Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2018; 6(6): 400-403

Received: 16-09-2018
Accepted: 18-10-2018

Bharat Lal
Ph. D. Scholar, RVSKVV, Gwalior, Madhya Pradesh, India

MK Nayak
Assistant Professor, Department of Entomology, JNKVV, College of Agriculture, Tikamgarh, Madhya Pradesh, India

DS Tomar
Associate Professor, Department of Plant Pathology, JNKVV, College of Agriculture, Tikamgarh, Madhya Pradesh, India

SR Thakur
Senior Technical Officer, Department of Entomology, JNKVV, College of Agriculture, Tikamgarh, Madhya Pradesh, India

Correspondence
MK Nayak
Assistant Professor, Department of Entomology, JNKVV, College of Agriculture, Tikamgarh, Madhya Pradesh, India

Efficacy of newer insecticides against mustard aphid, *Lipaphis erysimi* (Kalt.) in Indian mustard under Bundelkhand Agro climatic zone of Madhya Pradesh

Bharat Lal, MK Nayak, DS Tomar and SR Thakur

Abstract
An experiment was conducted during *Rabi* 2016-17 on mustard crop to test the bio- efficacy of insecticides namely Imidacloprid 17.8% SL, Acetamiprid 20% SP, Thiamethoxam 25% WG, NSKE 5%, Imidacloprid 17.8% SL + NSKE 5%, Acetamiprid 20% SP + NSKE 5%, Thiamethoxam 25 WG + NSKE 5% against mustard aphid. The results revealed that Imidacloprid 17.8 SL + NSKE 5% proved to the most effective in controlling the incidence of aphid followed by Thiamethoxam 25% WG + NSKE 5%. However, the NSKE 5% proved to be least effective. The highest net profit and incremental cost benefit ratio was observed from the plot treated with Imidacloprid 17.8% SL (Rs 19564/ha and 1:15.52) followed by Thiamethoxam 25% WG (Rs 18484/ha and 1:15.40). The maximum seed yield of 1621 kg/ha was recorded with the application of Imidacloprid 17.8 SL + NSKE 5% which was 581 kg/ha (35.84%) more than the control. Other treatments gave yield ranging from 1390-1606 kg/ha.

Keywords: Indian mustard, efficacy, *Lipaphis erysimi*, insecticide and biopesticide

1. Introduction
Oilseeds have been the backbone of agricultural economy of India since long. Indian vegetable oil economy is the fourth largest in the world next to U.S.A., China and Brazil. Oilseed *Brassica* because of resilience to grow under diverse agro-climatic conditions have gained good momentum in India. These crops are second most important after groundnut in our country contributing about 22.6% of the total oil production [1].

India accounts for 14.8% of rapeseed production at the global level and occupies a prime position in the World [2]. Indian mustard [*Brassica juncea* (L.) Czern and Coss.] is the premier oilseed *Brassica* which covers about 85-90% of the total area under cultivation of all these crops. During past few years it has gained substantial importance due to the fact that it possesses inherent high yielding ability and relative tolerance to biotic and abiotic stresses with wider adaptation. Rapeseed-mustard (*Brassica spp.*) are the major *Rabi* oilseed crops, grown over an area of 6.34 million hectare with a production of 7.82 million tones and productivity of 1234 kg/ha in 2012-13 in India [3]. Madhya Pradesh contributes nearly 10 per cent of the total mustard production in the country [4]. In Madhya Pradesh mustard crop is cultivated in area about 7.79 lakh ha with the production of 6.63 lakh tones and productivity of 851 Kg/ha [4]. More than 43 species of insect pests have been reported to infest rapeseed-mustard crop in India, of which sawfly (*Athalia lugens proxima*), aphid (*Lipaphis erysimi*), painted bug (*Bagrada hilaris*) and leaf miner (*Phytomyza horticola*) are the important ones. Among these, mustard aphid, *L. erysimi* (Hemiptera: Aphididae) is the major limiting factor causing up to 96 per cent yield losses and 5-6 per cent reduction in oil content [5]. A number of chemical insecticides have been found effective against this pest in different parts of the country [6, 7]. But the indiscriminate use of the insecticides has resulted into several problems like environmental pollution, health hazards to human beings, toxicity to pollinators & natural enemies etc. However chemical insecticides still remain the key tool for the control of this pest among farmers. New molecules are now emerging as a viable component of IPM strategies on all crops in view of their good efficacy to pest control and safety to non target organisms. Therefore, the present investigation was undertaken to evaluate the efficacy of some new insecticides against mustard aphid.

2. Materials and Methods

The field experiment was conducted at Research Farm, Jawaharlal Nehru Krishi Vishwa Vidyalaya, College of Agriculture, Tikamgarh (M.P.), India, during the *Rabi* season of 2016-2017. *Brassica juncea* cultivar "Pusa Bold" was sown in a plot size of 3.5 x 3.0 m^2 on 22nd October with row to row and plant to plant distance as 30 cm and 15 cm respectively. Experimental area was conducted in a Randomized Block Design with 3 replicates. All the agronomical practices were followed to raise a healthy crop. Eight treatments including control were T1: Imidacloprid 17.8 SL@ 300 ml per ha, T2: Acetamiprid 20 SP@ 500 gm per ha, T3: Thiamethoxam 25 WG@100 gm per ha, T4: NSKE 5% @ 3000 ml per ha, T5: Imidacloprid 17.8 SL + NSKE 5% @ (300 ml + 3000 ml) per ha, T6: Acetamiprid 20 SP + NSKE 5%@ (500 gm + 3000 ml) per ha, T7: Thiamethoxam 25 WG + NSKE 5%@ (100 gm + 3000 ml) per ha and T8: control (untreated) with no spray. The population of aphids was recorded on the 5 randomly selected plants from each plot one day prior to insecticide application and at 3, 7 and 15 days after spray of insecticides. The weekly aphid population was recorded on central terminal twigs (10 cm) randomly selected 5 plants/plot. The aphids were removed from the plants with the help of a soft brush and placed on a piece of white paper. Their number was counted by visual observation. Yield was also recorded from net plot area and converted in to kilogram per ha and data were statistically analyzed as per statistical guidelines given by Gomez and Gomez (1984). The percentage reduction of pest populations over control was also calculated by using the following formula giving by Henderson and Tilton (1955) [8].

3. Results and Discussion

To minimize the mustard aphid *L. erysimi* population, two sprays of newer insecticide alongwith combination of plant product were applied at 15 days intervals

3.1 First application

The data obtained from first spray against the population of *Lipaphis erysimi*/ 10 cm central apical twig at 24 hrs before and 3rd, 7th and 15th days after treatment were analyzed (Table 1). The mean aphid population before treatment was varied from 58.53 to 62.00 per 10 cm central apical twig and did not differ significantly. Data recorded on the third day after treatment**,** showed a decrease of an aphid population in all the treatment and increase in control plot. The minimum aphid was recorded in the plot treated with Imidacloprid + NSKE (13.20 aphids/10 cm central apical twig) and it was significantly superior to the rest of the treatment. It was followed by Thiamethoxam + NSKE (14.93 aphids/10 cm central apical twig), Acetamiprid + NSKE (15.10 aphids/10 cm central apical twig), Imidacloprid (17.60 aphids/10 cm central apical twig), Thiamethoxam (18.00 aphids/10 cm central apical twig), Acetamiprid (20.57 aphids/10 cm central apical twig) respectively. The observation recorded on the seventh day after the first application, aphid population was Imidacloprid + NSKE (13.90 aphids/10 cm central apical twig) was found to be the most effective. It was closely followed by Thiamethoxam + NSKE (14.03 aphids/10 cm central apical twig) and Acetamiprid + NSKE (14.97 aphids/10 cm central apical twig) respectively. The NSKE (46.13 aphids/10 cm central apical twig) was observed significantly least effective treatment. Observation recorded on the fifteenth day after first application exhibited increase pattern of aphids in all the treatments but still all treatments maintained their efficacy and significance over control. The most effective treatment was found Imidacloprid + NSKE (18.47 aphids/10 cm central apical twig which was at par with Thiamethoxam + NSKE (19.03 aphids/10 cm central apical twig). The next effective treatment was Acetamiprid + NSKE (21.10 aphids/10 cm central apical twig) followed by Imidacloprid (21.53 aphids/10 cm central apical twig), Thiamethoxam (21.57 aphids/10 cm central apical twig), Acetamiprid (24.90 aphids/10 cm central apical twig). Neem seed kernel extract (46.13 aphids/10 cm central apical twig) was the significantly least effective treatment.

On the basis of the overall mean the difference in aphid population among different treatment were significantly as compared to control plot (75.67 aphids/10 cm central apical twig). Imidacloprid + NSKE proved to be most effective in controlling the incidence of aphid (15.19 aphids/10 cm central apical twig) and provided a 79.93% reduction in population over control. Thiamethoxam + NSKE and Acetamiprid + NSKE recorded 16.00 and 17.36 aphids/10 cm central apical twig and they provided 78.86 and 77.06% reduction in population over control respectively. Imidacloprid was statistically at par with Thiamethoxam with 18.22 and 18.41 aphids/10 cm central apical twig and they provided 75.93 and 75.68% reduction in population over control respectively. Acetamiprid gave 71.70% reduction in aphid population, while NSKE was significantly poor and gave 38.08% reduction in aphid population but it is superior over control (Table 1). The present findings are in partial agreement with those of [9, 10]. They evaluated seven insecticides in the field against mustard aphid and found that maximum mortality of mustard aphid with highest yield (1963.5 kg ha-1) was observed in plot treated with Imidacloprid.

3.2 Second application

The second insecticide sprays was applied 15 days after first spray and data recorded on the incidence of *L. erysimi* (Table 2). A similar trend of efficacy of treatment as in first application on reduction of aphid was recorded after the second spray and all the treatment proved better than the control. Observation recorded on third day after second application revealed that Imidacloprid + NSKE (10.53 aphids/10 cm central apical twig) was found to be the again most effective treatment. The next effective treatment was Thiamethoxam + NSKE (11.47 aphids/10 cm central apical twig) followed by Acetamiprid + NSKE (12.63 aphids/10 cm central apical twig), Imidacloprid (11.20 aphids/10 cm central apical twig), Thiamethoxam (12.03 aphids/10 cm central apical twig), Acetamiprid (13.27 aphids/10 cm central apical twig). NSKE (41.53 aphids/10 cm central apical twig) was observed least effective in reducing the incidence of aphid. Data recorded on the seventh day after second application showed that all the treatments were found significantly effective in reducing the population of aphid as compared to untreated plots (86.47 aphids/10 cm central apical twig). Imidacloprid + NSKE (9.93 aphids/10 cm central apical twig) maintained its efficacy and recorded lowest aphid population. The next effective treatment was Thiamethoxam + NSKE (10.93 aphids/10 cm central apical twig) followed by Acetamiprid + NSKE (11.80 aphids/10 cm central apical twig), Imidacloprid (11.60 aphids/10 cm central apical twig), Thiamethoxam (11.97 aphids/10 cm central apical twig), Acetamiprid (12.90 aphids/10 cm central apical twig). The NSKE (42.20 aphids/10 cm central apical twig) was

significantly least effective in comparison to all tested insecticides. After the fifteenth day of insecticide application all the insecticidal treatments were still observed to be significantly effective in reducing the population of aphid as compared to untreated plots (86.87 aphids/10 cm central apical twig). The minimum population of aphid was recorded with Imidacloprid + NSKE (11.43 aphids/10 cm central apical twig). The next treatment was Thiamethoxam + NSKE (11.87 aphids/10 cm central apical twig) followed by Acetamiprid + NSKE (12.27 aphids/10 cm central apical twig), Imidacloprid (12.90 aphids/10 cm central apical twig), Thiamethoxam (12.93 aphids/10 cm central apical twig), Acetamiprid (13.07 aphids/10 cm central apical twig). NSKE (34.40 aphids/10 cm central apical twig) was observed significantly least effective than all tested insecticides.

Pooled statistical analysis of all the three observations (3, 7 and 15 DAS) of second spray indicated that all the insecticidal treatments were significantly effective in reducing the population of aphid as compared to control (86.23 aphids/10 cm central apical twig). The treatment Imidacloprid + NSKE, Thiamethoxam + NSKE and Acetamiprid + NSKE were very promising, which gave lesser aphid population i.e. 10.63, 11.42 and 12.23 aphids/10 cm central apical twig with 87.71%, 86.76% and 85.82% reduction in comparison to control plot respectively. Meanwhile Imidacloprid, Thiamethoxam and Acetamiprid showed 86.20%, 85.73% and 84.84% reduction in aphid population in comparison to the untreated plot respectively. The NSKE (39.38 aphids/10 cm central apical twig) was found significantly least effective than all tested insecticides which gave 54.32% reduction in aphid (Table 2). These results coincide with the findings of [11] they concluded that the lowest incidence of aphids was observed in combination of NSKE 5% and Imidacloprid 17.8% SL. While [12] indicated that Imidacloprid 17.8 SL @ 20 g a.i. per ha (0.70 aphids/10 cm main apical shoot & 97.88 per cent reduction over control) was most effective among all the tested treatments followed by Thiamethoxam 25 WG @ 25 g a.i. per ha (0.90 aphids/10 cm main apical shoot & 97.27 per cent reduction over control) and Dimethoate 30 EC @ 300 g a.i. per ha (1.10 aphids/10 cm main apical shoot & 96.67 per cent reduction over control).

4. Yield and economics of plant product and insecticides treatments

Data on mustard yield recorded under different treatments are presented in Table 3. All the treated plots resulted higher yield ranging between 1390 – 1621 Kg/ha and were proved significantly superior over control (1040 Kg/ha). The maximum seed yield of 1621 kg/ha was obtained from the Imidacloprid + NSKE treated plot and it was significantly superior over the rest of the treatments. The Thiamethoxam + NSKE was second most effective treatment with the yield of 1606 kg/ha followed by Acetamiprid + NSKE, Imidacloprid, Thiamethoxam with the yield of 1592 kg/ha, 1588 kg/ha and 1558 kg/ha respectively. Conformity according to [11] also reported that combination of NSKE 5% and Imidacloprid 17.8% SL was recorded maximum grain yield. The minimum seed yield (1390 kg/ha) was recorded in the plot treated with NSKE. Economic analyses of treatment were made on the basis of seed yield, treatment cost and marketable value of produce (Table 3). It is clear that the Imidacloprid 17.8% SL gave maximum net profit and incremental cost benefit ratio (Rs 19564/ha and 1:15.52) followed by Thiamethoxam (Rs 18484/ha and 1:15.40), Imidacloprid + NSKE (Rs 18418/ha and 1:5.03) and Thiamethoxam + NSKE (Rs 17908/ha and 1:4.97). The minimum net profit and cost benefit ratio (Rs 8780/ha and 1:2.92) was recorded in the plot treated with NSKE. Similar results was also reported by [13] they observed that the highest incremental cost benefit ratio was obtained from Imidacloprid (1:16.12) treated plot.

Table 1: Efficacy of insecticide and plant product on population of mustard aphid after first spray.

Treatments	Aphid population per 10 cm central apical twig					Mean percent reduction
	Before spray	Days after first spray				
	1 day	3 day	7 day	15 day	Mean	
T_1-Imidacloprid 17.8% SL @ 300ml/ha	58.53 (7.68)	17.60 (4.25)	15.33 (4.00)	21.53 (4.69)	18.22 (4.33)	75.93
T_2-Acetamiprid 20% SP@ 500gm/ha	61.53 (7.88)	20.57 (4.59)	18.80 (4.39)	24.90 (5.04)	21.42 (4.68)	71.70
T_3-Thiamethoxam 25%WG @100gm/ha	61.07 (7.85)	18.00 (4.30)	15.27 (3.97)	21.97 (4.74)	18.41 (4.35)	75.68
T_4-NSKE 5%@ 3000 ml/ha	60.00 (7.78)	45.10 (6.75)	46.13 (6.83)	49.33 (7.06)	46.86 (6.88)	38.08
T_5-Imidacloprid 17.8% SL + NSKE 5% @ (300 ml+3000 ml)/ha	60.47 (7.81)	13.20 (3.70)	13.90 (3.79)	18.47 (4.36)	15.19 (3.96)	79.93
T_6-Acetamiprid 20% SP + NSKE 5% @ (500 gm+3000 ml)/ha	60.40 (7.80)	15.10 (3.94)	14.97 (3.93)	22.10 (4.75)	17.36 (4.23)	77.06
T_7-Thiamethoxam 25% WG+ NSKE 5%@(100 gm+3000 ml)/ha	62.00 (7.91)	14.93 (3.93)	14.03 (3.81)	19.03 (4.42)	16.00 (4.00)	78.86
T_8-Control (untreated)	59.93 (7.77)	73.93 (8.63)	75.27 (8.70)	77.80 (8.85)	75.67 (8.73)	-
SEm ±	0.06	0.06	0.09	0.18	0.08	-
CD (5%)	NS	(0.18)	(0.28)	(0.54)	(0.24)	

Table 2: Efficacy of insecticide and plant product on population of mustard aphid after second spray.

Treatments	Aphid population per 10 cm central apical twig					Mean percent reduction
	Before spray	Days after second spray				
	1 day	3 day	7 day	15 day	Mean	
T_1-Imidacloprid 17.8% SL @ 300ml/ha	23.07 (4.85)	11.20 (3.42)	11.60 (3.48)	12.90 (3.66)	11.90 (3.52)	86.20
T_2-Acetamiprid 20% SP@ 500gm/ha	27.43 (5.29)	13.27 (3.71)	12.90 (3.66)	13.07 (3.68)	13.08 (3.68)	84.84
T_3-Thiamethoxam 25%WG @100gm/ha	24.63 (5.01)	12.03 (3.54)	11.97 (3.53)	12.93 (3.67)	12.31 (3.58)	85.73
T_4-NSKE 5%@ 3000 ml/ha	50.00 (7.11)	41.53 (6.48)	42.20 (6.53)	34.40 (5.51)	39.38 (6.31)	54.32
T_5-Imidacloprid 17.8% SL + NSKE 5% @ (300 ml+3000 ml)/ha	20.07 (4.54)	10.53 (3.32)	09.93 (3.23)	11.43 (3.45)	10.63 (3.34)	87.71
T_6-Acetamiprid 20% SP + NSKE 5% @ (500 gm+3000 ml)/ha	25.43 (5.09)	12.63 (3.62)	11.80 (3.51)	12.27 (3.57)	12.23 (3.57)	85.82
T_7-Thiamethoxam 25% WG+ NSKE 5%@(100 gm+3000 ml)/ha	22.57 (4.80)	11.47 (3.46)	10.93 (3.38)	11.87 (3.52)	11.42 (3.45)	86.76
T_8-Control (untreated)	78.47 (8.89)	85.37 (9.27)	86.47 (9.33)	86.87 (9.34)	86.23 (9.31)	-
SEm ±	0.23	0.08	0.07	0.10	0.08	
CD (5%)	(0.68)	(0.24)	(0.21)	(0.30)	(0.26)	

Figures in parentheses are transform ($\sqrt{x+0.5}$) values

Table 3: Economics and incremental cost benefit ratio of different treatments in mustard

Treatments	Dose/ha.	Grain yield (Kg ha)	Additional yield over control	Additional profit Rs/ha.	Cost of treatments	Net profit	ICBR ratio
T_1-Imidacloprid 17.8% SL	300ml	1588	548	20824	1260	19564	1:15.52
T_2-Acetamiprid 20% SP	500ml	1467	427	16226	1500	14726	1:10.00
T_3-Thiamethoxam 25%WG	100ml	1558	518	19684	1200	18484	1:15.40
T_4-NSKE 5%@3000	3000ml	1390	310	11780	3000	8780	1:2.92
T_5-Imidacloprid 17.8% SL + NSKE 5%	300ml +3000 ml	1621	581	22078	3660	18418	1:5.03
T_6-Acetamiprid 20% SP + NSKE 5%	500 ml +3000 ml	1592	552	20976	3900	17076	1:4.37
T_7-Thiamethoxam 25% WG + NSKE 5%	100 gm + 3000 ml	1606	566	21508	3600	17908	1:4.97
T_8-Control (untreated)	-	1040	-	-	-	-	-

Mustard= Rs 3800/q, Labour charge =Rs 600/two spray, Imidacloprid = Rs 1100/lit., Acetamiprid= Rs 900/lit., Thiamethoxam= Rs.3000/lit
NSKE = Rs 400/litre

5. Conclusion

It is concluded from the study that all the insecticidal treatments were found significantly effective in reducing the population of aphid as compared to untreated plots. The minimum aphid population was recorded in the plot treated with Imidacloprid 17.8% SL + NSKE 5% followed by Thiamethoxam 25% WG + NSKE 5%, Acetamiprid + NSKE 5%. The highest seed yield of 1621 kg/ha was obtained from the Imidacloprid 17.8% SL + NSKE 5% treated plot and it was significantly superior over the rest of the treatments. The Thiamethoxam 25% WG + NSKE 5% was second most effective treatment with a yield of 1606 kg/ha. The maximum net profit and incremental cost benefit ratio (ICBR) was observed in plots treated with Imidacloprid 17.8% SL followed by Thiamethoxam 25% WG.

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