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Badisa Sairam
M.Sc. Scholar, Department of Entomology, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Ashwani Kumar
Associate Professor, Department of Entomology, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Corresponding Author
Badisa Sairam
M.Sc. Scholar, Department of Entomology, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Field efficacy of selected bio pesticides and Fipronil against mustard aphid, *Lipaphis erysimi* (Kalt.)

Badisa Sairam and Ashwani Kumar

Abstract
A field trail was conducted at the Central Research Field (CRF), Department of Entomology, SHUATS, Prayagraj during *rabi* 2021-2022. With an investigation entitled seven treatments were evaluated against *Lipaphis erysimi,* i.e., Spinosad 45% SC (T1), *Beauveria bassiana* (T2), *Metarhizium anisopliae* (T3), *Bacillus thuringiensis* (T4), Neem oil 5% (T5), NISCO MECH 333 (T6), Fipronil 5% SC (T7) and untreated Control (T8). Results revealed that, among all the treatments highest per cent reduction of mustard aphid was recorded in Fipronil 5% SC (65.11%). Spinosad 45% SC (61.85%) is found to be the next best treatment followed by MECH 333 (57.98%). It is followed by *Bacillus thuringiensis* (57.02%). *Beauveria bassiana* (55.76%) is found to be the next effective treatment. It was followed by Neem oil 5% (52.93%) and *Metarhizium anisopliae* (50.46%) was the least effective among all treatments. While, the highest yield 20.17 q/ha was obtained from the treatment Fipronil 5% SC as well as B:C ratio (1: 5.28) was obtained high from this treatment. It was followed by Spinosad 45% SC (1: 4.24), MECH 333 (1:4.13), *Bacillus thuringiensis* (1:4.06), *Beauveria Bassiana* (1:3.61), Neem oil 5% (1:3.56), *Metarhizium anisopliae* (1:3.07), as compared to Control (1: 2.74).

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

Introduction

Oilseed crops play an important role in agricultural economy of India. It constitutes the second largest agricultural product in the country next to food grains. In India, oilseeds contribute 3 per cent and 10 per cent to gross national products and value of all agricultural products respectively (Singh *et al*., 2017) [21] Indian mustard *[Brassica juncea* L. Czern. and Coss.] is predominantly cultivated in Rajasthan, UP, Haryana, Madhya Pradesh, and Gujarat contributing 85 per cent of total rapeseed-mustard production (Kumar and Chauhan, 2005) [9] and 26.5 per cent of total domestic edible oil production in India (Singh *et al.*, 2017) [21] Rapeseed and mustard have occupied an important place among oilseed crops and act as a major source of edible oil, condiment and vegetable. In India, it is one of the three major oilseeds crops along with groundnut and soybean contributing around 24.2 per cent of the total oilseeds production. It is cultivated in 6. 41 million hectares of area with total production of about 6.33million tones with an average productivity of 1262 kg ha (Shivran *et al.*, 2020) [20].

The seed of rapeseed mustard is a rich source of oil (46- 48 percent) and protein (43.6 per cent) in whole seed meal and their green leaves are used for human food and animal fodder (Sahito *et al.*, 2019) [15]. The demand for vegetable oilseed is estimated to increase to level of 21.69 million tons during 2020 AD and about 14.0 million tons of mustard need to be produced to meet the minimum nutritional requirement of 12.5 kg per capita per year from the present 8.5 kg per capita per year which is possible only by adoption of new technologies (Thapa *et al.*, 2019) [22].

Among various constraints in rapeseed-mustard production, insect-pests are the most important biotic factors in reducing the crop yield. Mustard aphid (*Lipaphis erysimi* Kalt.) (Homoptera: Aphididae) is one of the major constraints of qualitative as well as quantitative production of rapeseed-mustard in India. Majority of the pests attacking rapeseed-mustard are stage specific. Aphid infest the crop right from vegetative stage to pod stage and cause up to 96 per cent yield losses and 5-6% reduction in oil content (Patel *et al.*, 2017) [13]. The mustard aphid, *Lipaphis erysimi* (Kaltenbach), is the key pest of rapeseed-mustard. Nymphs and adults suck cell sap from leaves, shoots, flower buds, flowers and pods. This pest is active from December to March when it infests various cruciferous oilseeds and vegetables. The cloudy and cold weather (20 °C or below), with high relative humidity (70-75 per cent) are very favourable conditions the multiplication of this pest (Kumar and Sangha. 2013) [11].

This pest is a prolific breeder and requires regular spraying of insecticides. In recent years, various types of insecticides belonging to different botanicals, chemical group were used as spray to manage the pest complex. Sometimes we don't know about best insecticide for aphid control, so best one can be identified for the management of mustard aphid on mustard by potential evaluation of few selected insecticides through their comparative effectiveness.

Materials and Methods

The experiment was conducted during *Rabi* season 2021-2022 at Central Research Field (CRF) of Sam Higginbottom University of Agriculture, Technology and Sciences, Naini, Prayagraj, Uttar Pradesh, India, in a randomized block design with eight treatments replicated three times using variety black gold seeds in a plot size of 2 m × 2 m at a spacing of 30 cm × 10 cm with a recommended package of practices excluding plant protection. The soil of the experimental site was well drained and medium high.

The observations on population of sucking pest were recorded visually using a magnifying lens early on top 10 cm 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 3, 7 and 14 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 Henderson and Tilton (1955) [6] referring it to be modification of Abbott (1925).

The average percent reduction of pest population of all two sprays was worked out by using Henderson and Tilton formula described as under:

$$\text{Percent reduction} = 1 - \frac{Ta}{Tb} \times \frac{Cb}{Ca} \times 100$$

Where,

Ta = Number of insects in treated plot after insecticides application

Tb = Number of insects in treated plot before insecticides application Ca= number of insects in Untreated check after insecticide application

Cb = Number of insects in untreated check before insecticide application

(Dotasara *et al*., 2017) [4]

Benefit Cost Ratio

Cost effectiveness of each treatment was assessed based on net returns. Net return of each treatment was worked out by deducting total cost of the treatment from gross returns. Total cost of production included both cultivation as well as plant protection charges.

Gross return = Marketable yield × Market price

Net return = Gross return – Total cost

$$\text{Benefit: Cost Ratio} = \frac{\text{Gross Returns}}{Total\ Cost} \times 100$$

(Zorempuii and Kumar, 2019) [27]

Results and Discussion

The data on the mean per cent population reduction of first spray and second spray overall mean revealed that all the treatments except untreated control are effective and at par. Among all the treatments highest per cent reduction of mustard aphid was recorded in Fipronil 5% SC (65.11%). Similar findings made by Sen *et al*. (2017) [17] with (60.58%), Dwivedi *et al*. (2019) [5] with (71.58%), Chandra *et al.* (2014) [3], Maurya *et al.* (2018) [12], Shivaleela and Chowdary (2020) [19]. (Spinosad 45% SC (61.85%) was found tobe the next best treatment which is in line with the findings of Khanal *et al.* (2020) [8] and Dwivedi *et al*. (2019) [5] with (61.77%), Akter *et al.* (2021) [2], Vishvendra *et al.* (2018) [25] highest percent reduction of mustard aphids. MECH 333 (57.98%) was found to be the next best treatment which is in line with the similar findings of Zorempuii and Kumar. (2019) [27] reduced maximum aphids population.

Bacillus thuringiensis (57.02%) was found to be the next best treatment which is in line with the similar findings of Kumar and Kumar. (2016) [10] and Khanal *et al.* (2020) [8] with (55.83%). *Beauveria Bassiana* (55.76%) was found to be the next best treatment which is in line with the similar findings of Shinde *et al.* (2021) [18] with (63.84%), Sajid *et al.* (2017) [16] with (56%) and Kamil *et al.* (2016) [7] with (51%). Neem oil 5% (52.93%) was found to be the next best treatment which is in line with the similar findings of Kumar and Kumar. (2016) [10] with (48.72%), Rashid *et al.* (2021) [14] with (47.16%), Akter *et al.* (2021) [2] *Metarhizium anisopliae* (50.46%) was found to be least effective but comparatively superior over the control, these similar findings are supported by Dwivedi *et al.* (2019) [5] with (51.05%) and Ujjan *et al.* (2012) [23] with (48.4%) percent reduction in mustard aphid.

Economics of various treatments

The yields among the treatments were found to be significant. The highest yield was recorded in Fipronil 5% SC (20.17 q/ha) which is in line with the similar findings of Chandra *et al.* (2014) [3] with (20.63 q/ha), Patel *et al.* (2020) [13] with (16.62 q/ha), Shivaleela and Chowdary (2020) [19] with (16.54 q/ha) and Maurya *et al.* (2018) [12] with (16 q/ha), followed by Spinosad 45% SC (15.80 q/ha) which is in line with the similar findings of Akter *et al.* (2021) [2] with (16.2 q/ha) and Chandra *et al.*(2014) [3] with (15.82 q/ha), MECH 333 (15.38 q/ha), *Bacillus thuringiensis* (14.95 q/ha) which is in line with the similar findings of Sajid *et al.* (2017) [16], *Beauveria bassiana* (13.72 q/ha) which is in line with the similar findings of Yadav *et al.* (2021) [26] with (13.39 q/ha), Neem oil 5% (13.09 q/ha) with similar findings of Yadav *et al.* (2021) [26] with (13.28%), Akter *et al.* (2021) [2] with q/ha), and *Metarhizium anisopliae* (11.45 q/ha).

When cost benefit ratio was worked out, interesting result was achieved. Among the treatments studied, the best and most economical treatment was Fipronil 5% SC (1:5.28) with the similar findings of Chandra *et al.* (2014) [3] with (1:5.20), Sen *et al*. (2017) [17] with (1:5.94), and Ahlawat *et al.* (2018) [1] with (1:5.65) followed by Spinosad 45% SC (1:4.24) with the similar findings of Dwivedi *et al.* (2019) [5] and Chandra *et al.* (2014) [3] with (1:2.6), MECH 333 (1:4.13), *Bacillus thuringiensis* (1:4.06) with the similar findings of Khanal *et al.* (2020) [8], *Beauveria Bassiana* (1:3.61) with the similar findings of Dotasara *et al.* (2021) [4] with (1:4.1), Neem oil 5% (1:3.56) with similar findings of Ahlawat *et al.* (2018) [1] and Vishal *et al.* (2019) [24] with (1:3.79), *Metarhizium anisopliae* (1:3.07) with the similar findings of Dotasara *et al.* (2021) [4] with (1:3.40) as compared to Control (1:2.74).

Table 1: To evaluate the effect of selected chemicals and biopesticides on the population of mustard aphid, *Lipaphis erysimi* (Kalt.)

S. No	Treatments	Population of *L. erysimi* /Five plants (top 10 cm central twig of plant)	Per cent population reduction of *L. erysimi* /top 10 cm central twig of plant						
			1ST Spray			2nd Spray			Overall Mean
		Before spraying	3 DAS	7 DAS	14 DAS	3 DAS	7 DAS	14 DAS	
T1	Spinosad 45% SC	271	35.75	52.38	66.71	58.69	71.81	86.29	61.85
T2	*Beauveria bassiana*	275.7	26.87	47.54	58.98	52.25	67.26	81.60	55.76
T3	*Metarhizium anisopliae* (106-108 spore load/gm)	276.4	22.91	43.3	56.13	47.67	52.29	74.02	50.46
T4	*Bacillus thuringiensis*	276.2	32.06	50.67	61.54	53.79	62.02	82.35	57.02
T5	Neem oil 5%	276	24.93	44.23	58.76	47.98	59.77	81.91	52.93
T6	MECH 333	273.3	34.46	51.17	63.04	55.47	67.50	85.86	57.98
T7	Fipronil 5% SC	272.9	40.06	53.50	69.57	64.17	73.68	90.32	65.11
T8	Control (Water spray)	277.1	00.000	00.000	00.000	00.00	00.00	00.00	00.00
	F-test	NS	S	S	S	S	S	S	S
	S. Ed. (±)	-	0.444	0.361	0.580	0.978	1.091	1.292	1.535
	C.D. (P = 0.05)	-	0.942	0.776	1.245	2.099	2.339	2.771	3.206

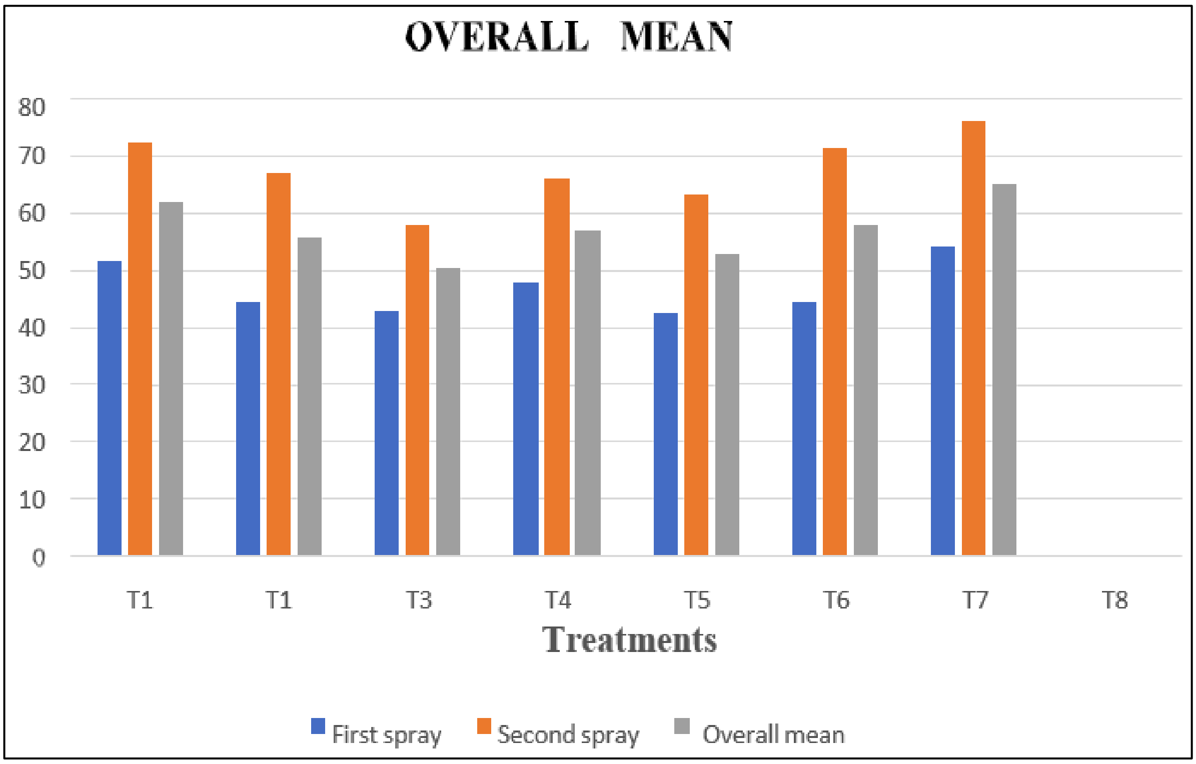

Fig 1: Graphical representation of efficacy of selected bio pesticides and Fipronilon the per cent population reduction of mustard aphid, *L. erysimi* (1st and 2nd spray)

Table 3: Economics of cultivation

S. No	Treatments	Yield of q/ha	Cost of Yield / ₹/QTL	Total cost of yield (₹)	Common Cost (₹)	Treatment Cost (₹)	Net Return (₹)	Total Cost (₹)	B:C Ratio
1	Spinosad 45% SC	15.80	6500	102700	22149	2100	80856	24249	1:4.24
2	*Beauveria bassiana*	13.72	6500	89180	22149	2550	64481	24699	1:3.61
3	*Metarhizium anisopliae* (108 spore load/gm)	11.45	6500	74425	22149	2088	50188	24237	1:3.07
4	*Bacillus thuringiensis*	14.95	6500	97175	22149	1760	73266	23909	1:4.06
5	Neem oil 5%	13.09	6500	85085	22149	1700	61236	23849	1:3.56
6	MECH 333	15.38	6500	99970	22149	2080	75741	24229	1: 4.13
7	Fipronil 5% SC	20.17	6500	131105	22149	2700	106256	24849	1: 5.28
8	Control (Water spray)	9.33	6500	60645	22149	----	38496	22149	1: 2.74

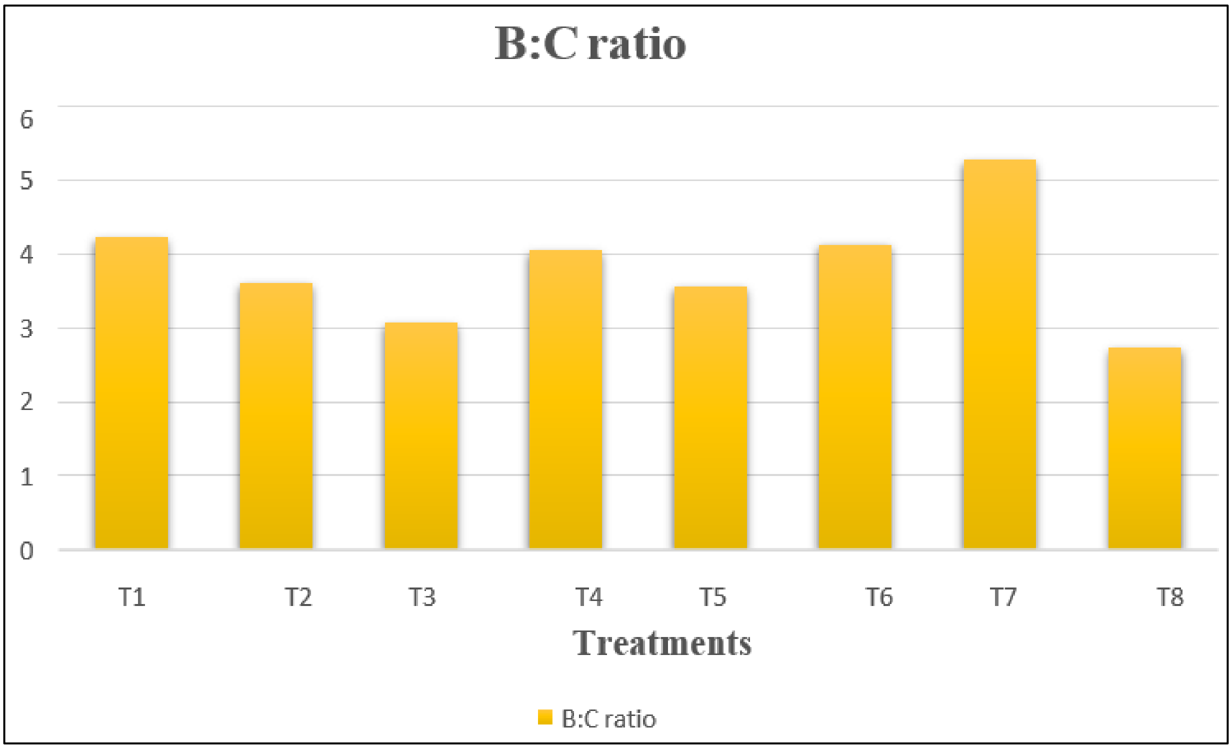

Fig 2: Graphical representation of efficacy of Cost benefit ratio of different treatments on the percent population reduction of mustard aphid, *L. erysimi*

Conclusion

From the experiment discussed above, the results revealed that the most efficient insecticide against *Lipaphis erysimi* was found to be Fipronil 5% SC followed by Spinosad 45% SC, MECH 333, *Bacillus thuringiensis*, *Beauveria bassiana*, Neem oil 5% Among the treatments studied, Fipronil 5% SC gave the highest cost benefit ratio (1:5.28) and marketing yield (20.17 q/ha) followed by Spinosad 45% SC (1:4.24 and 15.80q/ha), MECH 333 (1:4.13 and 15.09 q/ha), *Bacillus thuringiensis*, *Beauveria bassiana*, neem oil 5%, *Metarhizium anisopliae* respectively. Recommended dose of chemicals may be useful in devising integrated pest management strategy against mustard aphid.

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