorious pest that infests mustard (*Brassica juncea*) and other related crops. The mustard aphid is found throughout India's main mustard-growing states and areas. In the country's north and centres, where growing mustard is a major agricultural endeavour, this pest is very common. Throughout the crop-growing

season, mustard aphid infestations in India can harm many growth phases, such as seedlings, the vegetative stage, and the seed-forming stage. States where mustard farming is an important part of agriculture, including Rajasthan, Uttar Pradesh, Madhya Pradesh, Haryana, and others, have reported the pest's presence (Aarwe *et al.*, 2023). Ghosh *et al.* (2000) reported that maximum population of aphid was recorded during last week of December. Laskar *et al.* (2004) reported that population development of mustard aphid showed positive correlation with minimum temperature and negative correlation with both maximum temperature and temperature differences.

Host Range : The Brassicaceae family of plants is the primary host of the mustard aphid (*Lipaphis erysimi*). Several domesticated and wild plants in this botanical family are included in the host range of mustard aphids. The following are some types of plant that the mustard aphid may use as hosts. Mustard plants: Indian mustard, or *Brassica juncea* and rapeseed, or-*Brassica oleracea* (broccoli, cauliflower, and cabbage) (Aarwe *et al.,* 2023).

Lipaphis erysimi (Roy *et al.,* 2025)

Identification of Mustard Aphid

Egg : Along the veins of leaves, eggs are placed (Gautam *et al.*, 2019).

Nymphs : There are four instars. With the exception of size increases throughout later instars, each stage has a similar overall appearance. The nymph stage lasts 8–9 days in total, with the first, second, third, and fourth stages lasting 1-2 and 3 days, respectively. When reared on mustard, radish, cauliflower, and cabbage, winged and wingless forms exhibit slight differences in these durations (Gautam *et al.*, 2019).

Adult : Aphids are small, soft-bodied, pearl-shaped insects that have a pair of cornicles (wax-secreting tubes) projecting out from the fifth or sixth abdominal segment. Apterae aphids, which are female and wingless, are olive, gray, or yellowish green in colour, with a white waxy bloom covering their bodies. In humid conditions, the waxy covering becomes more dense. The dusky green abdomen of the winged female and adult aphids, known as alates, features is dusky wing veins and black lateral bands that divide the body segments (Gautam *et al.,* 2019).

Damage Symptoms : Adults and nymphs both consume cell sap from developing pods, leaves, stems, and inflorescences. Plant vitality is significantly diminished. At an advanced stage, plants may wither and die, and the infested leaves take on a curled appearance. The developing pods do not yield viable seeds, and the flowers do not mature into pods. Sooty moulds develop on the honey dew that the insects expel, and plants continue to be stunted. The afflicted field appears withered and sickly (Aarwe *et al.,* 2023).

2. Painted Bug: *Bagrada hilaris* (Pentatomidae : Hemiptera)

Distribution and status : This is commonly available in East Africa, India, Arabia, Sri Lanka, and Myanmar (Aarwe *et al.*, 2023).

Host Range : Crucifers, rice, sugarcane, indigo and coffee (Aarwe *et al.,* 2023).

Bagrada hilaris

Identification of Painted Bug

Egg : When the eggs are first laid, they are dirty white and turn pink two to three days following oviposition. The eggs are barrel-shaped. These bugs lay oval, pale-yellow eggs singly or in groups of 3-8 on leaves, stalks, pods and sometimes on the soil. Eggs may be laid during day or night.

Nymphs : Before becoming an adult, the insect goes through five nyphal instars. The nymphs in their first and second stages are bright orange, while those in their third and fourth stages are red.

Adults : Adults have shield-shaped bodies that are 3–4 mm wide and 5–7 mm long. Males are slightly smaller than females. The coloration of the adult is black with red and yellow markings. The pronotum (dorsal thoracic plate anterior positioned on the body) and the scutellum (central triangular plate on the dorsal surface of the thorax) of adult bagrada bugs both have an obvious longitudinal marking down the centre.

Damage Symptoms : In October and November, this pest attacks the crop at its early stage, then in March and April, when it reaches maturity. Adults and nymphs feed on the cell sap of leaves and pods, which gradually dry out and wilt. Additionally, by sucking the pods, this bug decreased the amount of oil; the pods shrivel up and the seed does not develop.

3. Mustard Saw fly: *Athalia lugens proxmia*

Distribution and status : This is widely distributed in Indonesia, Taiwan, Myanmar and the Indian Sub-continent (Aarwe *et al.*, 2023).

Host range : Cabbage, mustard, radish, turnip, okra (Gharde *et al.*, 2019).

Identification of Mustard Saw fly

Egg : Freshly laid eggs are creamy white in colour. At the time of hatching, eggs turn to dark colour with two black spots. Eggs are laid singly within the tissue of leaf at the leaf margin (Gharde *et al.*, 2019).

Larva : Eight pairs of abdominal prolegs are present in dark green larvae. The body appears wrinkled, and the back is striped with five black dots. The length of a mature larva is 16–18 mm. (Aarwe *et al.*, 2023).

Adults : The adults are tiny, orange-yellow beetles with black body patterns and smoky, black-veined wings. Abdomen is bright yellowish colour in adult (Aarwe *et al.,* 2023).

Damage Symptoms : In the beginning, larvae gradually consume the leaf's epidermal material from the margin to the midrib. The leaves' laminar area was damaged by the excessive feeding. After skeletonizing the leaves, the larvae move to the shoot, which causes the plants to dry completely (Gharde *et al.*, 2019).

4. Green Peach Aphid: *Myzus persicae* (Aphididae : Hemiptera)

Distribution and status : Throughout the world, including all areas of North America (Capinera *et al.*, 2001).

Host range : Mustard, peaches, beans, potato, tobacco, turnip, radish, etc (Aarwe *et al.*, 2023).

Identification of Green Peach Aphid

Eggs : Eggs are green or yellow in the beginning, but they quickly turn black. The elliptical-shaped eggs are generally 0.6 mm length and 0.3 mm broad (Capinera *et al.,* 2001).

Nymphs : initially appear greenish, but rapidly turn yellowish (Capinera *et al.*, 2001).

Adults : The head and thorax of winged (alate) aphids are black, while the abdomen is yellowish green with a large dark patch on the dorsal side. They are between 1.8 and 2.1 mm long. Aphids without wings (apterous) have a greenish or yellowish hue. They are between 1.7 and 2.0 mm long. There can be green stripes on the sides and the middle. The cornicles match the body in colour, are somewhat lengthy, and swell unevenly along their length (Capinera *et al.*, 2001).

Damage symptoms: Adults and nymphs destroy plants by actively consuming their sap. The aphid gathers on terminal buds and feeds there after the inflorescence appears. Consequently, poor pod formation, shrivelling of grains, and blossom shedding occur. Additionally, the bug spreads viruses that cause illnesses. Honey dew attracts sooty mould (Aarwe *et al.*, 2023).

5. Pea Leaf-miner: *Chromatomyia horticola* (Agromyzidae : Diptera)

Distribution and status : Northern India [Aarwe *et al.*, 2023].

Host Range : Cruciferous plants, antirrhinum, nasturtinum, pea, linseed (*Linum usitatissimum* L.) and potato (*Solanum tuberosum* L.) (Aarwe *et al.*, 2023).

Identification of Pea Leaf-miner

Egg : Eggs are oval, spherical, tapering towards bluntly rounded end. transluscent white when freshly laid, turning dull white before hatching (Sharma *et al.*, 1994).

Larva : When the larva hatches, it is translucent white and its oral hook—which is dark brown and shaped like an inverted 'Y'—is clearly apparent. The larva in its second instar is cylindrical and taper in front. It is possible to see both the anterior and posterior spiracles. Due of their similar appearances, it is challenging to distinguish between the third-instar larvae and second instar larvae (Sharma *et al.,* 1994).

Pupa : The fusiform pupa has clearly defined segments. It is light brown at first but darkens as it ages (Sharma *et al.,* 1994).

Adult : The female's head is light brown, body is black. Within one to two days following emerging, mating takes place. Copulation lasts for 15 to 20 minutes while at rest. The female begins to move across the leaf surface in order to lay eggs, and when it finds a good spot, it bends its abdomen and inserts the ovipositor into the leaf tissues. In a single insertion, one egg is laid. The leaf margins are where the majority of the eggs are placed (Sharma *et al.,* 1994).

Damage symptoms : The damage is caused by maggot larvae, which typically affect plants by tunnelling through the leaves. This type of damage, often caused by the larvae of certain species like leaf miners, can certainly impact the plant's health and aesthetics. The tunnels the larvae create disrupt the plant's ability to effectively carry out photosynthesis because they reduce the surface area of the leaf available to absorb sunlight. Over time, this can cause the plant to become weak, stunted, and less vibrant, leading to unattractive leaves. In severe cases, the damage might even cause the leaves to yellow and drop prematurely (Sharma *et al.,* 1994).

6. Bihar Hairy Caterpillar*: Spilosoma obliqua* (Arctiidae : Lepidoptera)

Distribution and status : Sporadic pest widely distributed in the orient. It is very serious in Bihar, Madhya Pradesh, Uttar Pradesh and Punjab.

Host range : Major hosts include cruciferous, oilseeds, vegetables, groundnut, castor, Papaya, sunflower, cashew, castor, cucurbits, mulberry, pigeon pea, beans, jute, sweet potato and millets crop (Kumar *et al.,* 2025).

Identification of Bihar Hairy Caterpillar

Egg : The greenish, grape-like eggs observed on the undersides of leaves are indeed characteristic of the Bihar hairy caterpillar, *Spilosoma obliqua*. These eggs typically measure around 0.34 mm in diameter (Desai *et al.,* 2015).

Larva : The larvae are distinctive, covered with long, yellowish to black hairs (Kumar *et al.*, 2025).

Adult : The insect's adult is a medium-sized moth with a pink abdomen and dull yellow to brown colouring. The wings have many black dots and are also pink in color. The adult moth's oblique line of black dots on its hind wings is one of its distinguishing characteristics. The abdomen has a yellow ventral side and a red dorsal side (Kumar *et al.,* 2025).

Damage symptoms : Newly hatched larvae feed gregariously on lower surface of leaves by scraping its surface which resulted into papery leaves. Larvae of third, fourth, fifth instars fed the whole leaves except veins and veinlets (Desai *et al.,* 2015).

7. Cabbage Butterfly: *Pieris Brassicae* (Pieridae : Lepidoptera)

Distribution and status : The Indian states of Punjab, Himachal Pradesh, Uttar Pradesh, Bihar, West Bengal, Assam, and the Sub-Himalayan tracts have all reported cases. It was not present in South India. In the Punjab, it can be found almost everywhere cruciferous vegetables are produced (Bhowmik *et al.,* 2017).

Host range : In several parts of the world, it has been described as a major pest of all cruciferous plants. Cauliflower,

cabbage, turnip, radish, mustard, broccoli Swedes, kohl rabi, horse radish, rape, and kale are some of these plants (Bhowmik *et al.,* 2017).

Identification of Cabbage Butterfly

Egg : Clusters of eggs are placed on the leaf's upper and below surfaces. Before hatching, the eggs, which are ribbed vertically and deposited upright in clusters of 40–100, change colour from white or pale yellow to vivid orange (Bhowmik *et al.,* 2017).

Larva : There are five instars and four moultings for large white larvae. It has been noted that the third instar larvae among the various instars devour a great deal and seriously harm their host plant. Their colour is seen to be more yellow, with black spots scattered throughout (Bhowmik *et al.,* 2017).

Pupa : The pupa has yellow and black patterns and is either pale green or greyish white (Bhowmik *et al.,* 2017).

Adult : Male and female adult butterflies have white wings with black points on the forewings. Additionally, each forewing of the female contains two black dots (Bhowmik *et al.,* 2017).

Damage symptoms : The caterpillars in the first instar just scrape the leaf surface, whereas the caterpillars in the following instars either bite a large hole in the leaf or consume the lamina along the border. After it attacks, the leaves become skeletonized, leaving only the veins (Bhowmik *et al.,* 2017).

8. Diamond Backmoth: *Plutella xylostella* (Plutellidae : Lepidoptera)

Distribution and status : In 1854, DBM was first originated in North America (Saravaiya and Patel, 2005). DBM has grown to be trouble for farmers worldwide and is thought to be a periodic migrating pest. Ghosh (2025) reported that at the present time in India, Diamond back moth has national significance.

Host range : Majority of crops like radish, cabbage, broccoli, turnip, cauliflower .When host is unavailable cruciferous weeds are also attacked by this pest.

Identification of Diamond Backmoth, *Plutella xylostella*

Eggs : Eggs are oval, yellow to pale green, 0.4 mm length, 0.2 mm broad, and slightly flattened. When field conditions are normal, eggs hatch in about five to six days.

Larva : It usually takes nine to thirty days for larvae to finish developing through their four instars. The early instars are tiny, colorless to yellow, and have a dark head capsule. Mid to later instars are green (Ramzan *et al.,* 2019).

Pupa : Typically, the loose silk cocoon that forms on the bottom or outer leaves is where pupation takes place. About 7 to 9 mm in length, the pupa is yellow to green. The pupa stage takes five to fifteen days to fully grow (Ramzan *et al.,* 2019).

Adult : The mature DBM moth is slender, greyish-brown, and 6 mm long, with pronounced antennae. The moth is marked with a broad cream or light-brown band along its back that is sometimes constricted to form one or more light-colour diamonds on the back, which is the basis for the common name of this moth. The average lifespan for adults is about two weeks, but they can live for seven or eight weeks. Typically, a single female may lay

between 18 and 356 eggs. The brown or grey moth is around 8–12 mm long, and its forewings have noticeable white dots that, when flattened over the body, resemble diamond patterns. The larvae are around 8 mm long when fully grown, and they have fine black hair all over their body and a pale yellowish green colour (Ramzan *et al.,* 2019).

Damage symptoms : This pest is notorious for its destructive impact on crops, particularly crucifers. The larvae's feeding behaviour, starting from first instars mining the leaf tissue to later instars consuming leaf tissue from the underside of leaves, is damaging at various stages of the plant's growth. The "window-like" appearance on the leaves results from the larvae feeding through the epidermal layers but leaving the veins intact. Larvae feed on foliage and caused damage by defoliation except leaf veins and in severe damage, leaves present a withered appearance or it will dry completely (Bista *et al.,* 2025). This feeding pattern reduces the plant's ability to photosynthesize effectively, which leads to stunted growth. Consequently, crop yield—both in quantity and quality—can be severely reduced due to this extensive damage (Philips *et al.,* 2014).

Minor pests

1. Flea Beetle : *Phylotreta Cruciferae* (Crucifer flea beetle) *and Phyllotreta striolata* (Striped flea beetle) (Chrysomelidae : Coleoptera)

Distribution and status : Flea beetle is abundant and economically damaging in cruciferous crops. One of the minor pests of mustard in India.The crucifer flea beetle, *Phyllotreta cruciferae* does the major damage in adult stage. Infestation starts early in the seedling stage of the crop. Peak infestation of this pest occurs in first fort-night of February. During flowering and fruiting stage, the crop goes through damage because of flea beetle. Ghosh *et al.* (2005), Ghosh (2014), Subba *et al.* (2014) and Ghosh (2023) reported that flea beetle showed significant positive correlation with average temperature and non significant negative correlation with average RH and weekly total rainfall.

Host Range: Crucifer flea beetle has a narrow host range. They mainly attack on the cruciferous crops- Rapeseed-Mustard, radish, cabbage, cauliflower, and broccoli. They are also found on other crops like spinach, eggplant, potatoes, sweat peas, maize. They occasionally damage flowers, shrubs and even trees (Patel *et al.,* 2017).

Identification

Eggs : Eggs are yellow, oval. It is about 0.38-0.46 mm long and 0.18-0.25 mm wide. Flea beetle deposit the eggs singly or in groups of three or four under to the host plant's roots. (Knodel *et al.,* 2002).

Larvae : Larvae are small about 3 mm. It is whitish, slender, and cylindrical. They have tiny legs and a brown head and anal plate (Knodel *et al.,* 2002)

Pupae : Pupae are as the same size as adult and white in colour except for the black eyes and the free body appendages, which are visible later in the pupa development (Knodel *et al.,* 2002).

Adult : The adult is a small, oval-shaped. It is black in colour with bright-blue elytra. The adult measures about 2-3 mm in length. Flea beetles have enlarged hind femora on their hind legs. When

disturbed they jump quickly using their hind legs, hence they got the name 'Flea' beetle (Knodel *et al.,* 2002).

Damage Symptoms : The damage of flea beetle is called 'pin hole' damage. It is described as small round holes on the leaves. Older feeding holes may become dry with brown tissue, while newer feeding holes are surrounding by green tissue. Flea beetles can cause enough foliage damage to seedlings resulting in death. The stem, flower and even pods may also be attacked. Direct seeded seedlings are more susceptible to damage than transplanted seedlings.

2. Leaf Webber : *Crocidolomia binotalis* (Pyraustidae : Lepidoptera)

Distribution and status : It is a regular pest of minor status of cruciferous crops, but sometimes can cause serious damage. Damage is mainly caused by the caterpillars. They are native to India and South-east Asia. It is also found in Africa, Australia, and some islands of the pacific.

Host range : Leaf Webber has a broad host range. Cabbage, radish, mustard other cruciferous plants, pulses, maize etc are infested by it.

Identification :

Egg : A female moth lays her eggs on the underside of leaves in clusters of 40 to 100. They erupt within 5–15 days (Prakash *et al.,* 2015).

Larva : Pale yellowish green coloured caterpillar with dark brown head and later becoming green with dark head and longitudinal stripes.

Adult : Moths are yellowish-brown. Forewings have reddish-brown distinct and in distinct wavy lines and prominent white spots. Hind wings are white with dark brown apical area.

Damage symptoms : Young larva damages the crop by feeding gregariously on leaves. The caterpillar forms silken web around the leaves. Later it webs together the leaves and feeds, so the name 'leaf webber'. They feed upon the leaves, leaving it completely skeletonized. They also feed on flower buds and pods. Severely attacked plants are defoliated.

3. Cabbage Head Borer : *Hellula undalis*

Distribution and status : This is a major pest for cabbage and cauliflower but in case of mustard it is considered as minor pest. If there is a cabbage field near mustard field, then cabbage head borer also attacks mustard. Cabbage head borer spread worldwide.

Host range : Cabbage, cauliflower, radish, knoll-kohl, beet root, mustard and the other cruciferous crops. It also attacks the weed *Gynadropis pentaphylla.*

Identification

Larva : Larva is pale whitish brown with 4 or 5 pinkish-brown longitudinal stripes. It is 12-25 mm long in size. The larva passes through four instars.

Adult : Moths are slender, pale greyish-brown, suffused with reddish colour. The male moths are greyish brown, the forewing has wavy grey markings and hind wings are pale dusky, however in newly emerged female, these markings are relatively darker than those in the male (Dhawan *et al.,* 2011).

Damage symptoms : Caterpillars initially mine the leaves and make it white papery. Later they feed on leaves and bore into stems. The entrance hole is covered with silk and excreta.

4. Jassid : *Amrasca biguttula biguttula* (Cicadellidae: Hempiptera)

Distribution and status : Jassid is a polyphagous pest. Like many other crops, mustard is also prone to jassid infestations. Jassids are small, leafhopper who sucks the sap of plants. They are widespread insects, can be seen all over the world.

Host range : It has a wide range of hosts including Cotton, tomato, okra, brinjal, beans, castor, cucurbits etc.

Identification

Eggs : Eggs are curved, elongated and yellowish white in colour and deeply embedded in the midribs of large veins on the under surface of the leaves (Chandrasekaran *et al.*, 2021).

Nymphs : Nymphs are flattened, yellowish green in colour. They remain confined to the underside of the leaves (Chandrasekaran *et al.,* 2021).

Adults : Adults are about 3.5 mm in length. They are elongate and wedge shaped with pale green body. Forewings and vertex have black spots. Adults are very active with sideway movements but quick to hop (hence referred as leaf hoppers) and fly when disturbed (Chandrasekaran *et al.,* 2021). Duration of life cycle of jassid was recorded minimum (25.11 days) in June-July and being maximum (36.36 days) in October-November (Ghosh and Senapati, 2003).

Damage symptoms : Jassisds damage the plants by sucking on their saps. Due to sucking, the colour becomes grayish or by injecting toxic saliva into the plant tissues of crops and fall down (Crinkling) which is the characteristic feature of jassids attack (Lohar, 2001).

Integrated Pest Management

Cultural Control

1. Early maturity variety seeds should be sown during the first week of October to protect the mustard crop against aphid attacks, which occur when the pest's greatest activity coincides with the crop's vulnerable stage (Gautam *et al.,* 2019).
2. Split application of recommended nitrogenous fertilizer is also advisable to reduce the pest (Gautam *et al.*, 2019).
3. Plough the ground deeply to eliminate painted bug eggs. Pest attacks can be prevented by seeding early. In order to minimize insect attacks, crops should be irrigated one week after sowing. Quick threshing of the harvested crop is necessary.
4. Early planting, clean cultivation, collecting and destroying sawfly grubs in the morning and evening, summer plowing to kill the pupae, and applying irrigation during the seedling stage to control sawflies (Gharde *et al.,*2019).
5. Regular monitoring of crop and destroying of pest infested/ infected plants. Hand picking of caterpillar-infested twigs in the initial attack (Bhowmik *et al.,* 2017).
6. Grow mustard as a trap crop. Grow two rows of mustard for every 25 rows of

cabbage to Destory the diamond back moth (Philips *et al.,* 2014).

7. Control weed plants so that the adult flea beetle cannot transfer from weeds to the crop plant.
8. Plant trap crops like other brassicae crops to divert the attack on mustard.
9. Doing zero tillage and minimum tillage can help to control the pest attack compared to ploughing.
10. Planting trap crops like cabbage, cauliflower, broccoli etc. cruciferous crops can help to manage leaf webber.
11. Ghosh and Senapati (2001) reported that use of excessive nitrogenous fertilizers increases pest attack.

Biological Control

1. Apply neem oil or neem kernel extract to control pest attack (Aarwe *et al.,* 2023).
2. *Bacillus thuringiensis*, also known as bt can be used for biological control.
3. Four natural enemies viz., Chrysopids, *Chrysopa carrnea* and *Chrysopa scelestes* @ 50,000 eggs ha^{-1}, lady bird beetles i.e., *Coccinella septumpunctata*, *Menochilus sexmaculata* etc., predate on aphids and reduce their population successfully (Verma *et al.,* 2023).
4. Neem seed kernel extract (NSKE) @ 1 L 10 L^{-1} water is also found to be very effective in controlling mustard aphid.
5. Bio-control agents such as *Alophora* spp. (tachinid fly) parasitizes eggs of painted bugs.
6. *Perilissus cingulator* (larval parasitoids) and *Serratia marcescens* infecting the saw fly larvae can be used. Apply bitter gourd seed oil emulsion as anti-feedant (Gharde *et al.,* 2019).
7. Ghosh *et al.* (2006) and Ghosh (2013) reported that predatory spider and predatory *Menochillus spp.* (Ghosh *et al.,* 2007) in terai region of West Bengal were found active throughout the year and play an important role in natural suppression of destructive insect pest.
8. Chakarborty and Ghosh (2010), Ghosh and Chakraborty (2012) and Ghosh (2016) reported that *Coccinella septempunctata* is recognized as the dominating and effective bio-control agent in Indian subcontinent and play an important role in natural suppression of destructive insect pest like thrips, aphids etc.
9. Ghosh (2015) reported that *Polygonum hydropiper* flower extract at 5 % concentration and tobacco leaf extract at 10 % concentration gave more than 70 % and 65 % aphid suppression respectively.
10. In-vivo studies in brinjal also indicated the maximum reduction of aphids (67.3–72.3%) within 5– 14 days after application of *A. squamosa* 40 EC formulation at 1.0% dose followed by *P. pinnata* 40 EC (Purkait *et al.*, 2019).
11. Ghosh *et al.* (2004) reported that neem is very effective for controlling aphid on brinjal eight days after spraying and provide more than 60% control. Microbial toxin like abamectin, extracted from soil acyinomycetes (*Streptomyces avermitilies*) is very effective against soft bodied insect and provides 66.59% aphid control on Brinjal.

12. It was observed that extracts of *Polygonum* plant and *Pongamia* leaves at a concentration of 5% and the microbial insecticide spinosad gave higher Jassid control, recording more than 50% mortality (Ghosh and Chakraborty, 2015).

Mechanical Control

- Use light traps to control the attack of the pest (Aarwe *et al.,* 2023).
- Set up yellow sticky traps @ 10 traps per acre. (Aarwe *et al.,*2023).
- Install 10 pheromone traps per acre for management of adult moth.
- Setting up light traps controls the adult moth.
- Trapping like mass trapping, that is, the placement of several traps in the field to capture beetles can be helpful.
- Barriers and physical destruction of the pest can be employed to control pest attack.

Chemical Control

- Selective use of pesticides at right stage of crop with proper method of application on the basis of economic threshold level and abundance of natural enemies effectively retards the pest severity.
- Foliar insecticide treatments can target adults, and should be applied before egg laying occurs.
- Controlling a caterpillar infestation using poison bait :

  Make poison bait with:10 kilogram of rice bran,1 kilogram of jaggery,100 g thiodicarb or 250ml lambda-cyhalothrin. Spread the mixture along bunds and in the field at night (Roy *et al.,*2025).

- For early-stage pest control (aphids, cabbage webber, and sawflies), apply 750 g/ha of spray acephate 75 WP before flowers appear, if the number of aphids and painted bugs surpasses the Economic Threshold Level (ETL) use, 150 g/ha of 25 WG thiamethoxam, Using 200 ml/ha of imidacloprid 17.8 SL.
- Aphids: Acetamiprid, Dimethoate, Imidacloprid (Ghosh, 2020 a); (Ghosh, 2020 b). Ghosh *et al.* (2001) reported that microbial toxin abamectin was equally effective with chemical pesticides malathion and DDVP against pest of cabage and produce higher yield. Laskar and Ghosh (2005) and Ghosh (2015) reported that neem based/ azadirachtin pesticides are very effective against thrips and aphids.

  Note : To save pollinators, apply before blossoming.

  Early Pod Development and Flowering Aphid Control: Use less hazardous pesticides if infestations are severe:50 WG–200 g/ha of flonicamid.EC 10 – 500 ml/ha of pyriprofen one liter of buprofezin 25 SC/ha. (Roy *et al.,* 2025).
- Mixed formulation of imidacloprid with azadiraction was found to be the most effective against leaf miner showing 79.24% mortality with imidacloprid 76.25% (Mandal and Ghosh, 2021).
- Acetamiprid was found highly efficacious against aphid and found to suppress 85.11% aphids closely followed by neem + Spilanthes (73.29% control) (Ghosh, 2017).

- Immidacloprid was the most effective in providing more than 80% aphid suppression on som plant followed by azadirachtin (>70% suppression) and Polygonum extract (>60% suppression) (Ghosh *et al.,* 2016).
- From overall observation clothianidin was found best insecticide to reduce 79.18 % jassid population followed by flubendiamide 78.38% reduction of pest population (Das *et al.,* 2010).

Some Important Tips to Prevent Predators from Destruction

- Highly toxic pesticides should not be used for controlling pest of mustard crops.
- Botanical extract, *Polygonum hydropiper* floral part, pathogens, *Beauveria bassiana* and *Bacillus thuringiensis* caused significant lower killing of the predator (less than 30 %) whereas the synthetic insecticides, profenophos and methomyl caused significantly higher killing (more than 52 %) (Ghosh, 2013 a).
- Synthetic insecticides, DDVP and malathion caused significantly higher killing (>50%) whereas botanical insecticide, neem caused lower killing (less than 40%) of the *Coccinella* sp (Ghosh, 2016).
- Chakraborty and Ghosh (2010) reported that neemactin based solution was less lethal to *Coccinella septempunctata*.
- The control of the pest through the use of synthetic pesticides during the fruit bearing stage is rather difficult as the fruits are harvested at frequent intervals, and there is every possibility that, if spray applications are made, harvested fruit would contain toxic residues that may cause health hazards. Bio-pesticides are often preferred and over synthetic one to overcome this problem (Ghosh, 2022).

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