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# Bio-pesticide management strategy for mustard aphid *Lipaphis erysimi* (Kaltenbach) (Homoptera: Aphididae)

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**Abstract**
Mustard aphid, *Lipaphis erysimi* (Kalt.) is a key pest on rapeseed-mustard. Experiment were undertaken to study the efficacy of biopesticides against mustard aphid in mustard crop. The efficacy of bio pesticides *viz*., *Beauveria bassiana*, *Verticillium lecanii*, azadirachtin and a standard insecticide check, dimethoate was studied against mustard aphid, *Lipaphis erysimi* under field conditions at Oil seed farm Kalyanpur, Chandrashekhar Azad University of Agriculture and Technology (C.S.A.U.A.T.), Kanpur, India. All the bio pesticides and standard check insecticide dimethoate were found equally effective in reducing the aphid population over the untreated control. The reduction of aphid after the application of all biopesticides and dimethoate was observed significantly superior over control at all the interval of observation. However, all the bio pesticidal treatments singly and in their combination were at par with the standard check insecticide dimethoate in terms of mean aphid population after the application of three sprays. Therefore, we recommend the use of biopesticides *Beauveria bassiana*, *Verticillium lecanii* and azadirachtin individually or in their combination as an eco-friendly and cost-effective alternative for the management of mustard aphid, *Lipaphis erysimi* (Kalt.).

**Keywords:** mustard aphid *Lipaphis erysimi*, bio pesticides, entomopathogenic fungi, *Beauveria bassiana*, *Verticillium lecanii*, azadirachtin

## Introduction
Rapeseed-mustard is an important oilseed crop which is grown in subtropical as well as tropical countries in the world. India is the second largest producer of this crop in the world (Dwivedi *et al.*, 2019) [3]. Rapeseed-Mustard is a most important edible oilseed crop in Northern India. In India, rapeseed-mustard is grown during *Rabi* season under rain-fed as well as irrigated conditions (Janu *et al.*, 2018) [9]. Mustard oil is an edible and high-energy food ingredient that is widely used in the preparation of foods to improve their palatability and flavour. Mustard oil seed cakes are also utilised as fertilisers and animal feed. (Cheema *et al.*, 2018) [1]. The yield of rapeseed-mustard is low due to various biotic and abiotic stresses.
Among the biotic stresses, mustard aphid, *Lipaphis erysimi* (Kalt.) considered to be the key pest of rapeseed and mustard crops in India (Gautam *et al.*, 2019) [5]. This dreaded pest infests the mustard crop and cause losses ranging from 19-96 per cent and adversely affects the oil production (Janu *et al.*, 2018) [9]. In past many workers have evaluated a number of chemical insecticides against insect pest and some of them have been found effective to control this insect. Use of chemical insecticides has been found more or less toxic to a number of parasitoid and predators i.e., *Diaeretiella rapae*, *Chrysoperla carnea*, coccinellids and syrphid flies present in mustard fields as natural enemies of aphid. Use of chemical pesticides is also responsible for environmental pollution, health hazards to human beings, toxic to pollinators, pest resurgence, development of resistance in insect-pests and residue in oil and cake (Meena *et al.*, 2013) [11]. Host plant resistance (HPR) is one of the most important cost effective and compatible mechanisms to manage insect pest which has adverse effects on the survival and other biological parameters of insect pests (Divekar *et al.*, 2019) [2]. Extreme and irrational use of synthetic chemicals for improved plant protection and plant productivity causes several adverse impacts on the ecosystem. Microbes belonging to different taxonomic group of bacteria, viruses, and fungi are employed in the biological suppression of phytopathogens. Such bioagents can more efficiently grow, survive and proliferate in several agro- horticultural ecosystems (Dukare *et al.*, 2020) [4]. A combination of the Entomopathogenic fungi like *Beauveria bassiana*, *Metarhizium anisopliae*, and *Lecanicillium lecanii* with neem oil at half of their recommended concentrations could be a viable eco-friendly option in the management

of the sucking pests of okra, along with the conservation of natural enemies (Halder *et al.,* 2021) [7]. Biocontrol agents like entomopathogenic nematodes are effective biological control agents for a variety of economically important insect pests and considered as potential alternatives to chemical insecticides (Gowda *et al.,* 2020) [6].

In recent year awareness towards the eco-friendly management of insect pest has been initiated and the insecticidal and antifeedent properties of some plant extracts has been reported against mustard aphid, ethanol extract of some plant materials were found effective against the pest under the laboratory condition as well as field condition (Pal *et al.,* 2020) [12]. An eco-friendly pest control approach against mustard aphid is the necessity of present time to safeguard the natural enemies and pollinators as well as human health. Keeping the above facts in mind the present investigation was undertaken to manage mustard aphid *Lipaphis erysimi* (Kaltenbach) through eco-friendly bio-pesticides.

## Materials and Methods

The experiment was conducted at Oil seed farm Kalyanpur, Chandrashekhar Azad University of Agriculture and Technology (C.S.A.U.A.T.), Kanpur, India (26°49′N latitude, 80°30′E longitude, 126 m altitude) during 2019-20. Seed of the "Urvashi" variety is provided by ICAR-DRMR, Bharatpur (ICAR- Directorate of Rapeseed & Mustard Research) and Oilseed Section C.S.A.U.A.T. Kanpur. The experiment was carried out in a randomised block design (RBD) with three replications and seven treatments. The plot size is 4.2 m x 3m.

### Evaluation of insecticides against mustard aphid, *Lipaphis erysimi*

The mustard aphid was regularly monitored during the crop season to impose treatments for management of mustard aphid on need basis. The application of treatments was done on the basis of ETL i.e. 25 aphids 10 cm−1 central twig per plant (Singh and Lal, 2011) [13].

The details of biopesticides and a standard insecticide check selected for the investigation were given in table 1. All of the treatments were sprayed with a Knapsack Sprayer at 15 days interval. Pre-treatment count of the insect pests was noted one day before insecticide application. The post treatments population of the insects were recorded regularly at ten randomly selected plants of each plot 3, 7, and 10 days after treatment application. The percentage reduction of the pest population over control was calculated by using the formula given by Henderson and Tilton (1955) [8].

**Table 1:** Insecticide for testing their effectiveness against mustard aphid.

| Treatments | Description | Trade Name | Formulation | Dose |
|---|---|---|---|---|
| T1 | *Beauveria bassiana* | Ecoria | 1.15 WP | 2g/L |
| T2 | *Verticillium lecanii* | Bioline | 1.15 WP | 2g/L |
| T3 | Azadirachtin | Achook | 5SL | 5ml/L |
| T4 | T1+T3 | - | - | T1 (2g/L) +T3 (5ml/L) |
| T5 | T2+ T3 | - | - | T1 (2g/L) +T3 (5ml/L) |
| T6 | Dimethoate | Rogor | 30 EC | 1ml/L |
| T7 | Untreated Control | - | - | - |

## Result and Discussion

### Efficacy of insecticides against mustard aphid, *Lipaphis erysimi*

The results of bio-efficacy of selected biopesticides against mustard aphid were presented in table 2. Pre-treatment count for mustard aphid population was non-significant and was recorded in the range of 79.69 to 89.12 (F (6, 14) = 1.07, p= 0.42) during season 2019-20. Significant differences were observed for the mean mustard aphid population among the treatments after first, second and third spray application (F (6, 14) = 13.29, $p$ <0.001); (F (6, 14) = 211.43, $p$ <0.001) and (F (6, 14) = 1125.82, $p$ <0.001), respectively. The pooled mean data showed that the aphid population was ranged in between 21.83-194.85 and the treatments were significantly different (F (6, 14) = 28.73, $p$ <0.001) (Table 1). Non-significant differences were observed in the treatments involving biopesticides, their combinations and dimethoate in terms of percent reduction over control after first, second and third spray of application ((F (6, 14) = 0.13, p=0.98); (F (6, 14) = 0.50, p= 0.76) and (F (6, 14) = 1.97, p =0.15), respectively. Pooled mean data in terms of percent reduction over control ranged in between 61.27- to 71.51. All the biopesticides and standard check insecticide dimethoate were found effective in reducing the aphid population over the untreated control. Results clearly revealed that the reduction of aphid after the application of all biopesticides and dimethoate treatments found significantly superior to control at all the interval of observation. However, all the bio pesticidal treatments singly and in their combination were at par with the standard check insecticide dimethoate in terms of mean aphid population after the application of three sprays. This clearly suggests that the *B. bassiana, M. anisopliae* and Azadirechtin singly and in combination are equally effective as dimethoate. Entomopathogenic fungi like *V. lecanii* or NSKE along with release of *C. septempunctata* can be used as alternative measure to manage mustard aphid instead of solely relying on insecticides (Yadav and Singh, 2015) [17].

Neem-based formulation nimbecidine has been reported compatible with *B. bassiana* and *L. lecanii* (Subbulakshmi *et al.,* 2012) [16]. Bio-efficacy of the insecticide imidacloprid 17.8% SL was at par with the different biopesticides, botanicals, and their combinations (Halder *et al.,* 2021) [7]. Dimethoate being a systemic insecticide used in the region over a decade. Local farmers frequently applied this insecticide more than their recommended concentration. Due to long-term regular use of this neonicotinoid in agri-horticultural ecosystem of the region caused development of resistance among sucking pests. The melon aphid, *Aphis gossypii* Glover, has developed 210-fold resistance to dimethoate (Lokeshwari *et al.,* 2016) [10]. Conversely, farmers are preferably using the pesticides as a first line of protection pest management over the biopesticides and other eco-friendly approaches. Therefore, the biopesticides alone and in their combinations proved equally effective as insecticide against mustard aphid, *L. erysimi.*

### Effect of biopesticides on yield and economics

The maximum yield recorded in treatment Dimethoate 30

EC@ 1ml/L is (2063 kg/ha) it was found to on par with treatment *Azadirachtin* 5 SL@ 5ml/L is (1930 kg/ha). Whereas minimum yield was recorded in control (745kg/ha). These results coincide with the finding of (Singh *et al.*, 2009) who observed a significantly higher yield of mustard seed under Dimethoate 30 EC @ 300 g a.i./ha. The higher efficacy of dimethoate for the management of mustard aphid *Lipaphis erysimi* (Kalt.) under field condition and with giving relatively the higher yield of mustard (Sinha *et al.*, 2001).

The highest IBCR (Incremental Benefit Cost Ratio) is recorded in Dimethoate 30 EC@ 1ml/L is (44.18) followed by Azadirachtin 5 SL@ 5ml/L is (11.10), *Verticellium leccani* 1.15 WP@ 2g/L is (10.47), *Beauveria bassiana* 1.15 WP @ 2g/L is (9.66) (Table 3). The lowest IBCR was obtained in *Azadirachtin* 5 SL@ 5ml/L followed by *Verticellium leccani* 1.15 WP @ 2g/L is (8.71), followed by *Azadirachtin* 5 SL@ 5ml/L followed by *Beauveria bassiana* 1.15 WP@ 2g/L is (9.14). (Yadav and Singh, 2015) [17] Reported the highest cost-benefit ratio (7.25) under the treatment of dimethoate @ 1 ml/l followed by *C. septempunctata* @ 5,000 beetles/ ha for the management of mustard aphid *Lipaphis erysimi* Kalt. Similarly, the most favourable cost-benefit ratio under the treatment in dimethoate 30 EC @ 300 g a.i. /ha (1:38) followed by neem seed kernel extract @ 5% (1:18) was also reported (Meena *et al.*, 2013) [11].

**Table 2:** Effect of biopesticides on the mustard aphid, *L. erysimi* in terms of reduction in population.

| Treatments | Mean population of mustard aphid per 10 cm central twig per plant | | | | | | | Pooled Mean population | Pooled Mean PROC |
|---|---|---|---|---|---|---|---|---|---|
| | 1 DBS | Spray I | PROC | Spray II | PROC | Spray III | PROC | | |
| T1 | 79.69a | 45.68a (6.79) | 61.00a | 21.11a (4.64) | 70.64a | 13.31a (3.71) | 59.87ab | 26.70a | 63.84a |
| T2 | 85.84a | 44.53a (6.71) | 64.71a | 22.03a (6.74) | 69.05a | 14.39a (3.85) | 50.05a | 26.98a | 61.27a |
| T3 | 85.02a | 41.04a (6.44) | 66.72a | 22.63a (4.80) | 67.04a | 13.85a (3.78) | 61.14ab | 25.84a | 64.97a |
| T4 | 89.12a | 44.39a (6.70) | 66.17a | 23.08a (4.85) | 67.92a | 11.47a (3.45) | 62.23ab | 26.31a | 65.44a |
| T5 | 84.09a | 42.23a (6.53) | 69.42a | 18.06a (4.30) | 74.04a | 8.94a (3.07) | 65.04b | 23.08a | 69.50a |
| T6 | 83.11a | 40.23a (6.38) | 72.55a | 17.09a (4.19) | 75.12a | 8.17a (2.94) | 66.85b | 21.83a | 71.51a |
| T7 | 84.55a | 154.98b (12.46) | - | 199.10b (14.12) | - | 230.48b (15.19) | - | 194.85b | - |
| F | 1.07 | 13.29 | 0.13 | 211.43 | 0.50 | 1125.82 | 1.97 | 28.73 | 1.33 |
| P | 0.42(NS) | <0.001 | 0.98(NS) | <0.001 | 0.76(NS) | <0.001 | 0.15(NS) | <0.001 | 0.31 (NS) |

PROC-Percent Reduction over control, Figures within parenthesis is$\sqrt{x}$ + 0.5 transformed value, DBS =Days before Spraying, DAS =Days after spraying

**Table 3:** Economics analysis of different treatments against mustard aphid, *L. erysimi*

| Treatment | Cost of insecticides (Rs. / ha) | Labour charge (Rs. / ha) | Total Expenditure (Rs. / ha) | Mean yield (kg/ha) | Gross income* (Rs. / ha) | Net return over control (Rs. /ha) | IBCR |
|---|---|---|---|---|---|---|---|
| T1 | 4024.00 | 696.00 | 4720.00 | 1930 | 85402.00 | 52436.00 | 11.10 |
| T2 | 2957.00 | 696.00 | 3653.00 | 1500 | 66375.00 | 33409.00 | 9.14 |
| T3 | 1870.00 | 696.00 | 2586.00 | 1310 | 57967.00 | 25001.00 | 9.66 |
| T4 | 3057.00 | 696.00 | 3753.00 | 1484 | 65667.00 | 32701.00 | 8.71 |
| T5 | 1890.00 | 696.00 | 2586.00 | 1357 | 60047.00 | 27081.00 | 10.47 |
| T6 | 624.00 | 696.00 | 1320.00 | 2063 | 91287.00 | 58321.00 | 44.18 |
| T7 | | | | 745 | 32966.00 | | |

IBCR= Incremental Benefit Cost Ratio

*Total expenditure includes cost of labour and cost of insecticide

** Income based on produce/ha and sale price of mustard @ 4425/q

## Conclusion

Biopesticides like *B. bassiana*, *M. anisopliae* and Azadirechtin were proved equally effective in the management of mustard aphid, *Lipaphis erysimi*. Considering the yield and economics of these biopesticides are the one of the cost effective alternatives to the chemical insecticides. Therefore, we recommend the use of biopesticides as an eco-friendly and economically viable alternative for the management of mustard aphid, *Lipaphis erysimi* in mustard.

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