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BIOEFFICACY OF DIFFERENT NEWER INSECTICIDES AGAINST MUSTARD APHID, *LIPAPHIS ERYSIMI (*KALTENBACH) UNDER SOUTH GUJARAT CONDITIONS

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ABSTRACT

The mustard aphid, *Lipaphis erysimi* (Kaltenbach), is a major pest limiting mustard productivity in India. A field experiment was conducted during *Rabi* 2023-24 at the College Farm, N.M. College of Agriculture, Navsari Agricultural University, Navsari, Gujarat, to evaluate the efficacy and economics of different insecticides against *L. erysimi* on mustard variety GM 3. The experiment was laid out in a randomized block design with eight treatments replicated thrice. Among the tested insecticides, flonicamid 50 WG (0.015%) was the most effective treatment, registering the lowest aphid index (0.59), highest seed yield (1696.67 kg/ha), maximum yield increase over control (98.83%), and the highest net return (□47,648.33/ha) with an incremental cost benefit ratio (ICBR) of 1:7.86. Afidopyropen 50 g/L DC (0.01%) and tolfenpyrad 15 EC (0.03%) were the next best treatments, statistically at par in reducing aphid population and enhancing yield. Clothianidin 50 WDG (0.005%) and thiamethoxam 25 WG (0.0025%) showed moderate effectiveness, while cyantraniliprole 10.26 OD (0.012%) and diafenthiuron 50 WP (0.06%) were the least effective.

Keywords **:** Mustard (*Brassica juncea*), *Lipaphis erysimi*, Bioefficacy of insecticides.

Introduction

Oilseed crops play a vital role in Indian agriculture, accounting for about 13% of the gross cropped area and 10% of the total value of agricultural products (Anon., 2022). Among oilseeds, mustard (*Brassica juncea* L. Czern. & Coss), also known as raya or rai, is the second most important crop after groundnut during the *rabi* season, contributing nearly 27.8% to the oilseed economy of India. India ranks third in global mustard production after Canada and China, contributing around 14% of the world's output (Anon., 2022). In Gujarat, mustard is cultivated in 6.79 lakh hectares with a productivity of 1996 kg/ha, with Banaskantha and Mehsana districts being major producers (DOA, 2021). Mustard seeds are valued for their high oil content (38–46%), proteins, essential fatty acids, and micronutrients, making the crop nutritionally and economically important (Dharavath *et al*., 2017). However, the productivity of mustard is constrained by several insect pests. More than 38 species have been reported on mustard, of which the mustard aphid, *Lipaphis erysimi* (Kaltenbach) (Hemiptera: Aphididae), is the most destructive (Bakhetia *et al*., 1989). Both nymphs and adults suck sap from tender plant parts, leading to stunting, poor pod setting, reduced seed weight, and quality losses. Infestation also promotes sooty mould growth on honeydew excretions, hampering photosynthesis (Gautam *et al*., 2019). Yield losses caused by this pest range from 35–96%, with significant reductions in seed weight and oil content (Chaudhari *et al*., 2022).

To mitigate these losses, chemical control remains the most practical option under field conditions, although overuse of conventional insecticides has led to concerns such as insecticide resistance, environmental hazards, and effects on natural enemies (Furlong & Zalucki, 2017). In this context, evaluation of newer insecticides with novel modes of action is necessary to achieve effective aphid management, enhance crop productivity, and ensure economic

viability. Therefore, the present investigation was undertaken to assess the bioefficacy and economics of different insecticides against mustard aphid under field conditions in South Gujarat.

Materials and Methods

In order to evaluate the efficacy of various insecticides against *L. erysimi* in mustard. The present investigation was conducted during the Rabi season of 2023-24 at College Farm, N.M. College of Agriculture, Navsari Agricultural University, Navsari, Gujarat. The research farm is geographically situated at the coastal region of South Gujarat at N 20˚55'24.3" latitude and E 72˚54'33.6" longitude with an altitude of 11.98 meters above the mean sea level. The weather during the growing season was normal and favourable for the crop growth. The experiment was laid out in a following randomized block design with three replications and eight treatments. The crop variety Gujarat Mustard 3 (GM 3) was sown on 22nd November with plot size of 4.05 m x 2.55 m and distance between row to row and plant to plant was 45 cm and 15 cm, respectively. Recommended agronomical practices were followed for raising the crop. Details of treatments are given as under.

Table 1: Details of treatments

Tr. No.	Insecticides	Concentration (%)	Dose (ml or g/10 l of water)
T_1	Afidopyropen 50 g/L DC	0.01	2
T_2	Clothianidin 50 WDG	0.005	1
T_3	Cyantraniliprole 10.26 OD	0.012	12
T_4	Diafenthiuron 50 WP	0.06	12
T_5	Flonicamid 50 WG	0.015	3
T_6	Thiamethoxam 25 WG	0.0025	1
T_7	Tolfenpyrad 15 EC	0.03	20
T_8	Control (Water spray)	-	-

In order to evaluate the efficacy of different insecticides, observations on aphids were recorded from ten randomly selected tagged plants from each net plot on before first spray as well as pre-treatment counts of aphid were made from ten randomly selected plant from net plot before 24 hrs and post-treatment counts were made after 1, 3, 5, 7, 10 and 14 days of each spray. The pest population was estimated by adopting zero to five indexes. The aphid index (Table 2) was recorded according to the grading system suggested by Mundra and Shah (1998). The first application was given on build up the sufficient population of aphid in mustard and Subsequent spray was made after 15 days of the first application.

Table 2: Aphid index and criteria

Grading No.	Criteria
0	No aphid on plant
1	One or two aphids (Nymphs/Adults) found without any colony
2	Small colony on plant but no damage
3	Big colony on plant build up still number of aphid in each colony can be counted. Plants are found damaged
4	Number of aphids on plant cannot be counted, plant withered with big colony on plant
5	Big colonies on plant and number of aphids cannot be counted, plant withered, development hampered and plant even dries up

The average aphid index was worked out by using following formula.

$$\textbf{Average aphid index} = \frac{\textbf{0N + 1N + 2N + 3N + 4N + 5N}}{\textbf{Total number of plants observed}}$$

Where,

0, 1, 2, 3, 4 and 5 are the grading numbers

N= Number of plants showing respective grading number

The periodical data of aphid populations were recorded before the treatment application and post treatment application from each treatment were statistically analyzed by adopting square root transformation. The data on aphid populations were analyzed periodically as well as pooled over periods.

Yield and Economics

The crop was harvested at time of physiologically mature and pods allowed to dry. The produce of each plot was harvested, threshed and cleaned to remove the trash. Seed yield per net plot was recorded from the net

plot area. The yield of mustard was recorded in kilograms per net plot, and thereafter it was converted to hectare basis. The per cent increase in yield over control was calculated by using the following formula.

$$\text{Percent yield increase over control (\%)} = \frac{T - C}{C} \times 100$$

Where,

T = Yield of insecticidal treatment (kg/ha)

C = Yield of treated control (kg/ha)

Moreover, Incremental Cost Benefit Ratio (ICBR) was also worked out for each treatment to ascertain the economics of different insecticidal treatments against *L. erysimi* infesting mustard. For this purpose, additional income and additional cost of treatment per hectare including labour expenditure was calculated for each treatment based on prevailing market price of each insecticide and mustard seed. Thus, effective insecticidal treatment was determined based on its efficacy and economics.

Results and Discussion

With a view to find out the bioefficacy of chemical insecticides against *L. erysimi* infesting mustard, seven insecticide *viz*., Afidopyropen 50 g/l DC @ 0.2 ml/l, Clothianidin 50 WDG @ 0.1 g/l, Cyantraniliprole 10.26 OD @ 1.2 ml/l, Diafenthiuron 50 WP @ 1.2 g/l, Flonicamid 50 WG @ 0.3 g/l, Thiamethoxam 25 WG @ 0.1 g/l, Tolfenpyrad 15 EC @ 2 ml/l were evaluated in comparison with control during *rabi*, 2023-24.

The pooled results of first spray presented in Fig. 1 revealed that the treatment of flonicamid 50 WG at 0.015 per cent was found to be superior among all other tested insecticidal treatments, which recorded 0.67 aphid index. The treatments of afidopyropen 50 g/l at 0.01 per cent (1.29 aphid index) and tolfenpyrad 15 EC at 0.03 per cent (1.31 aphid index) were recorded as next in order of effectiveness and statistically at par with each other. Further, the next best effective treatments were clothianidin 50 WDG at 0.005 per cent (2.10 aphid index) which was statistically at par with thiomethoxam 25 WG at 0.0025 per cent (2.11 aphid index). The remaining treatments viz., cyantraniliprole 10.26 OD at 0.012 per cent (2.97 aphid index) and diafenthiuron 50 WP at 0.06 per cent (3.02 aphid index) were found moderately effective, which was statistically at par with each other. Moreover, the aphid population was found to be highest in the untreated control (4.02 aphid index).

More or less similar trend of efficacy was observed during second spray (Fig. 1) resulted that the flonicamid 50 WG at 0.015 per cent was found to be superior among all other treatments which recorded 0.50 aphid index. The next best effective treatment was afidopyropen 50 g/l at 0.01 per cent (1.13 aphid index) and tolfenpyrad 15 EC at 0.03 per cent (1.14 aphid index), which were statistically at par with each other. Further, the next effective treatment was clothianidin 50 WDG at 0.005 per cent (1.93 aphid index), which was statistically at par with treatment of thiomethoxam 25 WG at 0.0025 per cent (1.94 aphid index). Moreover, the remaining treatments *i.e*. cyantraniliprole 10.26 OD at 0.012 per cent (2.88 aphid index) and diafenthiuron 50 WP at 0.06 per cent (2.89 aphid index) were found to be next in order of effectiveness and statistically at par with each other. However, the highest aphid population (3.97 aphid index) was recorded in control.

The result of pooled data over spray of first and second spray on infestation of aphid in *rabi* season during the year 2023-24 presented in Fig. 1 revealed that the treatment of flonicamid 50 WG at 0.015 per cent was found to be most effective against aphid with recorded 0.59 aphid index. The next best effective treatment was afidopyropen 50 g/l at 0.01 per cent (1.21 aphid index), which was statistically at par with tolfenpyrad 0.03 (1.22 aphid index). Moreover, the treatment of clothianidin 50 WDG at 0.005 per cent (2.02 aphid index) and thiomethoxam 25 WG at 0.0025 per cent (2.03 aphid index) were found to be next in order of effectiveness and statistically at par with each other. Whereas, the remaining treatments of cyantraniliprole 10.26 OD at 0.012 per cent (2.92 aphid index) were found least effective, which was at par with diafenthiuron 50 WP at 0.06 per cent (2.96 aphid index). Whereas, the highest population of aphids (3.99 aphid index) was observed in untreated control.

In nut-shell results of both sprays and pooled data over the period indicated that aphid, *L. erysimi* can be effectively managed by spray application of flonicamid 50 WG at 0.015 per cent. The next most effective treatments were afidopyropen 50 g/l at 0.01 per cent and tolfenpyrad 0.03 per cent, which were statistically at par with each other. Further, the treatments of clothianidin 50 WDG at 0.005 per cent and thiomethoxam 0.0025 per cent were found to be next in order of effectiveness and statistically at par with each other. The rest of the treatments *i.e*. cyantraniliprole 10.26 OD at 0.012 per cent and diafenthiuron 50 WP at 0.06 per cent were least effective and statistically at par with each other. These results are concerned with the findings of Kanjiya (2017) found that the lowest aphid index (0.44) was found in the treatment of flonicamid 0.015 per cent. According to Bavisa *et al*. (2018b), the

lowest aphid index (1.01) was noticed in the treatment of flonicamid 0.015 per cent. Further, Italiya et al. (2018) revealed that minimum aphid population *i.e*. 2.63 aphids per 5 cm shoot was recorded in treatment of tolfenpyrad at 0.03 per cent, followed by flonicamid at 0.015 per cent (4.98 aphid /5 cm shoot). However, Mahato and Misra (2019) found that tolfenpyrad 15 EC effective against *A. gossypii*. Similarly, Chaudhary *et al.* (2020) reported that the lowest aphid index (1.04 aphid index) was registered in seed treatment with imidacloprid with spray of flonicamid. Chavada *et al.* (2020) reported that the lowest number of aphids (2.04 aphid/3 leaves) was observed in the treatment of tolfenpyrad and it was at par with flonicamid (2.19 aphid/3 leaves) and afidopyropen (2.37 aphid/3 leaves) followed by thiamethoxam 25 WG at 5 per cent (4.33 aphid/3 leaves). Shewale and Borad (2020) found that the least aphid index (0.43) was observed in treatment of flonicamid at 0.015 per cent, and it was at par with tolfenpyrad at 0.03 per cent (1.21) against Fennel aphid, *H. coriandri*.

Seed yield

The significantly highest (1696.67 kg/ha) grain yield was obtained in treatment of flonicamid 50 WG 0.015 per cent (Table 3). The next best effective treatments were tolfenpyrad 15 EC at 0.03 per cent (1396.67 kg/ha) and afidopyropen 50 g/l DC 0.01 per cent (1203.33 kg/ha), which were statistically at par with each other. However, the treatment of clothianidin 50 WDG at 0.005 per cent (1103.33 kg/ha) and thiamethoxam 25 WG at 0.0025 per cent (1053.33 kg/ha) were found to next best in order of effectiveness and statistically at par with each other. Further, the least yield among all evaluated insecticides, was produced in treatment of cyantraniliprole 10.26 OD at 0.012 per cent (1030.00 kg/ha) which was statistically at par with the treatment of diafenthiuron 50 WP at 0.06 per cent (1036.67 kg/ha). The lowest yield (853.33 kg/ha) was obtained in the untreated control.

Yield increase over control

The maximum increase in seed yield i.e. 98.83 per cent was calculated from the plots treated with flonicamid 50 WG 0.015 per cent (Table 3). The treatment of tolfenpyrad 15 EC at 0.03 per cent (63.67%) was found to be next effective, followed by afidopyropen 50 g/l DC at 0.01 per cent (41.02%). Moreover, the lowest increase in yield over control was exhibited in the treatment of cyantraniliprole 10.26 OD at 0.012 per cent (20.70%) followed by diafenthiuron 50 WP at 0.06 per cent (21.48%), thiamethoxam 25 WG at 0.0025 per cent (23.44%) and clothianidin 50 WDG at 0.005 per cent.

Economics

Economics of various insecticides (Table 3) evaluated against *L. erysimi* infesting mustard indicated that maximum (47648.33 Rs./ha) realization was obtained in the treatment of flonicamid 50 WG at 0.015 per cent, which was followed by tolfenpyrad 15 EC at 0.03 per cent (30698.33 Rs./ha) and afidopyropen 50 g/l DC 0.01 per cent (19775.00 Rs./ha). The treatment of clothianidin 50 WDG at 0.005 per cent, thiamethoxam 25 WG at 0.0025 per cent and diafenthiuron 50 WP 0.06 per cent worked out the realization of 14125.00 Rs./ha, 11300.00 Rs./ha and 10358.33 Rs./ha, respectively. The lowest realization (9981.67 Rs./ha) was obtained in treatment of cyantraniliprole 10.26 OD at 0.012 per cent.

Looking to the ICBR, the highest (1:7.86) incremental cost benefit ratio was obtained when crop was treated with flonicamid 50 WG at 0.015 per cent, which was followed by afidopyropen 50 g/l DC at 0.01 per cent (1:7.16). The ICBR calculated as 1:5.77, 1:3.97, 1:3.50 and 1:1.32 in treatments of thiamethoxam 25 WG at 0.0025 per cent, clothianidin 50 WDG at 0.005 per cent, tolfenpyrad 15 EC at 0.03 per cent and cyantraniliprole 10.26 OD at 0.012 per cent. Whereas, the lowest (1:1.18) incremental cost benefit ratio was found in treatment of diafenthiuron 50 WP at 00.06 per cent. flonicamid 50 WG at 0.015 per cent and afidopyropen 50 g/l DC at 0.01 per cent registered higher ICBR, however these insecticides were fall under moderately effective insecticides against aphids in mustard. The results are in agreement with the findings of Kanjiya (2017), who obtained the highest seed yield (2880 kg/ha) in treatment of flonicamid 50 WG (0.015%) and the highest (1:70.25) ICBR was found in treatment of dimethoate 30 EC (0.030%) followed by flonicamid 50 WG (1:32.82) and thiamethoxam 25 WG (1:24.59) in fennel. Bavisa *et al*. (2018b) reported that highest (1:16.93) Incremental Cost Benefit Ratio (ICBR) was found in treatment of imidacloprid at 0.005 per cent followed by flonicamid at 0.02 per cent (1:12.20) and clothianidin at 0.003 per cent (1:09.71). According to Italiya *et al.* (2018), the highest increase in seed yield over control and maximum net realization was obtained in plot treated with tolfenpyrad 0.03% (145.22% and 161131 Rs./ ha, respectively) followed by flonicamid (137.45% and 154938 Rs./ha, respectively). Shewale and Borad (2020) found that the highest seed yield (23.12 q/ha) of fennel was in treatment of flonicamid 50 WG at 0.015 per cent and it was at par with tolfenpyrad 15 EC at 0.03 per cent (22.80 q/ha).

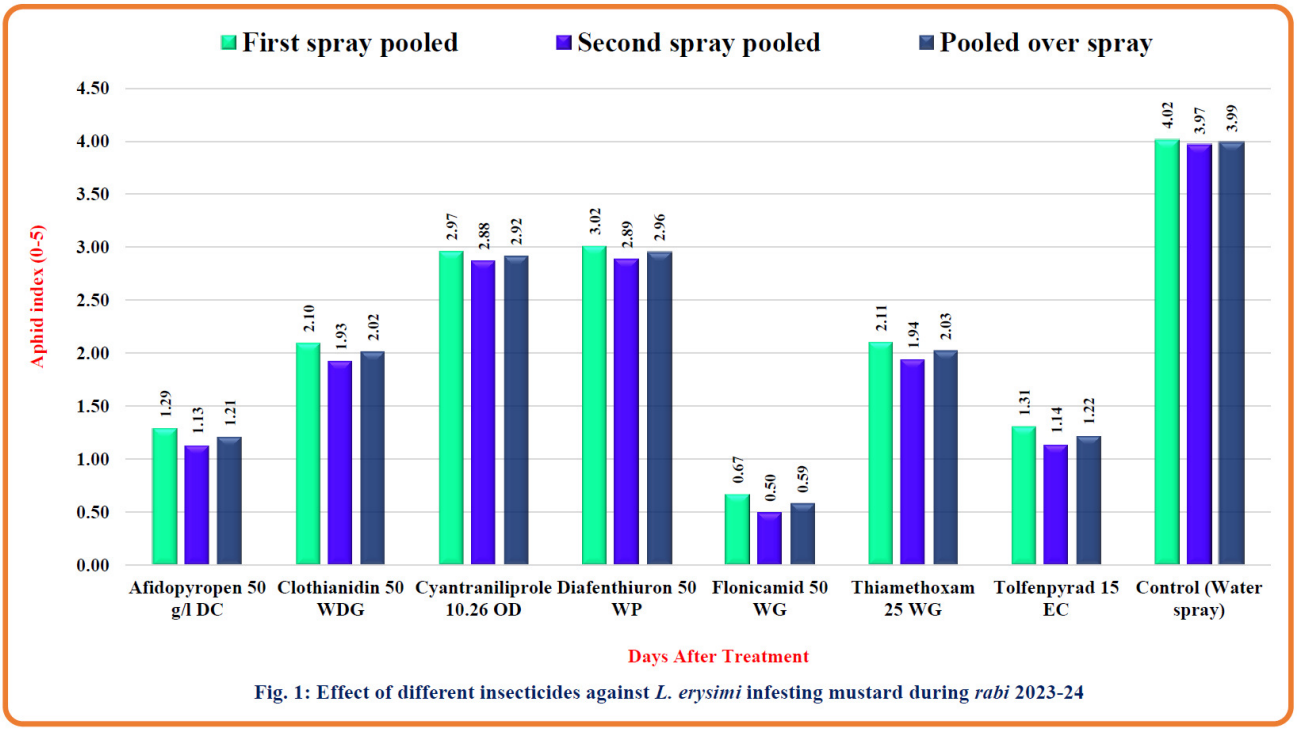

Fig. 1: Effect of different insecticides against *L. erysimi* infesting mustard during *rabi* 2023-24

Table 3: Impact of insecticides on seed yield of mustard and economics of insecticides

No.	Treatment	Conc. (%)	Yield (kg/ha)	Yield increase over control (%)	Realization (Rs./ha)	ICBR
T_1	Afidopyropen 50 g/l DC	0.01	1203.33	41.02	19775.00	1: 7.16
T_2	Clothianidin 50 WDG	0.005	1103.33	29.30	14125.00	1: 3.97
T_3	Cyantraniliprole 10.26 OD	0.012	1030.00	20.70	9981.67	1: 1.32
T_4	Diafenthiuron 50 WP	0.06	1036.67	21.48	10358.33	1: 1.18
T_5	Flonicamid 50 WG	0.015	1696.67	98.83	47648.33	1: 7.86
T_6	Thiamethoxam 25 WG	0.0025	1053.33	23.44	11300.00	1: 5.77
T_7	Tolfenpyrad 15 EC	0.03	1396.67	63.67	30698.33	1: 3.50
T_8	Control (Water spray)	-	853.33	-	-	-
S.Em. ±		-	0.03	-	-	-
CD at 5%		-	-	-	-	-
CV%		-	8.40	-	-	-

Conclusion

The present investigation revealed that foliar application of flonicamid 50 WG at 0.015 per cent found most effective against mustard aphid under field condition which produced highest grain yield and best return on investment (cost benefits ratio of 1:7.86). Thus, flonicamid 50 WG at 0.015 per cent could return Rs. 7.86 for every rupee you spend. Therefore, insecticide flonicamid 50 WG at 0.015 percent appears to be the most profitable choice for protecting mustard crop from aphids. Afidopyropen 50 g/L DC (0.01%) and tolfenpyrad 15 EC (0.03%) were the next best alternatives, whereas clothianidin 50 WDG (0.005%) and thiamethoxam 25 WG (0.0025%) exhibited moderate effectiveness. Cyantraniliprole 10.26 OD (0.012%) and diafenthiuron 50 WP (0.06%) were comparatively less effective and are not economical for aphid management in mustard.

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