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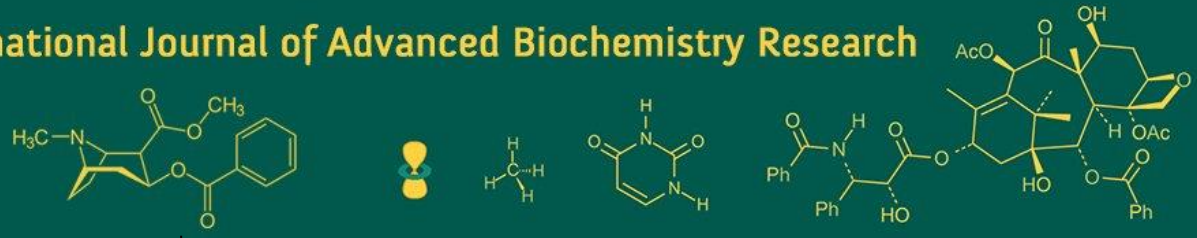

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Efficacy of selected insecticides and biopesticides against mustard aphid, *Lipaphis erysimi* (Kaltenbach) on Indian mustard (*Brassica juncea* L.) in Prayagraj (U.P)

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Abstract
The field investigation was carried out in *Rabi* season of 2023-2024 at Central Research Farm (CRF), Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India. The experiment was laid out in Randomised Block design (RBD) with eight treatments each replicated thrice using a variety, Kala Sona. The treatments *viz.*, Imidacloprid 17.8 SL (0.2/l), Thiamethoxam 25 WG (0.2 g/l), Azadiractin 1500 ppm (1 ml/l), Fipronil 5 SC (1.6 ml/l), *Beauveria Bassiana* 1.15 Wp (2 g/l), Karanj oil 5% (5 ml/l), NSKE 5% (5 ml/l) and along with an untreated control were used against *Lipaphis erysimi* infesting mustard. The data on the mean (3rd, 7th and 14th DAS) Population over control on mustard aphid after spray revealed that all the chemical and biopesticides insecticide treatment were significantly superior over control. Among all the treatments, minimum infestation of aphid was recorded in Fipronil 5 SC (T_4) (74.79) which was lower than the check treatment Imidacloprid 17.8 SL (61.647), followed by Thiamethoxam 25 WG (T_2) (76.657), Azadiractin 1500 ppm (T_3) (82.387), NSKE 5% (T_7) (88.113), Karanj oil 5% (T_6) (94.790), *Beauveria bassiana* 1.15 WP (T_5) (99.567) and untreated (T_8) (188.600). Among the treatments studied, Fipronil 5 SC give the highest cost benefit ratio (1: 5.07) and marketing yield (16.28 q/ha) which was lower than the check treatment Imidacloprid 17.8 S (1: 6.25 and 19.3 q/ha) followed by and Thiamethoxam 25 WG (1: 4.58 and 14.1 q/ha), Azadiractin 1500 ppm (1: 3.99 and 12.41 q/ha), NSKE 5% (1: 3.32 and 10.53 q/ha), Karanj oil (1: 2.84 and 8.9 q/ha), *Beauveria bassiana* 1.15 WP (1: 217 and 6.8 q/ha) and untreated (1:212 and 6.2 q/ha).

Keywords: Chemical, cost benefit ratio, imidacloprid, *Lipaphis erysimi*, population, yield, mustard

Introduction
Brassica oilseed crops are the major *Rabi* oilseed crops grown in India, which is collectively referred to as rapeseed-mustard. Ayurvedic Samhitas describes the use of 'Sarson' in India. In Sanskrit literature, 'sorson' seeds have been described as antiseptic. Mustard is the second most important oilseed crop in India and constitutes the major source of edible oil for human consumption and cake for animals. India is the largest rapeseed-mustard growing country in the world, occupying first position in area and second position in production after China (Maurya *et al.*, 2018) [9]. The oleiferous Brassica species, commonly known as rapeseed-mustard, are one of the economically important agricultural commodities. Rapeseed-mustard comprising eight different species *viz*. Indian mustard, toria, yellow sarson, brown sarson, gobhi sarson, karan rai, black mustard and taramira, are being cultivated in 53 countries spreading all over the globe. (DRMR, 2020) [6]. Mustard oil is one of the healthiest edible oils as it has no trans-fat, has low saturated fats, high mono-unsaturated and poly-unsaturated fats like omega-3. Mustard is also rich in minerals like Calcium, Manganese, Copper, Iron, Selenium, Zinc, Vitamin (A, B and C) and proteins (Daravath *et al.*, 2016) [4]. 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 per cent of the total oilseeds production. (Sen *et al.*, 2017) [16]. In India, the total area under rapeseed-mustard cultivation is 8.06 million hectares in 2021-22 and that of production is 11.75 million tonnes in 2021-22. By analyzing state wise production in 2021-22, The total yield of rapeseed-mustard in 2021-22 is 1458 kilogram per hectare (Anonymous, 2023) [1].

The mustard aphid, *Lipaphis erysimi*, (Kalt.), mustard sawfly, *Athalia lugens proxima* (Klug.), painted bug, *Bagrada hilaris* (Kirk.) and the leaf miner, *Phytomyza horticola* (Goureau) are major pests of mustard. Mustard aphid, *L. erysimi* is a predominant and key pest causing upto 96 per cent yield loss and 5-6 per cent reduction in oil content (Shylesha *et al.,* 2006) [19]. Both the nymphs and adults suck sap from leaves, inflorescence, stems, flowers and pods; as a result, the plant shows stunted growth, flowers wither and pod formation are hindered. The losses of mustard due to aphids varied from 35 to 90 percent depending upon the seasons (Biswas and Das, 2000) [3]. It is reported that mustard aphid reduces the yield from 9 to 95% different places in India. The yield losses may be 10-90% depending upon the severity of damage and the stage of the crop. The economic thresh hold (ETL) of this insect pest is infestation of 40 aphids per 10 cm length of the twig on the top portion of the central shoot or infestation of 30% plants (Sarkar and Kumar, 2022) [15].

Materials and Methods

The investigation was carried out the studies on the effect of different insecticides and bio pesticides against Mustard aphid, under the field conditions at the central research field, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India during the *Rabi* 2023-2024. The Mustard variety Kala Sona was sown @ 550 gm per hectare for line sowing method with spacing of 45 cm between row to row and 30 cm between plant to plant by placing 1-2 seeds per hill at depth of 1.5 to 2.5 cm. Plot size is 2 x 1 = 2 m^2. Trial was laid out in a randomized block design consisting of seven different treatments. Each treatment was replicated thrice and Mustard variety kala sona was used for study. The observations on aphid population were recorded in the morning at weekly interval. To record the observation of aphid population, five randomly selected plants were tagged in each plot. Timely visit made on the experimental plots to observe the occurrence of aphids. The population will be recorded from 10 cm terminal portion of the central shoot of a plant at 1st day before spray and 3rd, 7th and 10th days after spray. Grain yield was recorded on harvesting of the crop. Cost Benefit ratio was calculated by taking the difference in Gross returns from the respective treatments over the control. Further the C:B ratio was obtained by taking the ratio of benefit to the cost of insecticide.

$$\text{C:B} = \frac{\text{Gross return}}{\text{Total cost}} * 100$$

Result and Discussion

In the experiment, eight treatments consisting application of Control (T_0), Imidacloprid 17.8 SL (T_1), Thiamethoxam 25 WG (T_2), Azadiractin 1500 ppm (T_3), Fipronil 5 SC (T4), *Beauveria Bassiana* 1.15 WP (T_5) Karanj oil 5% (T_6), NSKE 5% (T_7) and were tested to compare the efficacy of against *Lipaphis erysimi* and their influences on the yield of mustard. Among all the treatments, minimum infestation of aphid was recorded in Fipronil 5 SC (T_4) (74.790) which was lower than the check treatment Imidacloprid 17.8 SL (T_1) (61.647) followed by Thiamethoxam 25 WG (T_2) (76.657), Azadiractin 1500 ppm (T_3) (82.387), NSKE 5% (T_7) (88.113), Karanj oil 5% (T_6) (94.79) and *Beauveria bassiana* 1.15 WP (T_5) (99.567). Among all the treatments least nymph and adult population of mustard aphid was recorded in Imidacloprid 17.8 SL (61.5). similar finding made by Imidacloprid 17.8 SL (58.00%) aphid/ plant which lines with the findings Dotasara *et al*., (2017) [5] and Pippal *et al*., (2022) [12], Raju and Tayde (2022) [13], Sharma *et al.,* (2020) [17]. Evaluation with Fipronil 5 SC (74.790) is similar with findings made by Maurya *et al*., (2018) [10] and Sairam and Kumar (2022) [14], Thiamethoxam 25 WG (76.657) similar finding made by Kumar *et al.,* (2022) [8]. Azadiractin 1500 ppm (82.387) similar finding made by Pal *et al.,* (2020) [11]. The result of Karanj oil 5% (94.79) which is par with *Beauveria Bassiana* (99.567) is found to be least effective but superior over the control, these finding are supported by Pal *et al.,* (2020) [11] and Sairam and Kumar (2022) [14], Janu *et al.,* (2018) [7] and Aswitha *et al.,* (2023) [2].

When cost benefit ratio was worked out, interesting result was achieved among the treatment studied, the best and most economical treatment was, Fipronil 5 SC (1: 5.07) which was lower than the check treatment Imidacloprid 17.8 SL (1: 6.25) followed by Thiamethoxam 25 WG (1: 4.58), Azadiractin 1500 ppm (1:3.99), NSKE 5% (1: 3.32), Karanj oil 5% (1: 2.84) and *Beauveria Bassiana* 1.15 WP (1: 2.17). These are supported by Aswitha *et al.,* (2023) [2], Shinde *et al.,* (2022) [18].

From the critical analysis of the present findings, it can be concluded that Fipronil 5 SC is more effective in controlling population reduction of mustard aphids which was lower than the check treatment Imidacloprid 17.8 SL, followed by Thiamethoxam 25 WG, Azadiractin 1500 ppm, in managing *Lipaphis erysimi*. Among the treatments studied, Fipronil 5 SC give the highest cost benefit ratio (1: 5.07) and marketing yield (16.28 q/ha) which was lower than the check treatment Imidacloprid 17.8 S (1: 6.25) and marketing yield (19.3 q/ha) followed by and Thiamethoxam 25 WG (1: 4.58 and 14.1 q/ha), Azadiractin 1500 ppm (1: 3.99 and 12.41 q/ha), NSKE 5% (1: 3.32 and 10.53 q/ha), Karanj oil (1: 2.84 and 8.9 q/ha), *Beauveria bassiana* 1.15 WP (1: 217 and 6.8 q/ha) respectively as such more trials are required in future to validate the findings for the farmers in a feasible manner for sustainable production of mustard and to prevent the losses occurring from this insect pest infesting the crop.

Table 1: Efficacy of Insecticides and biopesticides on the incidence of mustard aphid (*Lipaphis erysimi*) during *rabi* season 2022-2024).

Mean population of aphid numbers							
Treatments	**1 DBS**	**3 DAS**	**7 DAS**	**14DAS**	**Mean**	**Yield q/ha**	**C:B Ratio**
T_0 – Untreated	222.40	219^{a}	195.67^{a}	151.13^{a}	188.60^{a}	6.2	1: 2.12
T_1 – Imidacloprid 17.8 SL	228.67	125^{f}	41.07^{f}	18.87^{g}	61.65^{d}	19.3	1: 6.25
T_2 – Thiamethoxam 25 WG	217.27	149.70^{e}	54.47^{e}	25.80^{f}	76.66^{cd}	14.1	1: 4.58
T_3 – Azadiractin 1500 pPM	224.07	155.70^{de}	64.93^{e}	26.53^{ef}	82.39^{bcd}	12.41	1: 3.99
T_4 – Fipronil 5 SC	220.80	147.30^{cd}	53.40^{d}	23.67^{e}	74.79^{bcd}	16.28	1: 5.07
T_5 – Beauveria Bassiana 1.15 WP	218.93	171.30^{c}	81.00^{c}	46.40^{d}	99.57^{bc}	6.8	1: 2.17
T_6 – Karanj oil 5%	215.40	165.30^{b}	77.80^{b}	41.27^{c}	94.79^{bc}	8.9	1: 2.84
T_7 -NSKE 5%	217.40	158.00^{b}	71.67^{b}	34.67^{b}	88.11^{b}	10.53	1: 3.32
F- test	NS	S	S	S	S		
S. E (±)		3.35	2.79	0.86	10.11		
C. D. (P =0.05)		6.457	6.048	2.506	22.913		

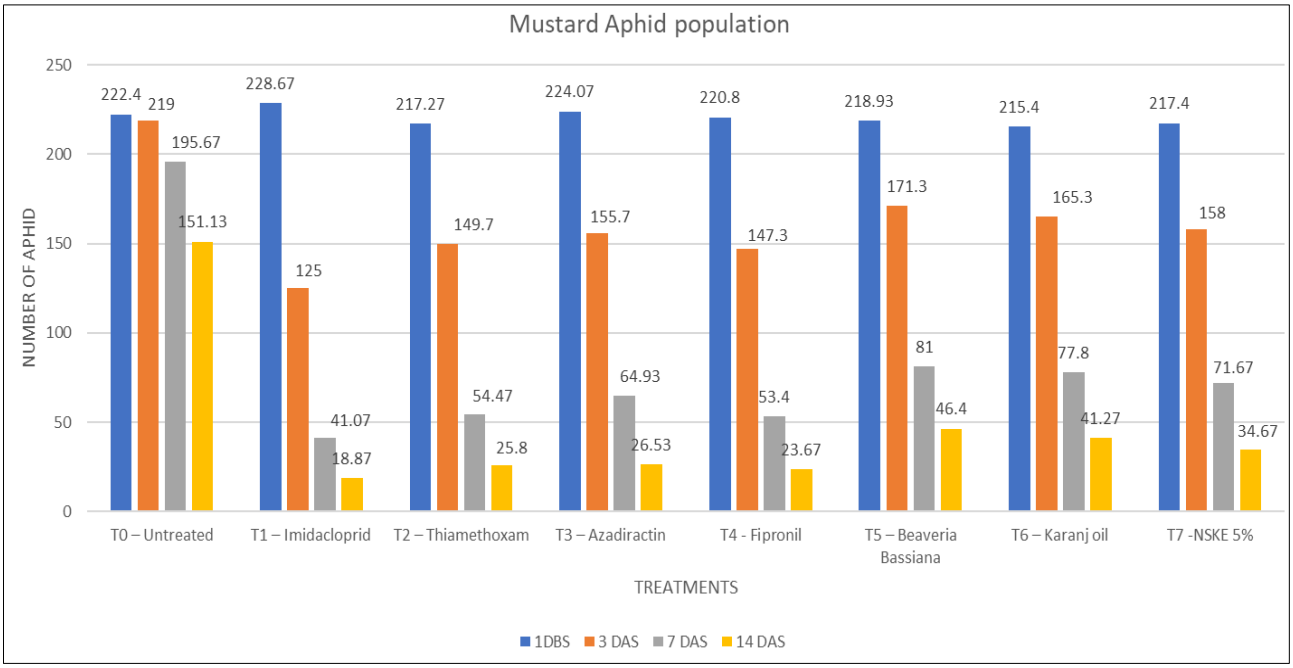

Fig 1: Mean population of mustard aphid

Conclusion

The study found that Fipronil 5 SC was the most effective treatment in controlling the population of mustard aphids (Lipaphis erysimi), achieving the highest cost-benefit ratio (1:5.07) and a marketable yield of 16.28 q/ha. While Imidacloprid 17.8 SL showed a higher cost-benefit ratio (1:6.25) and yield (19.3 q/ha), Fipronil 5 SC still proved superior in terms of aphid population reduction. Thiamethoxam 25 WG, Azadiractin 1500 ppm, NSKE 5%, Karanj oil, and Beauveria bassiana 1.15 WP were also effective but less so compared to Fipronil 5 SC and Imidacloprid 17.8 SL. Further trials are recommended to validate these findings for sustainable mustard production.

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