International Journal of Plant & Soil Science

Volume 35, Issue 14, Page 201-208, 2023; Article no.IJPSS.100159
ISSN: 2320-7035

Comparative Efficacy and Economics of Biopesticides and Imidacloprid against Mustard Aphid [*Lipaphis erysimi* (Kalt.)] (Hemiptera: Aphididae)

Manu Kumar Sen [a++*] and Ashwani Kumar [a#]

[a] *Department of Entomology, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India.*

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2023/v35i143037

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/100159

Original Research Article

Received: 22/03/2023
Accepted: 25/05/2023
Published: 02/06/2023

ABSTRACT

The present research study was carried out applying the Randomised Block Design (RBD) approach in three replications during the rabi season of 2022–2023 at the Central Research farm, NAI, SHUATS, Prayagraj. Results revealed that, among all the treatments combination insecticide *Metarhizium anisopliae* (T_7) recorded lowest reduction percent of aphid (47.94%), followed by Nisco MECH 333(T_6) (53.00%), Nisco MECH 333 + Neem oil 5% (T_1) (54.63%), Neem oil 5% (T_4) (55.33%), Spinosad 240 EC (T_3) (63.94%) and Spinosad 240 EC+ Neem oil 5%(T_2) (69.37%). Imidacloprid 17.8 SL (T_5) (74.77%) was the most successful of all the treatments, and the first spray is also significantly more successful than the other treatments. While the Imidacloprid 17.8% SL treatment produced a superior yield (18.15 q/ha). With imidacloprid 17.8 SL(T_5) (1:6.43), the best economics cost-benefit ratio was attained followed by Spinosad 240 EC+ Neem oil 5%(T_2)

[++] *M.Sc. Scholar;*
[#] *Associate Professor;*
**Corresponding author: E-mail: senmanu02@gmail.com;*

(1:5.96), Spinosad 240 EC(T_3) (1:5.64), Neem oil 5% (T_4) (1:5.06), Nisco MECH 333 + Neem oil 5% (T_1) (1:4.87), *Metarhizium anisopliae* (T_7) (1:4.65), Nisco MECH 333(T_6) (1:4.21), The control (1:3.25) yielded the lowest financial return.

Keywords: Comparative efficacy; economics; imidacloprid; insecticides; Lipaphis erysimi; mustard.

1. INTRODUCTION

According to Sanskrit language from around 3000 BC, mustard is one of the first recorded spices and was one of the first crops to be domesticated [1]. The term "mustard" originally referred to a condiment and was derived from the Latin word "mustum". Mustard, *Brassica juncea* (L.) A significant oilseed crop in the cruciferae (also known as the brassicaceae) family is czern and coss. Brown mustard or Indian mustard has chromosomal number (2n=36). Although it self-pollinates, some (2–15%) of the pollination is carried out by insects and other things. The origin of mustard is in China, and it has spread from there through India to Afghanistan [2]. Proteins, vitamins (A, B, and C), minerals including calcium, manganese, copper, iron, selenium, and zinc are all abundant in mustard. 1000 g mustard seed has 508 k. cal. calories, 28.09 g carbs, 26.08 g proteins,26.08 g total fat and 12.2 g dietary fibre, 31 I.U. Vitamin A,4.733 mg Niacin, 7.1 mg Vitamin C, 266 mg Calcium, 9.21 mg Iron, 370 mg Magnesium, 13 mg Sodium and 738 mg Potassium [3]. In terms of area and production, India ranks third in the world for its importance as an oil crop. Along with groundnut and soybean, it is one of the three main oilseeds crops, accounting for around 25% of the overall oilseeds production [4].

In the nation's economics of oil seeds, mustard is significant. It comprises 24% protein and 38 to 42% oil [5]. A rapeseed-mustard crop in India is infested by around 43 species of insect pests, of which 12 species are regarded as important pests. The main pests [6] that cause both qualitative and quantitative losses are the aphid species *Lipaphis erysimi* (Kaltenbach), *Brevicoryne brassicae* (Linnaeus), and *Myzus persicae* (Sulzer). They include the most harmful insect pest of mustard, *Lipaphis erysimi* Kalt. (Hemiptera: Aphididae) [7].

The Aphididae family's *Lipaphis erysimi*, also known as the mustard aphid, contains these insects. It is a global pest that can be found on the leaf surfaces and in the leaf folds of developing heads, as well as on leaf stalks and axles. They cover the entire plant with a high density and are predominantly found on the host plants' growing points, such as tips, flowers, and developing pods [8]. Plants that are infected become stunted and deformed because they sucking sap from the hosts [9]. However, aphids generate an enormous amount of honeydew, which promotes the growth of a fungus that discolours the leaves and pods and hinders their ability to photosynthesize [10]. According to Lal et al. [6], it predominates and can result in yield losses of up to 96% and an oil content fall of 5%–6%. Most farmers who grow mustard use synthetic pesticides, and occasionally even chemicals that are prohibited, in repeated applications at higher concentrations to control insects, mainly mustard aphids. Aphids have developed a resistance to pesticides as a result of frequent insecticide applications, and the dangerous use of pesticides has resulted in phototoxicity, the eradication of beneficial organisms, the disturbance of agroecosystems, and risks to human health. Bio-insecticide can therefore be used as an alternative to chemical pesticides because it is economically more advantageous, environmentally responsible, and safe for humans, animals, and natural predators and pollinators while still being effective against harmful pests.

It is crucial to control the pest population at the right time with adequate and appropriate measures in order to prevent the infestation of the mustard aphid and to produce a high-quality crop. This study compared eco-friendly bio-pesticides with several conventional insecticides in order to manage the mustard aphid, *Lipaphis erysimi* (Kaltenbach). To develop a pest management module that needs a minimum of assets and offers farmers the most advantages.

2. MATERIALS AND METHODS

In India's Uttar Pradesh during the Rabi season of 2022, the experiment was carried out in the Central Research Field (CRF) of the Sam Higginbottom University of Agriculture, Technology, and Sciences in Naini, Prayagraj. In a randomised block design with eight treatments that were replicated three times on a plot of 2m x 2m, Kala Sona seeds were planted without using plant protection and using the suggested set of practises. The spacing between the seeds was 15cm × 20cm the test site's soil was medium-high and had good drainage. Five randomly chosen and tagged plants from each plot were used to make the visual observations on the number of sucking pests early on top 10cm central apical twigs. Five randomly chosen plants from each plot were examined for aphid populations in the field one day prior to spraying as well as three, seven and fourteen days afterwards. Using the formula below, the number of aphids per plant was transformed into a percentage of the aphid population under the control.

$$\textit{Percent reduction over control} = \frac{(\textit{Population in control plot} - \textit{Population after spray})}{\textit{population recorded in the control plot}}$$

(Kumar et al. 2020)

The cost-efficient and healthy marketable yield achieved from various treatments was collected and weighed separately. During the Rabi season of 2022, the cost of pesticides employed in this experiment was documented. Botanical expenses were obtained at a nearby market. The affordable overall cost of plant protection included the cost of treatments, sprayer rental, and spray manpower costs. During the research period, there were two sprays, and the total plant protection expenditures were computed. The following formula may be used to compute the Cost-Benefit ratio:

C: B = Gross returns / Total costs in curred

Where,
CBR = Cost-Benefit Ratio
Gross returns = Marketable yield × Market price

3. RESULTS AND DISCUSSION

The trial included eight distinct treatments, which included the use of Control (T0), Nisco MECH 333 + Neem oil 5% (T_1), Spinosad 240 EC+ Neem oil 5%(T_2), Spinosad 240 EC(T_3), Neem oil 5%(T_4), Imidacloprid 17.8 SL(T_5), Nisco MECH 333(T_6), *Metarhizium anisopliae* (T_7) were studied to compare their efficiency against *Lipaphis erysimi* and their effects on mustard yield.

The results indicated that all treatments, with the exception of the untreated control, are effective and comparable. Among all of the treatments, combination insecticide *Metarhizium anisopliae* (T_7) recorded the lowest reduction percent of aphid (47.94%), followed by Nisco MECH 333(T_6) (53.00%), Nisco MECH 333 + Neem oil 5% (T_1) (54.63%), Neem oil 5% (T_4) (55.33%), Spinosad 240 EC (T_3) (63.94%) and Spinosad 240 EC+ Neem oil 5%(T_2) (69.37%). During spray, the most effective treatment was Imidacloprid 17.8 SL (T5) (74.77%).

The statistics on the mean percent population decrease from the first spray overall mean indicated that all treatments, with the exception of the untreated control, are effective and at par. Imidacloprid 17.8% SL (88.184%) indicated the lowest percent decrease of mustard aphid across all the treatments while also improving yield. Chandra et al. [11], Aziz et al. [12], Sen et al. [4], Maurya et al. [13], Patel et al. [14], and Rashid et al. [15] all reached similar conclusions. According to the results of Akter et al. [16], Khanal et al. [17], and Vishvendra et al. [18], spinosad 45% SC (81.498%) is determined to be the second-best treatment. Who evaluated that it was most successful in decreasing the percentage of *Lipaphis erysimi* population.

According to Bhatta et al. [19] and Shiva and Rajesh [20], Spinosad 45% SC is the next-best treatment. According to data by Yadav et al. [21], Kumar and Kumar [22], and Zorempuii and Kumar [23], neem oil 5% (72.976%) is found to be the next successful treatment. Nisco MECH 333 (68.251%) is also shown to be the next effective treatment. These findings are validated by Meena et al. [24] and Kumar et al. (2020). The results of Sixer plus (58.914%), which are at par with *Metarhizium anisopilae* (53.123%), are determined to be least effective yet somewhat superior above the control.

There were observable yield differences amongst the treatments. The Imidacloprid 17.8% SL (18.15 q/ha) yield was the highest, followed by Spinosad 240 EC (17.85 q/ha), Spinosad 240 EC+ Neem oil 5% (16.35 q/ha), Neem oil 5% (14.98 q/ha), Nisco MECH 333+ Neem oil 5% (14.58 q/ha), Nisco MECH 333 (13.03 q/ha). These conclusions are backed up by Vishal et al. [25], Bhatta et al. [19], Akter et al. [16], Yadav et al. [21], Aziz et al. [12], Meena et al. [24], and Sreeja and Kumar [26].

When the cost-benefit ratio was calculated, an intriguing outcome was obtained. Imidacloprid 17.8% SL (1: 5.20), Spinosad 45% SC (1: 4.87), Spinosad 240 EC+ Neem oil (5/1: 4.58), Neem oil 5% (1: 4.15), MECH 333 + Neem oil 5% (1: 3.98), Nisco MECH 333 (1: 3.46), and

Table 1. Efficacy of biopesticides and Imidacloprid against mustard aphid (*L. erysimi* Kalt.) on reduction per cent over control during *rabi* season 2022-2023 (1st spray)

S. No.	Name of treatments	Dosages	Population of mustard aphid /top 10 cm central twig of plant	Per cent population reduction of mustard aphid /top 10 cm central twig of plant			
			(Day before spraying)	3rd DAS	7th DAS	14th DAS	Mean
T_0	Control	-	256.73	0	0	0	0.00
T1	Nisco MECH 333 + Neem oil 5%	2ml/ lit. + 5 ml/lit.	256.47	29.77	62.74	69.78	54.10
T2	Spinosad 240 EC+ Neem oil 5%	0.75ml/ lit + 5ml/lit	243.07	48.23	74.61	85.69	69.51
T3	Spinosad 240 EC	0.75 ml/lit	269.00	37.8	71.97	83.02	64.26
T4	Neem oil 5%	5 ml/lit	251.73	31.38	64.87	71.52	55.92
T5	Imidacloprid 17.8 SL	1ml/2.5 lit of water	254.47	53.45	78.27	91.71	74.48
T6	Nisco MECH 333	2ml/lit.	249.27	27.6	60.7	71.25	53.18
T7	*Metarhizium anisopliae*	5gms/lit	245.40	21.02	55.32	67.78	48.04
Overall mean			-	35.60	66.92	84.60	59.92
F- test			**NS**	**S**	**S**	**S**	**S**
SE. d (±)			-	**0.81**	**0.58**	**0.69**	**0.29**
C. D. (P = 0.05)			-	**1.701**	**1.249**	**1.479**	**0.622**

Table 2. Economics of treatments and Cost: Benefit ratio under consideration for the control of mustard aphid during *rabi* season 2022-2023

S. No	Treatments	Yield of q/ha	Cost of yield / ₹/q	Total cost of yield (₹)	Common cost (₹)	Treatment cost (₹)	Cost of cultivation	Net return	Total cost (₹)	C:B ratio
T_0	Control	9.17	6500	59605	21749	____	21749	37856	21749	1: 2.74
T_1	NiscoMECH 333 + Neem oil 5%	14.58	6500	94770	21749	2080	23829	70941	23829	1: 3.98
T_2	Spinosad 240 EC+ Neem oil 5%	16.35	6500	106275	21749	1472	23221	83054	23221	1: 4.58
T_3	Spinosad 240 EC	17.85	6500	116025	21749	2100	23849	92176	23849	1: 4.87
T_4	Neem oil 5%	14.98	6500	97370	21749	1700	23449	73921	23449	1: 4.15
T_5	Imidacloprid 17.8% SL	18.15	6500	117975	21749	960	22709	95266	22709	1: 5.20
T_6	Nisco MECH 333	13.03	6500	84695	21749	2720	24469	60226	24469	1: 3.46
T_7	*Metarhizium anisopilae*	12.55	6500	81575	21749	2088	23837	58126	23837	1: 3.42

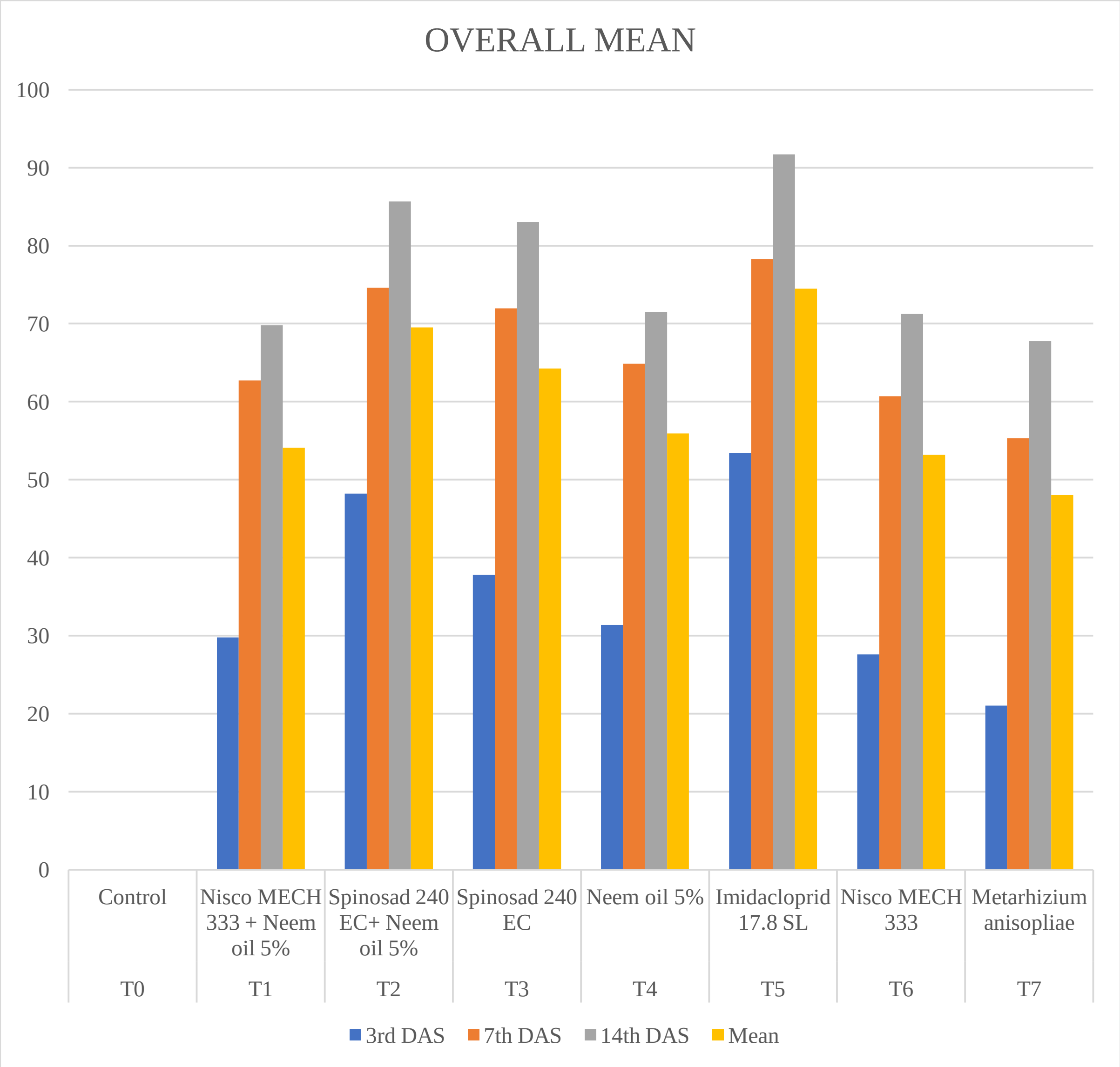

Fig. 1. The efficacy of biopesticides and Imidacloprid against mustard aphid, (*L. erysimi* Kalt.) (Mean)

Metarhizium anisopilae (1:3.42) were the best and most cost-effective treatments among those examined. Akter et al. [16], Ahlawat et al. [27] and Sreeja and Kumar [26,28,29].

4. CONCLUSION

When it comes to managing population of *Lipaphis erysimi*, Imidacloprid 17.8% SL is more effective than Spinosad 240 EC, Spinosad 240 EC + Neem oil 5%, Neem oil 5%, and Nisco MECH 333+ Neem oil 5%. Imidacloprid 17.8% SL had the best economic cost-benefit ratio (1: 5.20) and marketing yield (18.15 q/ha) among the treatments, followed by Spinosad 240 EC (1: 4.87 and 17.85 q/ha).), Spinosad 240 EC+ Neem oil 5% (1: 4.58 and 16.35 q/ha), Neem oil 5%, Nisco MECH 333 + Neem oil 5%, Nisco MECH 333, *Metarhizium anisopilae* as a result, more studies will be needed in the future to confirm the results. Therefore, additional trials must be carried out in the future to corroborate the findings that can benefit farmers in a practical way for the sustainable production of mustard and to avoid losses brought on by this insect pest infesting the crop.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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The peer review history for this paper can be accessed here:
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