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Evaluation of chemical insecticides along with cypermethrin and biopesticides against mustard aphid [*Lipaphis erysimi]* (Kalt.) in mustard (*Brassica juncea*)

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Abstract
The field experiment on Efficacy of Cypermethrin and some biopesticides against mustard aphid [*Lipaphis erysimi* (Kalt.)] was conducted during *Rabi* 2021-2022, at Central Research Field, Department of Entomology, SHUATS, Naini, Prayagraj, UP. The relative evaluation of different insecticides *viz*., Nisco sixer Plus (T_1), Neem oil (T_2), Spinosad 45% SC (T_3), *Metarhizium anisopliae* (T_4), Cypermethrin (T5), Cypermethrin + Neem oil (T_6), Cypermethrin + Nisco Sixer Plus (T_7) and untreated control (T_0) was evaluated against mustard aphid (*Lipaphis erysimi*). Results revealed that, among the different treatments, the highest per cent population reduction of mustard aphid was recorded in Cypermethrin + Nisco Sixer Plus (83.22%) followed by Spinosad 45% SC (80.11%), Cypermethrin + Neem oil (78.37%). It is followed by Nisco Sixer Plus (74.83%) and Cypermethrin 10% EC (76.25%), *Metarhizium anisopliae* (74.08%) and Neem oil (71.60%) was the least effective among all treatments. While, the highest yield 28.123 q/ha was obtained from the treatment Cypermethrin + Nisco Sixer Plus as well as B: C ratio 1: 2.94 was obtained high from this treatment. It was followed by Spinosad 45% SC (1: 2.61), Cypermethrin + Neem oil (1: 2.16), Nisco Sixer Plus (1:1.98), Cypermethrin 10% EC (1: 1.66), *Metarhizium anisopliae* (1: 1.23), Neem oil (1: 1.18), as compared to Control (1: 0.97).

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

Introduction
Indian mustard (*Brassica juncea* (L.) is the second largest oilseed crop in India after Groundnut. Among rapeseed-mustard, Indian mustard is one of the most important oil seed crops which contribute about 85 per cent of total rapeseed mustard produced in India (Kumar and Chauhan., 2005) [15]. India is the largest country in mustard production after China and Canada. Globally, India accounts for 23.33%
(61.24 lakh ha) and 26.24% (92.55 lakh TN) of the total acre age and production with yield of 1511 kg/ha. Indian mustard having potential up to 3.5 ton per hectare with bold seeded and up to 42% oil content. It hold sa premium position in rapeseed-mustard economy of the world with 2nd and 3rd rank in area and production respectively (Choudary., 2018) [7]. In India mustard is predominantly cultivated in Rajasthan (50%), Uttar Pradesh (12.3%), Haryana (11.2%), Madhya Pradesh (9.8%), Gujarat (6.5%) and West Bengal (5.1%). Among these states, Rajasthan, Uttar Pradesh and Madhya Pradesh are the Uttar Pradesh accounts for 10.85% and 11.19% of area and production, respectively in the country with the average yield of 11.49 q/ha which is equivalent to the national average (11.17 q/ha). (Singh *et al.*, 2007) [30].
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) [22]. They may cause 66 to 99 per cent loss in *B. campestris* L. and 27-28% *B. juncea* L with losses in oil content of 15 per cent. The avoidable yield losses due to aphids are anywhere between 20- 50 per-cent and in extreme condition, the yield losses could be as high as 78%.
Lipaphis erysimi belongs to family Aphididae and is commonly known as mustard aphid. It is a cosmopolitan insect and found on both the leaf surfaces and in leaf folds of developing heads, on leaf stalks, and on leaf axles. They are found primarily on the growing points of the host plants, including tips, flowers and developing pods and cover the whole plant with high density**.** They suck sap from the hosts and infested plants become stunted and distorted. Their infestation causes wilting, yellowing and stunting of plants. On the other hand, aphid produces a good amount of honey dew which facilitates the growth of the fungus that makes the leaves

And pods appear dirty black and also interferes in the photosynthetic activity of the leaves (Chauhan *et al.*, 2011) [8].

Materials and Methods

The experiment was conducted during rabi season 2021-2022 at Central Research Field (CRF) of Sam Higgin bottom 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 30cm×10cm 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 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 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 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:

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

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) [9]

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

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

(Zorempuii and Kumar, 2019) [38]

Results and Discussion

Among all the treatments highest percent population reduction of mustard aphid was recorded in T7 Cypermethrin + Nisco Sixer plus (70.38%). Similar findings made by Kumar *et al.* (2007) [16] Dotasara *et al.* (2017) [9], Meena *et al.* (2013) [18], Vishal *et al.* (2019) [32], Giri *et al.* (2020) [11] and Sen *et al.*, (2017) [26]. T_3 Spinosad 45% SC (67.75%) is found to be the next best treatment which is in line with the findings of Aziz *et al.* (2014) [4], Rashid *et al.* (2021) [24] Vishal *et al.* (2019) [32] they reported that was found most effective in reducing percent population of *Lipaphis erysimi* T6 Cypermethrin + Neem oil (66.43%) is found to be the next best treatment which is in line with the findings of Meena *et al.* (2013) [18] T_1 Nisco Sixer plus (63.51%) is found to be the next effective treatment which is in line with the findings of Sen *et al.* (2021) [26], and T_5 Cypermethrin 10 EC (64.84%) is found to be the next effective treatment which is in line with the findings of Zorempuii and Kumar. (2019) [38]. The result of T_4 *Metarhizium anisopliae* (62.32%) which is at par with T_2 Neem oil (60.24%) is found to be least effective but comparatively superior over the control, these findings are supported by Meena *et al.* (2013) [18], Kumar *et al.* (2020) [17].

Table 1: Efficacy of insecticides, and bio-pesticides on Aphid Population reduction (%) at different days interval

S. N.	Treatments	Aphid Population reduction at different days interval									Yield (q/ha)	B:C Ratio
		First Spray					Second Spray					
		1 DBS	3 DAS	7 DAS	14DAS	Mean	3 DAS	7 DAS	14DAS	Mean		
T0	Control	352.3	0	0	0	0	0	0	0	0	21.52	1:1.98
T1	Nisco Sixer Plus	366.8	42.5	52.45	61.64	52.19	65.2	71.34	87.95	74.83	15.45	1:1.18
T2	Neem oil	352.93	38.75	48.83	59.1	48.89	62.92	68.2	83.7	71.60	25.80	1:2.61
T3	Spinosad45 SC	365.2	44.45	56.56	65.18	55.39	71.83	75.57	92.95	80.11	15.95	1:1.23
T4	*Metarhizium anisopliae*	361.66	41.76	50.15	59.78	50.56	64.72	69	88.52	74.08	18.99	1:1.66
T5	Cypermethrin	360.33	42.6	54.41	63.3	53.43	67.45	72.25	89.06	76.25	23.10	1:2.16
T6	Cypermethrin + Neem oil	364.33	43.24	56.08	64.18	54.5	69.72	74.28	91.13	78.37	28.21	1:2.94
T7	Cypermethrin + Nisco Sixer Plus	363	47.05	58.82	66.77	57.54	74.39	81.08	94.2	83.22	13.72	1:0.97
	C.D.(5%)	-	0.41	0.88	0.71	2.95	1.72	3.08	1.25	7.20		
	SE. d ±	-	0.87	1.90	1.52	6.33	0.80	1.43	0.58	3.35		

Cost Benefit ratio and Mustard yield

The yields among the treatments were significant. The highest yield was recorded in T_7 Cypermethrin + Nisco Sixer plus (28.12 q/ha) followed by T_3 Spinosad 45% SC (25.80 q/ha), T_7 Cypermethrin + Neem oil (23.10 q/ha), T_1 Nisco Sixer plus (21.52 q/ha), T_5 Cypermethrin 10 EC (18.99 q/ha), T_4 *Metarhizium anisopliae* (15.95 q/ha), T_2 Neem oil (15.45 q/ha), as compared to control plot (13.72 q/ha). These findings are supported by Vishal *et al.* (2019) [32], Bhatta *et al.* (2019) [5], Akter *et al.* (2021) [3], Yadav *et al.* (2017) [35], Aziz *et al.* (2014) [4], Meena *et al.* (2013) [18].

When cost benefit ratio was worked out, interesting result was achieved. Among the treatments studied, the best and most economical treatment was T_7 Cypermethrin + Nisco Sixer

plus (1: 2.94) followed by T_3 Spinosad 45% SC (1: 2.61), T_6 Cypermethrin + Neem oil (1:2.16), T_1 Nisco Sixer plus (1: 1.98), T5 Cypermethrin 10 EC (1:1.66), T_4 *Metarhizium anisopliae* (1: 1.23), T_2 Neem oil (1:1.18), as compared to T_0 Control (1: 0.97).The highest yield and cost benefit ratio was recorded in T_7 Cypermethrin + Nisco Sixer plus (28.21 q/ha & 1:2.94) followed by T_3 Spinosad 45% SC (25.80 q/ha & 1:2.61). These findings are supported by. Ahlawat *et al.* (2018) [2] and Akter *et al.* (2021) [3].

Conclusion

From the above discussion it was found that, treatments used chemical is considered to have the best treatment in which Cypermethrin + Nisco Sixer Plus (2.5 ml/lit) proved to be the best treatment in managing *Lipaphis erysimi* Infestation and the highest yield was observed in Cypermethrin + Neem oil (2.5 ml/lit), Spinosad 45 SC and Nisco Sixer plus (2ml/lit) having the best benefit ratio. The sole usage of Neem oil and *Metarhizium anisopliae* did not show any specific results, the sole usage of these two treatments that have different results, however the *Metarhizium anisopliae* shows better results than Neem oil. It is better to know the compatibility of the botanical and Insecticides should be examined for their efficiency.

Therefore, insecticide of short residual effect and may be useful in devising proper integrated pest management strategy against aphid. Harmony with existing integrated pest management programs in order to avoid problems associated with insecticidal resistance, pest resurgence etc. Botanical low cost and risk without adverse effect on environment, human and animals.

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