



Introduction and Management of Mustard Aphid [*Lipaphis erysimi* Kaltenbach (Homoptera: Aphididae)]: A Review

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Mustard crops tend to be more vulnerable to various insect pests compared to other oilseed crops. This increased susceptibility is due to several factors, including the crop growth habits, environmental conditions, and the range of pests that specifically target mustard plants. One of the major causes of reduced production is the introduction of insects, such as *L. erysimi* (K.), *B. brassica* (L.), *Athelia lugens proxima* (K.), *Pieris brassicae* (L.), *B. picta* (K), *Spodoptera litura* (F.), *Chromatomyia horticola* (G.) *Thrips tabaci* and *Bemisia tabaci* (G.). Among them, *Lipaphis erysimi* K., is the most destructive pest in India and is present in many other nations. It is also discovered that the most favored crop for sucking complexes. Aphids are small, soft-bodied insects with a pearl-like shape and two cornicles, or honey tubes extending from the 5th or 6th abdominal segment. They go through four instars or nymphal stages before reaching adulthood. The abdomen of winged female aphids is a dark green color marked by dark lateral stripes between the body sections and dark veins on the wings. Aphids in males are typically olive-green to brown. The infestations usually begin in December and persist until March, thriving at temperatures of 20°C or lower. Cloudy and cold weather conditions further promote their growth. Aphids can produce about 45 generations annually.

Keywords: *Cornicles; olive-green colour; nymphal stages; pearl-shaped and Lipaphis erysimi.*

1. INTRODUCTION

Mustard crops are susceptible to several pests, including painted bugs, mustard sawflies, mustard aphids, potato aphids, leaf miners, flea beetles, diamondback moths, Bihar hairy caterpillars, cabbage butterflies, and tobacco caterpillars. Among these, *L. erysimi* K. is the most destructive. It can cause significant seed yield losses of up to 73.3% and reduce oil content by as much as 66.9% [1]. Mustard is the primary oilseed crop in north-west Madhya Pradesh, with the mustard aphid (*Lipaphis erysimi* K.) being its principal pest. This pest inflicts significant damage by sucking sap from the tender shoots and flowers early on, and later from the tender pods. Infested plants become weak and stunted. The aphids excessive honeydew excretion leads to the growth of black sooty mold on the leaves, which hinders photosynthesis [2,3]. Although managing this pest with systemic insecticides is effective, it negatively impacts the pest's natural predators and parasitoids. However, apart from the high cost of insecticides, chemical control has several other disadvantages. These include the pest comeback, development of resistance to widely used pesticides, and secondary pest outbreaks, the accumulation of insecticide residues in oil and cake beyond permissible limits, and environmental degradation [4]. Among all insect

pests, *Lipaphis erysimi* K. is recognized as the primary pest of rapeseed-mustard in India. It damages the crop by sucking sap from the host plant, with crop damage ranging from 9% to 96% depending on the agro-climatic conditions across the country (Singh and Sharma, 2002; Bakhetia, 1984; Chorbandi and Bakhetia, [5] Singh and Sachan, [6] Singh and Sachan, [7] Parmar et al., [8]. In some mustard-growing regions, the loss could reach 100 per cent [9]. Aphid colonies of a considerable size have the potential to distort plants by causing their leaves to shrink and curl [10]. Both sides of leaves are affected during a strong infestation [11]. *Lipaphis erysimi* loves to eat both the leaves and the flowers of mustard plants [12].

2. IDENTIFICATION

Lipaphis erysimi adult apterae are tiny to medium-sized aphids that usually have an olive, grey, or yellowish-green color and a thin white wax bloom. In humid environments, the wax coating on them could be thicker. On the thorax and abdomen of the apterae, there are two rows of black bands that combine into a single band close to the tip of the abdomen. The mature *Lipaphis erysimi* apterae has pale siphunculi with black tips, and their body length varies between 1.4 and 2.4 mm.

3. SYMPTOM OF DAMAGE

Heavy infestations result in symptoms such as yellowing, curling, and drying of leaves, leading to the formation of weak pods and small seeds. The aphids also secrete honeydew, which fosters the growth of sooty mold and reduces the photosynthetic rate [1]. Consequently, it is essential to monitor mustard crops regularly during the aphids breeding season. In cases of severe infestation, chemical control becomes the only viable option to manage the mustard aphid outbreak. Therefore, this study was conducted to assess each insecticide bio-efficacy against *Lipaphis erysimi*, the mustard aphid.

4. POPULATION DYNAMICS OF *LIPAPHIS ERYSIMI*

The most important factor for raising aphid populations was found to be the greatest relative humidity three days before observation [13]. Similar findings were reported by Singh et al., [14] Jaglan et al., (1988), and Rossi [15]. Narang et al., [16] found that mustard aphid populations were abruptly and dramatically decreased by rainfall, with simulated rainfall of 1.0 to 2.0 cm resulting in a 45.47 per cent to 66.43 per cent reduction in population. Tomar and Yadav [17] observed that the aphid infestation peaked in the third week of February, with temperatures ranging from 10.5 to 25.7°C and a relative humidity of 68%, having started in the fourth week of December. Debjani-Dey and Akhtar [18] shown that the dispersion parameter and the variance/mean relationship (from 0.005 to 0.605) were used to aggregate the aphid distribution, [19] discovered that there was a negative association with relative humidity and a positive correlation with temperature for aphid numbers. A mean population of 6.03 aphids (averaged over 30 plants) was found during the 17th standard week in April, the lowest, and 94.7 aphids, the highest, during the 48th standard week.

5. BIONOMICS

This aphid reproduces in two ways: through sexual reproduction, where females are fertilized by males to produce eggs, and through parthenogenesis, where adult females give birth to live female nymphs without male fertilization. Parthenogenesis is the predominant mode of reproduction since male are not common. Almost entirely, female viviparous (giving birth to live young) year-round, with males observed only during the cooler months [20].

5.1 Eggs

This aphid usually deposits its eggs along the veins of leaves [20]. Nonetheless, no evidence of this aphid species eggs has been found in Hawaii.

5.2 Nymphs

Four nymphal phases, or instars, exist in this aphid species. Each stage appears similar in general appearance, with the size increasing in subsequent instars. According to Sachan and Bansal [21] the durations of the first, second, third, and fourth nymphal stages are 1-2 days each, totaling approximately 8-9 days for the nymphal stage overall. When raised on cabbage, cauliflower, mustard, and radish, there are slight differences in these durations between winged and wingless forms [21]. For a thorough description of the first and fourth instars [22].

5.3 Adults

Wingless female aphids, known as apterae, exhibit colors ranging from yellowish-green to gray-green or olive-green, covered with a white waxy bloom over their bodies [23]. This waxy coating becomes denser in humid conditions. Winged female and adult aphids, referred to as alates, possess a darkish green abdomen, dusky wing veins, and dark lateral stripes separating body segments [23]. With the exception of the base, the antennae are black [24]. Female apterae measure approximately 1.2-2.4 mm (3/50-1/10 inch) in length, while alate forms measure about 1.4-2.2 mm (3/50-1/12 inch) long [23]. For detailed illustrations of apterous and alate adults, refer to Sidhu and Singh [22].

5.4 Host Crop

Brassicas belong to the Cruciferae family and are predominantly cultivated in India during the *rabi* season for their roles as oilseed, condiment, and medicinal crops. They hold a distinct agricultural significance by serving as sources of vegetables, oilseeds, forage, Green manure, sauces, and feed. Application areas for brassica seed oil include the culinary, lubricant, and polymer sectors; the cake is used as animal feed and organic manure in agriculture. Mustard-rape seed seeds are particularly valued for their high oil content, ranging from 32% to 42%, with the oil being primarily used for edible purposes. Additionally, the mustard verdant leaves and stalks plants are also rich sources of oil [25].

5.5 Injury

Aphids feed by extracting sap from their host plants. When colonies grow large, they can distort the plants, causing leaves to curl, shrivel, and turn yellow [10]. The turnip aphid, in particular, tends to congregate in significant numbers in the flowers (inflorescences) or on the undersides of the outer leaves [23]. In extreme situations, the leaves may have a heavy infestation on both sides [26]. High populations of cabbage can lower output and alter the size of the leaves [24,27]. These aphids favor the blossoms of mustard plants above the foliage [12]. Aphids, like other soft-bodied insects like mealybugs, scales, and leafhoppers, secrete a sweet, watery excretion called honeydew, which is eaten by wasps, ants, bees, and other insects. Honeydew promotes the growth of a black sooty fungus known as sooty mold, giving cabbage plants a grimy appearance that lowers their market value [24]. Aphids also transmit numerous plant diseases, often causing more damage through disease transmission than through direct feeding. The turnip aphid, for instance, acts as a vector for approximately ten non-persistent plant viruses, such as the ones that cause turnip, radish, and cauliflower mosaic diseases and cabbage black ring spot [23]. The virus multiplies inside the plant during non-persistent transmission, and aphids aid in the infection process and virus's dissemination.

6. MANAGEMENT

6.1 Using Agronomic Practices to Address Diseases and Pests

6.1.1 Cultural control

A substantial amount of experimental data from Indian literature demonstrates how well cultural and agronomic approaches may lower insect losses in mustard crops. Practices such as timely

sowing in early October [28] balanced nutrient application like N₁₀₀:P₄₀:K₄₀ [29] sanitation, plowing, crop rotation, intercropping, spacing, and nutrient management. Delayed planting directly correlates with increased infestation rates of aphids like AB, WR, and SSR in most mustard-growing regions of the country [30-33].

6.2 Inter-Culture Operation

Thinning operations were conducted to maintain an optimal plant population by selecting healthy seedlings in both of them. Manual weeding was performed one month after sowing, ensuring that the field remained free of weeds for the entire season [34,35].

6.3 Biological

Mari et al., [36] discovered that *C. undecimpunctata* (L) adults and larvae demonstrated noteworthy feeding abilities on every species of aphid investigated. During the study period, alfalfa aphids showed the highest feeding efficiency when compared to mustard and maize aphids, most likely because alfalfa aphids have a higher survivability rate than other species. Hakim et al., [37] observed predator activities on varieties with the highest pest activity, indicating consistent populations of insect pests and predators across all varieties. Sajid et al., [38] reported that among entomopathogenic biopesticides, *M. anisopliae* (83.23%), *B. bassiana* (78.33%) and *B. thuringiensis* (73%) were effective against mustard aphids. They suggested that biopesticides could serve as valuable components of integrated pest management strategies against mustard aphids, following successful field trials. Liz et al., [39] highlighted the significant role of biological control in crop pest and disease management, reducing dependency on chemical pesticides [40-42].



Fig. 1. Infested crop by the mustard aphid, *Lipaphis erysimi*

6.4 Botanical

Kumar and Patel (2017) investigated the crude aqueous extracts of several plants, including *Ageratum conyzoides*, *Parthenium hysterophorus*, *Lantana camera*, *Solanum nigrum*, *Cannabis sativa*, *Calotropis gigantea*, *Livistona chinensis* and *Cassia angustifolia*, for their insecticidal and repellent effects against *Myzus persicae* and *Brevicoryne brassicae*. They found that the repellent activity of these extracts decreased with increasing concentration. Inayat et al., [43] evaluated the antioxidant activities of different fractions of methanolic extracts from these plants, ranging from 69.08% to 84.89%. The study indicated that these selected plants possess potential antimicrobial and antioxidant properties, which are beneficial for controlling diseases caused by various bacterial pathogens and neutralizing free radicals in the body [44,45].

6.5 Chemical

The use of systemic insecticides can effectively manage the mustard aphid *Lipaphis erysimi* (Kalt); however, this approach does not provide a long-term solution, as the aphid population returns to previous levels within two weeks after chemical application [13]. Imidacloprid 17.8 SL at a concentration of 0.2 g/litre demonstrated the most significant reduction among the insecticides tested against the mustard aphid *Lipaphis erysimi* Kalt. Imidacloprid 17.8 SL applied at a concentration of 0.2 g/litre resulted in an 87.53% reduction in mustard aphid incidence, while fipronil 5 SC applied at 1.0 ml/litre achieved an 83.56% reduction seven days after the initial spray. Similarly, a comparable trend was observed 15 days after spraying, with both chemicals showing reductions of 83.86% and 78.90%, respectively. The experiment was repeated after 15 days to monitor the aphid population, revealing that imidacloprid 17.8 SL at 0.2 g/litre remained the most effective, followed by fipronil 5 SC at 1.0 ml/litre and neem oil 2% at 2.0 ml/litre, as recorded 7 and 15 days after spraying [46]. Insecticides tested against *Lipaphis erysimi*, the mustard aphid, included imidacloprid 17.8 SL at 0.2 g/litre showed the highest reduction, decreasing the incidence of mustard aphids by 87.53%, followed by fipronil 5 SC at 1.0 ml/litre with an 83.56% reduction seven days after the first spray [47-49].

7. CONCLUSION

One of the most harmful insects to mustard is the aphid. One of the main causes of India's

declining mustard yield was this insect. It was discovered that the incidence of insects was noticeably higher in Jan.-Feb., when the mustard flowering season is characterized by low temperatures and higher relative humidity. Aphid infestations were once managed by farmers using two to three insecticide sprays. Even though they all agreed that insect pests were the leading cause of the reduction in India's mustard crop, none of them had expressed any interest in switching to alternative methods of chemical insecticides for aphid control. Therefore, growers need to educate people about using non-chemical pesticides to reduce aphids and growing mustard.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc have been used during writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology.

Details of the AI usage are given below:

1. ChatGPT

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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