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Comparative efficacy of different bio- pesticide with Imidacloprid against mustard aphid [*Lipaphis erysimi* (Kalt.)] on mustard (*Brassica juncea* L.)

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Abstract
The present study was conducted at the Central Reacher Field (CRF), Department of Entomology, SHUATS, Prayagraj during *Rabi* season 2023- 2024. The management of Mustard Aphid was done using 7 different treatment Control (T_0), Imidacloprid 17.8SL (T_1), Spinosad 45 SC (T_2), Nisco sixer plus (T_3), *Metarhizium anisopliae* ($2x10^8$ CFU/gm) (T_4), *Beauveria bassiana* ($2x10^8$ CFU/gm) (T_5), NSKE 5% (T_6) and Neem oil 5% (T_7) were evaluated against mustard aphid (*Lipaphis erysimi*). Result revealed that, among the different treatments, the highest percent population reduction of mustard aphid was recorded in Imidacloprid 17.8 SL (70.114%), followed by Spinosad 45 SC (55.350%), followed by the Nisco sixer plus (36.340%), Neem oil 5% (22.634%), NSKE 5% (17.531%), *Beauveria bassiana* ($2x10^8$ CFU/gm) (12.140%), and last the least effective *Metarhizium anisopliae* ($2x10^8$ CFU/gm) (10.312%). While the highest yield 18.33 q/ha was obtained from the treatment Imidacloprid 17.8 SL as well as C:B ratio (1:6.57) was obtain high from this treatment. It was followed by the Spinosad 45 SC (1:5.62), then Nisco sixer plus (1:4.76), Neem oil 5% (1:3.88), NSKE 5% (1:3.97), *Beauveria bassiana* ($2x10^8$ CFU/gm) (1:2.99) and last the least effective *Metarhizium anisopliae* ($2x10^8$ CFU/gm) (1:2.76). as compared to control (1:2.54).

Keywords: Biopesticides, efficacy, imidacloprid, *Lipaphis erysimi*, mustard aphid

Introduction

Mustard, *Brassica juncea* (L.) Czern & Coss is an important oilseed crop belonging to family cruciferaceae (Syn. Brassicaceae). Indian mustard or brown mustard is having chromosome no (2n=36). It is self-pollinated but certain amount (2-15%) pollination occur due to insects and other factors. Mustard, believed to have originated in China and northeastern India, has historically spread westward to Afghanistan through Punjab (Kalasariya, 2016) [8]. This versatile crop, belonging to the Brassica genus, ranks among the earliest domesticated plants and has been cultivated as an herb across Asia, North Africa, and Europe for millennia. Oplinger *et al.* (2016) [15]. It ranks world's third important oil crop in terms of production and area, and in Bangladesh, it is the first in ranking. India ranks world's third important oil crop in terms of production and area. it is one of the three major oilseeds crops along with groundnut and soybean contributing around 25 percent of the total oilseeds production. Sen *et al.* (2017) [22].

Within the Brassica genus, Brassica napus and Brassica campestris are commonly known as rapeseed, while *Brassica juncea* is recognized as mustard. Mustard oil stands out as a highly beneficial edible oil, distinguished by its absence of trans fats, low levels of saturated fats, and richness in mono- and polyunsaturated fats such as omega-3 Das *et al.* (2009) [6]. Mustard assumes a pivotal role in the oilseed economy of various countries. It has 38 to 42% oil and 24% protein. Meena *et al.* (2015) [14].

Mustard is also rich in minerals like Calcium, Manganese, Copper, Iron, Selenium, Zinc, Vitamin (A, B and C) and proteins. 1000 g mustard seed contains 508 k. cal. energy, 28.09 g carbohydrates, 26.08 g proteins, 26.08 g total fat and 12.2 g dietary fiber, 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. These crops hold a significant status as the world's second most important oilseeds, a position they also maintain in India.

[Biology of *Brassica juncea* L. (Indian mustard) Ministry of Environment, Forest and Climate Change (MoEF&CC)].

Rapeseed-mustard production in India lags behind other countries primarily due to significant losses caused by insect pests, diseases, and other factors (Bakhetia and Sekhon, 1989) [2]. India faces challenges from over 43 species of insect pests affecting the rapeseed-mustard crop, with approximately a dozen species considered major pests Purwar *et al.* (2004) [17]. Among all the insect pests, the mustard aphid, *Lipaphis erysimi* has gained the status of key pest of rapeseed-mustard in India. It feeds by sucking sap from its host and damage to the crop ranging from 9 to 96% in different agroclimatic conditions of India Chorbandi and Bakhetia, 1987; Singh and Sachan, 1994) [24, 5] The loss may go upto 100% in certain mustard growing regions (Singh and Sachan, 1999) [26].

But chemical insecticides are not only toxic to natural enemies of aphid such as *Diaeretiella rapae, Chrysoperla zastrowi* arabica, coccinellids and syrphid flies but these are also responsible for environmental pollution, health hazards to human beings, toxic to pollinators, pest resurgence, development of resistance in insect-pests and residues in oil and cake It is therefore, there is urgent need to discourage the chemical insecticides and adopt the alternate method i.e. biopesticides which manage the pest without harming non target organisms and environment. Keeping this fact in view, present investigation was carried out to study the efficacy of different biopesticides against mustard aphid.

Martials and Methods

The experiment was conducted at the experimental research plot of the Department of Entomology, Central Research Farm, Sam Higginbottom University of Agriculture Technology and Sciences, during the rabi season of 2023-2024 in a randomized block design with seven treatments replicated three using "Kala sona" in a plot size of $2m \times 1m^2$ with a recommended package of practices excluding plant protection. The site selected for experiment was uniform, cultivable with typical sandy loam soil having good drainage. The observations on population of sucking pest were recorded visually using a magnifying lens early on top 10cm central apical twig per plant from five randomly selected and tagged plants in each plot. Aphid count was taken 24 hours before spraying at 5 tagged plants per treatment, which was further converted in to per plant population and subsequent observation was recorded at 3rd, 7th and 14th days after spraying on same plants. The formula used for the calculation of percentage reduction of pest population over control using following formula giving by Abbott (1925) [34].

$$\text{Populaiton reduction over control } = \frac{(\text{Population in control plot} - \text{Population after spray})}{\text{Population recorded in control plot}}$$

The cot- efficient and health marketable yield achived form various treatment was collected and weighed Seprately. During rabi season of 2023, the cost of pesticide employes in this expitement was documented. Botanical expenses overall cost of the plant protection including the cost of treatment, spruing rental, and sprying manpower costs. During the reacher period, there were 1 spary, and the total plant protection expenditure were computed. The following formula may be used to compute the Cost- Benefit ration;

$$\text{C: B} = \frac{\text{Gross treturn}}{\text{Total cost of cultivation}} \times 100$$

Thuppukonda and Kumar. (2022) [33]

Where,
CBR = Cost- Benefit ratio
Gross return = Marketable yield × Market price
Net retune = Gross return – Cost of cultivation
(Zorempuii and Kumar, 2019) [32]

Results and Discussion

In the experiment seven different treatment consisting application of Control (T_0), Imidacloprid 17.8SL(T_1), Spinosad 45 SC (T_2), Nisco sixer plus (T_3), *Metarhizium anisopliae* ($2x10^8$ CFU/gm) (T_4), *Beauveria bassiana* ($2x10^8$ CFU/gm) (T_5), NSKE 5% (T_6) and Neem oil 5% (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* ($2x10^8$ CFU/gm) (T_3) recorded the lowest reduction percent of aphid (10.312) followed by *Beauveria bassiana* ($2x10^8$ CFU/gm) (T_5) (12.140), NSKE 5% (T_6) (17.531), Neem oil 5% (T_7) (22.634), Nisco sixer plus (T_3) (36.340), Spinosad 45 SC (T_2) (55.350) During spray, the most effective treatment was Imidacloprid 17.8 SL (T_1) (70.114%).

The data on percent population reduction over control overall mean of 3rd, 7th and 14th revealed that all the treatments except untreated control are effective and at par. Biopesticides, chemicals were found to be effective to control rapid multiplication of aphid. Imidacloprid 17.8 SL act as a synergistic composition which was found to be effective. The present investigation is also similar with the following authors, in Imidacloprid 17.8 Sl (70.114%). Similar findings by Sen K. *et al* (2017) [22] with (72.86%) Aphid/ plant and Lal *et al.* (2018) [12] with (71.70%) Aphid/ plant.

The next best treatment found Spinosad 45 SC (55.350%) aphid/ plant which lines with the findings by Akter *et al.* (2021) [1] with (56.00%) aphids / plant and Sairam and Kumar (2022) [19] with (58.85%) aphids/plant.

The next best treatment found Nisco sixer plus 45 SC (36.340%) aphid/ plant which lines with the finding Sreeja and Kumar (2022) [29] with (40.914%) aphid/plant and Sarkar and Kumar (2022) with (39.82%).

The Neem oil 5% (22.634%) is the next best treatment is found to be the next effective treatment which is in line with Sajid and Khuram (2017) [20] with. The next treatment *Beauveria bassiana* (2x108CFU /gm) (22.634%) which is support with Sairam and Kumar (2022) [19]. Fallowed by NSKE 5% which support Yadav *et al.* (2018) [31]. The and least effective treatment *Metarhizium anisopliae* (2×10^8 CFU/mg) (10.312%) which is support with Kumar and Kumar. (2016) [11].

Economics of various treatments

The data also showed that the highest grain yield of 18.33 q/ha was registered in Imidacloprid 17.8 Sl (T_1) which was followed by Spinosad 45% Sc 17.8 Sl (T_2) 15.16 q/ha, Nisco sixer plus @ 2 ml/lit (T_3) 13.33 q/ha, Neem oil 5% (T_7) 11.5 q/ha, NSKE 5% (T_6) 10.6q/ha, *Beauveria bassiana* (2CFU×10^8 ml) (T_5) 8.66q/ha, *Metarhizium anisopliae (2x108CFU /gm)* (T_4)7.6 q/ha. As low as 6.3 q/ha was recorded in untreated plot control (T_0).

Metarhizium anisopliae (2x108CFU /gm) (T4) 7.6 q/ha. As low as 6.3 q/ha was recorded in untreated plot control (T0). These findings are supported by (Chandra *et al.*, 2014) [3] with a yield of (17 q/ ha) for Spinosad 45 SC. The findings supported by (Singh *et al*., 2014) [27] with a yield of (19.63 q/ ha) for Imidacloprid 17.8 SL.

The analysis of Cost benefit ratio of all treatment was also carried out which revealed that the highest monetary return was obtained with in Imidacloprid 17.8 Sl (1:6.57) with the similar findings made by (Khandelwal and Kumar., 2022) with the cost benefit ratio (1:2.61) followed by Spinosad 45% Sc (1:5.62) with the similar findings made by (Sreeja and Kumar., 2022) [29] with (1:7.20). Followed by Nisco sixer plus @ 2ml/lit (1:5.12), Neem oil 5% EC (1:3.88) with the similar finding made by (Singh and Kumar 2022) [28] with (1:5.60), NSKE 5% (1:3.97), *Beauveria bassiana* (2CFU×10^8 ml) (1:2.99), *Metarhizium anisopliae* (2x10^8 CFU gm) (1:2.76) with similar finding made by (Singh and Kumar 2022) [28] with (1:4.87) Lest monetary return was obtained with control (1:2.56).

Table 1: Percent population reduction over control due to application of certain biopesticides and chemicals against mustard aphid, *L. erysimi* on Indian mustard

Treatment		Population of *L. erysimi*/Plant	Percent population reduction of mustard Aphid/5 plant			
		1 DBS	3 DAS	7 DAS	14 DAS	Mean
T_0	Control	63.33	00	00	00	00
T_1	Imidacloprid 17.8 SL	59.53	59.807	72.767	77.767	70.114
T_2	Spinosad 45 SC	58.73	43.677	59.993	62.380	55.350
T_3	Nisco sixer plus 45 SC	63.6	30.843	40.290	37.887	36.340
T_4	*Metarhizium anisopliae* (2x108CFU/gm)	60.2	10.293	13.257	7.387	10.312
T_5	*Beauveria bassiana* (2x108CFU/gm)	57.27	14.957	16.150	5.313	12.140
T_6	NSKE 5%	57.8	15.183	13.187	24.223	17.531
T_7	Neem oil 5%	59.00	16.197	26.783	24.923	22.634
F-TEST		NS	S	S	S	S
S.E (±) d			4.94	7.25	4.46	4.57
CD (P=0.05)			11.11	15.59	9.75	9.93

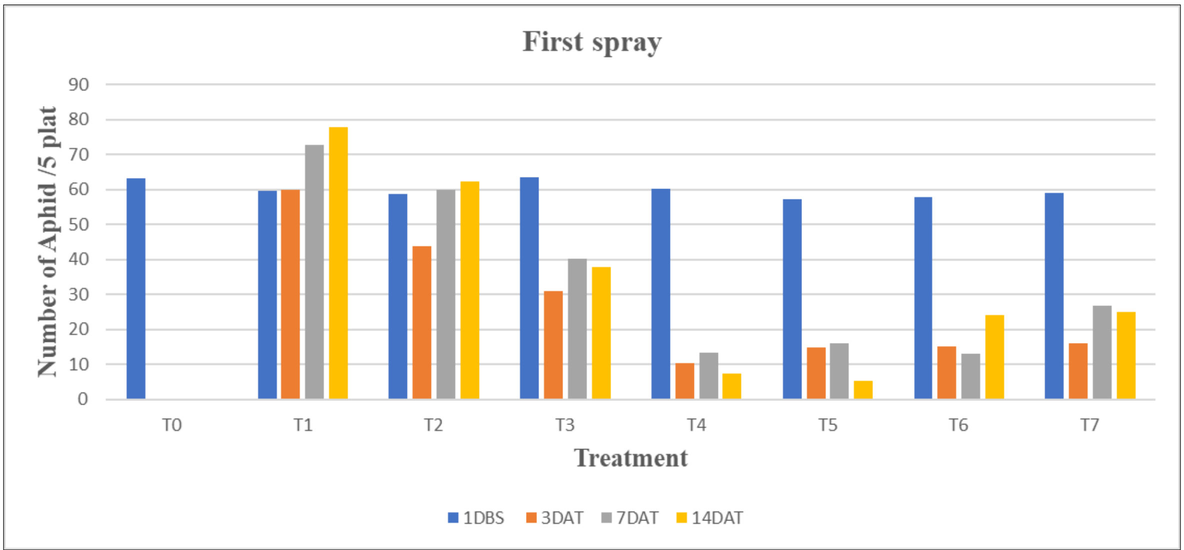

Fig 1: Graphical representation of percent population reduction over control (3rd, 7th, 14th DAS and Mean) due to application of biopesticides and chemicals against *Lipaphis erysimi* on Indian mustard

Table 2: Economics of Cultivation

S. No.	Treatment	Yield q/ha	Cost of yield (₹/q)	Total cost of yield (₹) (Gross return)	Common cost (₹)	Treatment cost (₹)	Net Return (₹)	Total cost of cultivation (₹)	C:B ratio
T_0	Control	6.3	6000	37800	14884	0	22916	14884	1:2.54
T_1	Imidacloprid 17.8 SL	18.33	6000	109980	14884	1850	93246	16734	1:6.57
T_2	Spinosad 45 SC	15.16	6000	93600	14884	1300	74776	16184	1:5.62
T_3	Nisco sixer plus	13.33	6000	79980	14884	1920	63176	16804	1:4.76
T_4	*Metarizium anisopilae* (2x108CFU /gm)	7.6	6000	45600	14884	1632	29084	16516	1:2.76
T_5	*Beauveria bassiana* (2x108CFU /gm)	8.66	6000	51960	14884	2490	34586	17374	1:2.99
T_6	NSKE 5%	10.6	6000	63600	14884	1125	47591	16009	1:3.97
T_7	Neem oil 5%	11.5	6000	69000	14884	2880	51236	17764	1:3.88

Conclusion

When it comes to managing population of *Lipaphis erysimi*, Imidacloprid 17.8% SL is more effective than Spinosad 45 SC, Nisco sixer plus, Neem oil 5%, and NSKE 5%. Imidacloprid 17.8% SL had the best economic cost-benefit ratio (1: 6.57) and marketing yield (18.33 q/ha) among the treatments, followed by Spinosad 45 SC (1: 5.62 and 15.16 q/ha), Nisco sixer plus (1: 4.76 and 13.33 q/ha), Neem oil 5%, NSKE 5%, *Beauveria bassiana* ($2x10^8$ CFU/gm), *Metarhizium anisopilae* ($2x10^8$ CFU/gm) 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.

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