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Efficacy of Selected Biopesticides against Mustard Aphid, *Lipaphis erysimi* (Kalt.) (Hemiptera: Aphididae)

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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

The present experiment was carried out at Central Research Farm, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, during *Rabi* season of the year 2023-2024under Randomized Block Design (RBD) with eight treatments and three replications. Single spray Twosprays were undertaken at fourteen days interval. Neem oil 5 %, imidacloprid 17.8

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SL, *Beauveria bassiana* 1.15 % WP, Nisco Sixer plus, *Metarhizum anisopliae*, spinosad + neem oil 5 %, spinosad 45% SC were the treatments tested against the mustard aphid, *Lipaphis erysimi* (Kalt.). Results show that imidacloprid 17.8% SL was significantly superior over the other treatments showing 30.08/top 10cm twig and *Beauveria bassiana* being least effective recorded the highest number of aphids of 69.53/top 10cm twig of plant. The highest yield and cost benefit ratio was recorded from the plots treated with imidacloprid 17.8% SL (18.5 q/ha and 1:5.19) and the lowest from *Beauveria bassiana* (12.55 q/ha and 1:3.43).

Keywords: Biopesticides; imidacloprid; Lipaphis erysimi; mustard aphid.

1. INTRODUCTION

"Mustard, *Brassica juncea* (L.) is an important oilseed crop belonging to family Cruciferaceae (Syn. Brassicaceae). The origin of mustard is China, northeastern India from where it has extended to Afghanistan via Punjab" [1]. Rapeseed-mustard is the third important oilseed crop grown in the world after soyabean (*Glycine max*) and palm oil.

"Mustard is rich in minerals, Vitamins (A, B and C) and proteins. A 1000g of mustard seeds contains 508Kcal energy, 28.09g carbohydrates, 26.08g proteins, 26.08g total fat, and 12.2g dietary fiber,4.733mg Niacin, 7.1mg Vitamin C, 266mg Calcium, 9.21mg Iron, 370mg Magnesium, 13mg Sodium, and 738mg Potassium.It has 38 – 42 % protein" [2].

"Mustard Oil relieves the pain associated with arthritis, muscle sprains and strains. Seed paste applied on wounds whereas paste of leaf said to heal cattle wounds" (Hossain et al. 2015).

"The estimated area, production, and yield of rapeseed-mustard in the world was 36.59 million hectares, 72.37 million tones and 1980 kg/ha, respectively, during 2018-19. Globally, India accounts for 19.8 and 9.8 per cent of the total acreage and production, respectively. The productivity of India is the lowest among the major mustard growing countries, with an average yield of only 1.4 tonnes/ha during 2019-20. Mustard plays an important role in the oil seed economy of the country" (Kalia et al. 2021).

"The mustard crop is damaged at various stages of plant growth by a number of insect pests viz; mustard sawfly (*Athalia lugens proxima* Klug.), painted bug (*Bagrada cruciferarum* Kirk.), mustard aphid (*Lipaphis erysimi* Kalt.), cabbage leaf Webber (*Crocidolomia binotalis* Zeller), flea beetle (*Phyllotreta Cruciferae* Geoze) and leaf minor (*Phytomyza horticola* Meign)" [3]. Among these, the mustard aphid (*Lipaphis erysimi* Kalt.) is of prime significance, originally is a European species, belonging to family Aphididae .it was described by Kaltenbach, 1843 the turnip aphid is now found in most parts of the world in tropical and temperate locations. "Major hosts include: broccoli, Brussels sprouts, cauliflower, and Mustard. Plants are infested at all the stages. Both nymph and adults suck the sap from leaves, inflorescence or the developing pods. Curling may occur for infested leaves and at advanced stage plants may wither and die. Plants remain stunted and sooty molds grow on the honey dew excreted by the insects. The infected filed looks sickly and blighted in appearance. The aphid attacks generally during December and continues till March. The most favorable temperature is 20°C or below. Cloudy and cold weather help in accelerating the growth of insects. About 45 generations are completed in a year" [4].

1.1 Objective

1. To evaluate the efficacy of biopesticides on the incidence of mustard aphid (*L. erysimi*) on mustard during the *rabi* season 2023-2024.
2. To calculate the cost benefit ratio.

2. MATERIALS AND METHODS

Field trails were conducted to study theefficacy of selected biopesticides against mustard aphid, *Lipaphis erysimi* (Kalt.) (Hemiptera: Aphididae) at central research field, SHUATS, Prayagraj, U.P. during *Rabi* 2023-2024. The trail was laid out in RBD having seven treatments and three replications with the plot size 2m. The research was done on Mustard variety kala sona single spraying was done in fourteen days interval using a hand operated sprayer during morning hours to avoid photo oxidation of chemicals. The treatments imposed were,neem oil 5% (T_1), imidacloprid 17.8SL (T_2), *Beauveria bassiana* (T_3), Nisco Sixer Plus (T_4), *Metarhizium anisopliae* (T_5), spinosad 240 EC+ neem oil 5%

(T_6), spinosad 45 SC (T_7) and an untreated control (T).

Observations and calculations on pest population, grain yield and B:C ratio were made on 5 randomly selected plants in each replication along with the unsprayed control. Post treatments observations on number of nymphs and adults were recorded on 3 rd, 7th and 14th days after spray and were subjected to statistical analysis.

2.1 Cost Benefit ratio

Gross return = Marketable yield × Market price

Net return = Gross return – Total cost

Cost Benefit Ratio = $\frac{\text{Gross return}}{\text{Total cost}}$

Zorempuii and Kumar, [5]

3. RESULTS AND DISCUSSION

The data of the mean (3rd,7th and 14th) nymph and adult population of first spray revealed that all treatments except untreated control are effective and on par with each other. Among all the treatments lowest nymph and adult population of *L.erysimi*was recorded in midacloprid 17.8 SL (33.08) followed by Spinosad 240 EC+ Neem oil 5% (39.22), Spinosad 45 SC (43.95), Neem oil 5% (45.69), *Metarhizium anisopliae* (49.02), Nisco Sixer Plus (62.04), *Beauveria bassiana* (69.53) as compared to control plot (202.08).

Among all the treatments least nymph and adult population of mustard aphid was recorded in Imidacloprid 17.8 SL (87.21%). Similar findings were made by Sreeja and Kumar [6] with 88.14% effectiveness and Dotasara [7] with 87.53%aphid population reduction/plant.

The next best treatment spinosad 240 EC+ Neem oil 5% 84.29 %) aphid population reduction/plant which lines with the findings of Sen and Kumar [8] with 85.93%. The next best treatment found Spinosad 45 SC 78.06% aphid/plant which lines with the finding Akhter et al. [9], Dwivedi and Singh [10] with (74.83%) aphid/plant. Neem oil 5% (70.25%) these results are supported by Yadav et al. [11]. *Metarhizium anisopliae* (69.22%) supported by Sajid et al. [12]**,** Tomar et al. [13]. Nisco Sixer Plus (70.25%) supported by Khandelwal and Kumar [14]. *Beauveria bassiana* (2×10^{8}CFU/ml) (64.85%) these results are support with Janu et al. [15] with. is found to least effective but comparatively superior over the control which support Dotasara et al. [7] with (73.92).

3.1 Cost Benefit and Mustard Yield

The data showed that the highest grain yield of 18.15 q/ha was registered in Imidacloprid 18.15 SL (T_2) which was followed by Spinosad 240 EC+ Neem oil 5% (T_6) 17.85 q/ha, Spinosad 45 SC (T_7) 16.35 q/ha, Neem oil 5% EC (T_1) 14.58 q/ha, *Metarhizium anisopliae* (T_5) 14.98 q/ha, Nisco Sixer Plus (T_4) 13.03q/ha, *Beauveria bassiana* (T_3) 12.55 q/ha. As low as 9.17 q/ha was recorded in untreated plot control (T_0).

Table 1. Effect of aphid population during first spray at 3rd, 7th and 14th days of spraying under different treatments during Rabi season 2023-24 (1st spray)

Tr. No	Treatment	Mean population of aphid / plant (10 cm top twig)				
		1DBS	After Spray			
			3rd Day	7th Day	14th Day	Mean
T0	Control	180.4	192.8	201.4	148.73	180.83
T1	Neem Oil 5 %	183.8	74.33	54.46	36.93	87.38
T2	Imidacloprid 17.8 SL	173	50.4	37.46	11.4	68.06
T3	*Beauveria bassiana* 1.15% WP	197.06	89	69.73	49.86	101.41
T4	Nisco Sixer Plus	189.93	80.6	63.006	42.53	94.01
T5	*Metarhizium anisopliae*	179.2	64.93	51.4	30.73	81.56
T6	Spinosad 240 EC + Neem Oil 5%	179.8	56.6	41.4	19.66	74.367
T7	Spinosad 45% SC	185.6	60.4	46.66	24.8	74.368
Overall Mean		183.6	83.63	70.69	45.58	95.87
F- test		NS	S	S	S	S
S. Ed. (±)			2.855	2.250	1.587	
C. D. (P = 0.05)			6.12	4.82	3.4	

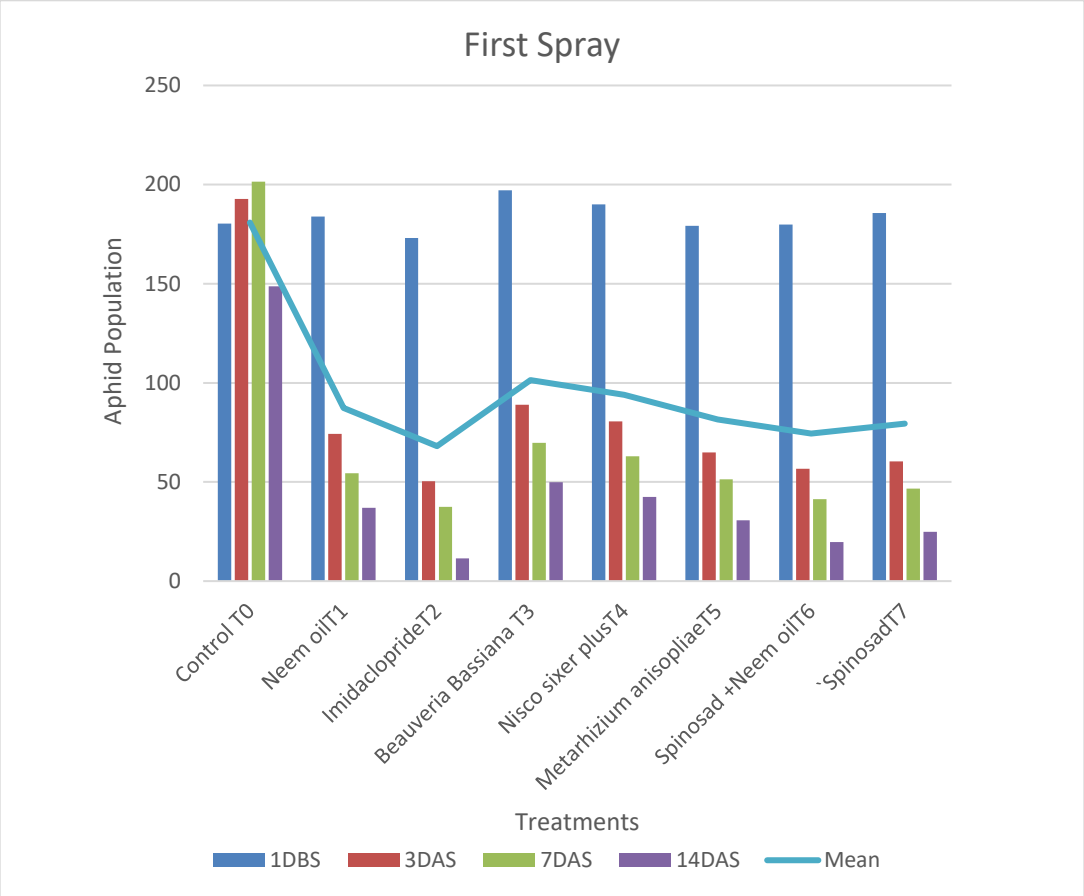

Fig. 1. The efficacy of biopesticides against mustard aphid (*L. erysimi* Kalt.) (First spray)

These findings are supported by Raju and Tayde [16] with a yield of 24.6 q/ ha for Imidacloprid 17.8 SL andby Sen and Kumar [8] with a yield of (17.8 q/ ha) for Spinosad 240 EC+ Neem oil 5%.

When cost benefit ratio was worked out, the best and most economical treatment was Imidacloprid 17.8% SL (1: 5.19) followed by Spinosad 240 EC+ Neem oil 5% (1: 4.74), Spinosad 45% SC (1: 4.45), Neem oil 5% (1: 4.04), *Metarhizium anisopliae* (1:4.08), Nisco Sixer Plus (1: 3.65), *Beauveria bassiana* (1:3.43), as compared to Control (1: 2.74). These findings are supported by Ahlawat et al. [17], Sen and Kumar [8] and Akter et al. [9].

Table. 2. Economics of treatments and benefit: Cost ratio taken up for the management of mustard aphid during rabi season 2023-2024

Sr. No:	Treatment	Yield q/ha	Cost Yield (₹)	Total cost (₹)	Common cost(₹)	Treatment cost (₹)	Net Return	Total cost (₹)	B:C ratio
T1	Neem Oil 5 %	14.58	6500 ₹/q	94770	21749	1700	76021	23449	1:4.04
T2	Imidacloprid 17.8 SL	18.15	6500 ₹/q	117975	21749	960	96226	22709	1:5.19
T3	*Beauveria bassiana* 1.15% WP	12.55	6500 ₹/q	81575	21749	2000	59826	23749	1:3.43
T4	Nisco Sixer Plus	13.03	6500 ₹/q	84695	21749	1400	62946	23149	1:3.65
T5	*Metarhizium anisopliae*	14.98	6500 ₹/q	97370	21749	2088	75621	23837	1:4.08
T6	Spinosad 240 EC + Neem Oil 5%	17.85	6500 ₹/q	116025	21749	2720	94276	24469	1:4.74
T7	Spinosad 45% SC	16.35	6500 ₹/q	106275	21749	2100	84526	23849	1:4.45
T8	control	9.17	6500 ₹/q	59605	21749	-	37856	21749	1:2.74

Sreeja and Kumar [6] states, the highest yield 18.15 q/ha was obtained from the treatment Imidacloprid 17.8% SL as well as B:C ratio 1: 5.20 was obtained high from this treatment [18,19]. It was followed by Spinosad 45% SC (1: 4.87), Cypermethrin 10% EC (1: 4.58), Neem oil 5% (1:4.15), MECH 333 (1: 3.98), Sixer plus (1: 3.46), *Metarhizium anisopliae* (1: 3.42), as compared to Control (1: 2.74) [20,21].

4. CONCLUSION

The critical analysis leads to the conclusion that imidacloprid (17.8% SL) is more effective than spinosad 240 EC + 5% neem oil, spinosad 45 SC, 5% neem oil, and Metarhizium anisopilae in controlling L. erysimi. Methyzium anisopilae, Nisco Sixer Plus, Beauveria bassiana, Spinosad 240 EC+ Neem oil 5% (1: 4.74 and 17.85 q/ha), Spinosad 45SC (1: 4.45 and 16.35 q/ha), Neem oil 5%, and Imidacloprid 17.8% SL yielded the highest cost-benefit ratio (1: 5.19) and marketing yield (18.15 q/ha) of all the treatments studied. Therefore, additional trials must be carried out in the future to confirm the results that can help farmers produce mustard sustainably and to avoid losses from happening.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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