Efficacy of selected biopesticides against Mustard aphid, *Lipaphis erysimi* (Kalt.) (Hemiptera: Aphididae)

ABSTRACT

The present experiment was carried out at Central Research Farm, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, during *Rabi* season of the year 2023-2024. The experiment was conducted under Randomized Block Design (RBD) with the eight treatments and three replications. Two sprays wereand undertaken two spraying with at fourteen days interval. Neem oil 5 %, iImidacloprid 17.8 SL, *Beauveria bassiana* 1.15 % WP, Nisco Sixer plus, *Metarhizum anisopliae*, sSpinosad + neem oil 5 %, sSpinosad 45% SC are werethe treatments tested against the mustard aphid,*Lipaphis erysimi*, (Kalt.)used in this experiment. Results show thatAmongall the treatments, (T_2) iImidacloprid 17.8%SL and it was significantly superior over the other treatments showing 30.08/top 10cm twig and *Beauveria bassiana* being least effective recorded the highest number of aphids of 69.53/top 10cm was found to be least effective against mustard aphid. The highest yield and cost benefit ratio was recorded in from the plots treated with iImidacloprid 17.8% SL(18.5 q/ha) and (1:5.19) and the lowest from*B*b*eauveria bassiana*(12.55 q/ha)and (1:3.43).

Key words: Biopesticides, Imidacloprid, *Lipaphis erysimi*, Mustard aphid.

INTRODUCTION

Mustard, *Brassica juncea* (L.) is an important oilseed crop belonging to family Ceruciferaceae (Syn. Brassicaceae). It is self pollinated but certain amount (2-15%) pollination occur due to insects and other factors. The origin place of mustard is China, northeastern India from where it has extended up to Afghanistan via Punjab **(Kalasariya, 2019)**. Rapeseed-mustard is the third important oilseed crop grownth in the world after soyabean (*Glycine max*) and palm oil.

Mustard is also rich in minerals like Calcium, Manganese, Copper, Iron, Selenium, Zinc, Vitamins (A, B and C) and proteins. A 1000g of mustard seeds contains 508K k.cal. energy, 28.09g carbohydrates, 26.08g proteins,26.08g total fat, and 12.2g dietary fiber, Vitamin A,4.733mg Niacin, 7.1mg Vitamin C, 266mg Calcium, 9.21mg Iron, 370mg

Formatted: Font: 12 pt

Formatted: Font: 12 pt, Not Bold

Comment [st1]: What is this? Aphids per top 10 cm?

Comment [st2]: Nowhere in the article this is mentioned

Magnesium, 13mg Sodium, and 738mg Potassium **(Daravath *et al.*, 2021).** It also helps stimulating sweat glands and help lowering body temperature.

In traditional medicines, it is used to relieve the pain associated with arthritis, muscle sprains and strains. Seed paste applied on wounds whereas paste of leaf said to heal cattle wounds. The purpose of the present investigation was to determine protein, oil, carbohydrate, energy and nutritive value of the *Brassica* spp. Species which represent natural resources with potential economic for use in human and animal nutrition **(Hossain *et al.*, 2015).**

In India, it is the second most important edible oilseeds after groundnut which shares 27.8% in the India's oilseed economy. **(Bhanu *et al.*, 2019).**

The estimated area, production, and yield of rapeseed-mustard in the world was 36.59 million hectares, 72.37 million tones and 1980 kg/ha, respectively, during 2018-19. Globally, India accounts for 19.8 and 9.8 per cent of the total acreage and production, respectively. The productivity of India is the lowest among the major mustard growing countries, the Indian with an average yield was ofonly 1.4 tonnes/ha during 2019- 20. Mustard plays an important role in the oil seed economy of the country. It has 38 to 42% oil and 24% protein. **(Kalia *et al.*,2021**).

Objective:

1. To evaluate the efficacy of biopesticides on the incidence of mustard aphid (*L. erysimi*) on mustard during the *rabi* season 2023-2024.

2. To calculate the cost benefit ratio.

Materials and Methods

Field trails were conducted to study the " efficacy of selected biopesticides against mustard aphid, *Lipaphis erysimi* (Kalt.) (Hemiptera:Aphididae)" at central research field, SHUATS, Prayagraj, U.P. during *Rabi* 2023-2024. The trail was laid out in RBD having seven treatments and three replications with the plot size 2 x 2m. The experiment was carried out on Chickpea variety Pusa-362. Two rounds of spray were given at fifteen days interval using a hand operated sprayer during morning hours to avoid photo oxidation of chemicals. The treatments imposed were,s details are: nNeem oil 5% (T_1), iImidacloprid 17.8SL (T2),

Formatted: Font: Italic

Comment [st3]: Reduce the content. Put the purpose of the current research at the end of introduction

Formatted: Indent: First line: 0"

Comment [st4]: Don't put this in this paragraph

Comment [st5]: Write about the aphid in this chapter

Comment [st6]: Write as subscripts

Formatted: Subscript

Beauveria bassiana (T3), Nisco Sixer Plus(T4), *Metarhizium anisopliae* (T5), sSpinosad 240 EC+ nNeem oil 5% (T6), sSpinosad 45 SC(T7) and T$_0$–an untreated control (T0).

Observations and calculations on pest population, grain yield and B:C ratio were made on 5 randomly selected plants in each replication along with the unsprayed control. Post treatments observations on number of larvae were recorded on 3 rd, 7th and 14th days of after spray and were subjected to statistical analysis.

Benefit: Cost ratio:

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

Result and Discussion

In the experiment, eight different treatments, The data of the mean (3rd,7th and 14th) nymph and adult population of first spray revealed that all treatments except untreated control are effective and on par with each other. Among all the treatments lowest nymph and adult population of mustard aphid was recorded in Imidacloprid 17.8 SL (33.08) followed by Spinosad 240 EC+ Neem oil 5% (39.22), Spinosad 45 SC (43.95), Neem oil 5% (45.69), *Metarhizium anisopliae* (49.02), Nisco Sixer Plus (62.04), *Beauveria bassiana* (69.53) as compared to control plot (202.08) is found to be effective but comparatively superior over the control.

The data on mean nymph and adult population of first spray, overall mean revealed that the all treatment except untreated control is effective and par with each other. Among all the treatments least nymph and adult population of mustard aphid was recorded in Imidacloprid

Comment [st7]: ???

Comment [st8]: Write reference to this

Comment [st9]: It is better to use scientific names everywhere

Comment [st10]: Insecticides names are written in lower case. Make changes in whole article

Comment [st11]: What is this??

Comment [st12]: Which is?

Comment [st13]: What's the value

17.8 SL (87.21%). Similar findings were made by **Sreeja and Kumar (2022)** with~~(~~88.14% effectiveness~~)aphids/plant~~ and **Dotasara** (**2017)** with ~~(~~87.53%~~)~~ aphids/plant.

The next best treatment ~~found s~~Spinosad 240 EC+ Neem oil 5% ~~(~~84.29%)aphid/plant which lines with the findings of **Sen and Kumar (2023)** with ~~(~~85.93%~~)~~. The next best treatment found Spinosad 45 SC (78.06%) aphid/plant which lines with the finding **Akhter *et al.* (2021), Dwivedi and Singh (2019)** with (74.83%) aphid/plant. Neem oil 5% (70.25%) these results are supported by ***Yadav et al.* (2021)**. *Metarhizium anisopliae* (69.22%) supported by **Sajid *et al.*, (2017), Tomar *et al.* (2023).** Nisco Sixer Plus (70.25%) supported by **Khandelwal and Kumar (2022)**. *Beauveria bassiana* (2×10^{8}CFU/ml) (64.85%) these results are support with **Janu *et al.*, (2018)** with. is found to least effective but comparatively superior over the control which support **Dotasara *et al.*, (2017)** with (73.92).

Cost benefit and mustard yield

The data ~~also~~ showed that the highest grain yield of 18.15 q/ha was registered in Imidacloprid 18.15 SL (T_2) which was followed by Spinosad 240 EC+ Neem oil 5% (T_6) 17.85 q/ha, Spinosad 45 SC (T_7) 16.35 q/ha, Neem oil 5% EC (T_1) 14.58 q/ha, *Metarhizium anisopliae* (T_5) 14.98 q/ha, Nisco Sixer Plus(T_4) 13.03q/ha, *Beauveria bassiana* (T_3) 12.55 q/ha. As low as 9.17 q/ha was recorded in untreated plot control (T_0). These findings are supported by **Raju and Tayde (2022)** with a yield of (24.6 q/ ha) for Imidacloprid 17.8 SL and~~. The findings supported~~ by **Sen and Kumar (2023)** with a yield of (17.8 q/ ha) for Spinosad 240 EC+ Neem oil 5%.

Mustard over control was obtained in Imidacloprid 17.8 SL (T_2) 8.98 which was followed by Spinosad 240 EC+ Neem oil 5% (T_6) 8.68, Spinosad 45 SC (T_7) 7.18,Neem oil 5% EC (T_1) 5.41, *Metarhizium anisopliae* (T_5) 5.23,Nisco Sixer Plus(T_4) 3.86 *Beauveria bassiana* (T_3) 3.38 and lowest increased over control observed in Control (T_8).

When cost benefit ratio was worked out, interesting result was achieved. Among the treatments studied, the best and most economical treatment was Imidacloprid 17.8% SL (1: 5.19) followed by Spinosad 240 EC+ Neem oil 5% (1: 4.74), Spinosad 45% SC (1: 4.45), Neem oil 5% (1: 4.04), *Metarhizium anisopliae* (1:4.08), Nisco Sixer Plus(1: 3.65), *Beauveria bassiana* (1:3.43), as compared to Control (1: 2.74). These findings are supported by **Ahlawat *et al.* (2018), Sen and Kumar (2023)and Akter *et al.* (2021).**

Comment [st14]: Check if this is right

Comment [st15]: Either percent or aphids/plant. Change it throughout the article

Comment [st16]: Don't put them in parenthesis when the sentence is continuous, applies to whole article

Comment [st17]: parenthesis

Comment [st18]: Write your result and the respective reference result. Don't cut-short anything

Comment [st19]: Need not mention this when the actual treatment itself is mentioned

Comment [st20]: Check for unnecessary parenthesis in whole article

Comment [st21]: Check for the correctness

Comment [st22]: ??

Comment [st23]: Write about their findings

Sreeja and Kumar (2022) While, the highest yield 18.15 q/ha was obtained from the treatment Imidacloprid 17.8% SL as well as B:C ratio 1: 5.20 was obtained high from this treatment. It was followed by Spinosad 45% SC (1: 4.87), Cypermethrin 10% EC (1: 4.58), Neem oil 5% (1:4.15), MECH 333 (1: 3.98), Sixer plus (1: 3.46), *Metarhizium anisopliae* (1: 3.42), as compared to Control (1: 2.74)

Comment [st24]: ??

Table 1. Effect of aphid population during first spray at 3rd, 7th and 14th days of spraying under different treatments during Rabi season 2023-24 (1st spray).

Tr. No	Treatment	Mean population of aphid / plant (10 cm top twig)				
		1DBS	After Spray			
			3rd Day	7th Day	14th Day	Mean
T0	Control	180.4	192.8	201.4	148.73	180.83
T1	Neem Oil 5 %	183.8	74.33	54.46	36.93	87.38
T2	Imidacloprid 17.8 SL	173	50.4	37.46	11.4	68.06
T3	*Beauveria bassiana* 1.15% WP	197.06	89	69.73	49.86	101.41
T4	Nisco Sixer Plus	189.93	80.6	63.006	42.53	94.01

T5	*Metarhizium anisopliae*	179.2	64.93	51.4	30.73	81.56
T6	Spinosad 240 EC + Neem Oil 5%	179.8	56.6	41.4	19.66	74.367
T7	Spinosad 45% SC	185.6	60.4	46.66	24.8	74.368
Overall Mean		183.6	83.63	70.69	45.58	95.87
F- test		**NS**	**S**	**S**	**S**	**S**
S. Ed. (±)			**2.855**	**2.250**	**1.587**	
C. D. (P = 0.05)			**6.12**	**4.82**	**3.4**	

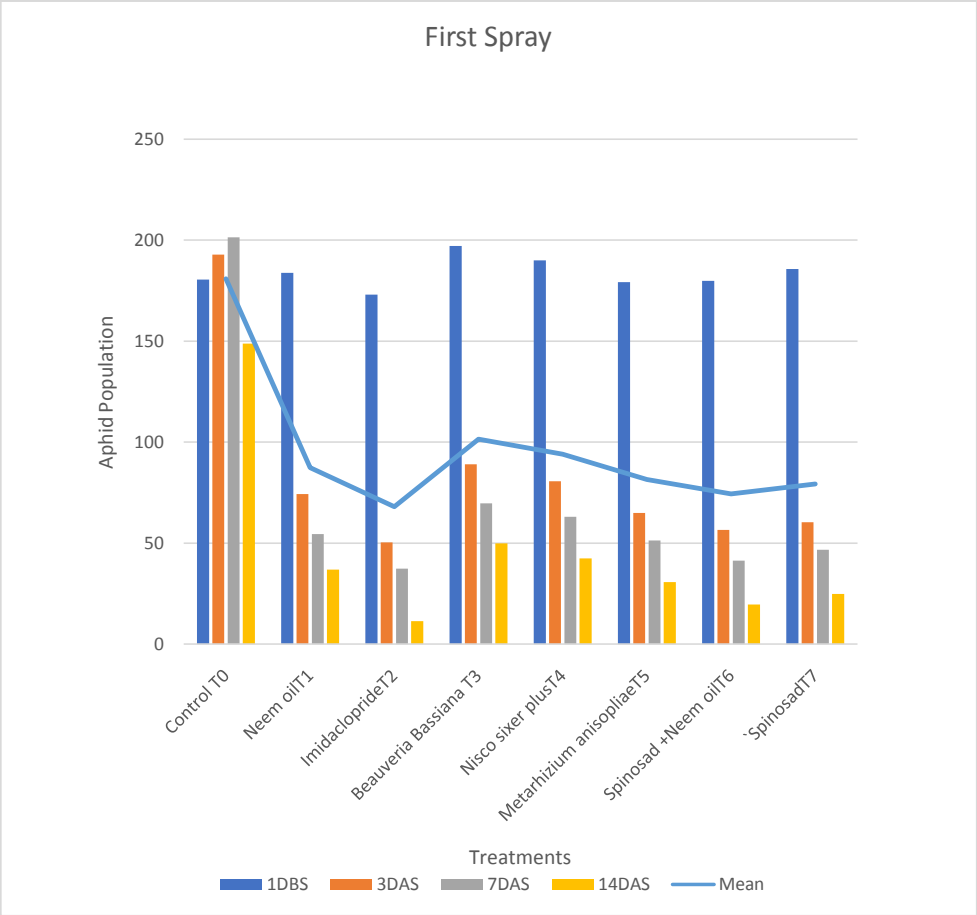

Fig. 1. The efficacy of biopesticides against mustard aphid (*L. erysimi* Kalt.) (First spray)

Table. 2. Economics of treatments and Benefit: cost ratio taken up for the management of mustard aphid during rabi season 2023-2024

Sr. No:	Treatment	Yield~~of~~q/ha	Cost ~~of~~ Yield (₹)	Totalcost ofyield (₹)	Common cost(₹)	Treatmentcost (₹)	Net Return	Totalcost(₹)	B:C r
T_1	Neem Oil 5 %	14.58	6500 ₹ /q	94770	21749	1700	76021	23449	1:4.04
T_2	Imidacloprid 17.8 SL	18.15	6500 ₹ /q	117975	21749	960	96226	22709	1:5.19

Comment [st26]: ??
Comment [st25]: ??

T3	*Beauveria bassiana* 1.15% WP	12.55	6500 ₹ /q	81575	21749	2000	59826	23749	1:3.43
T4	Nisco Sixer Plus	13.03	6500 ₹ /q	84695	21749	1400	62946	23149	1:3.65
T5	*Metarhizium anisopliae*	14.98	6500 ₹ /q	97370	21749	2088	75621	23837	1:4.08
T6	Spinosad 240 EC + Neem Oil 5%	17.85	6500 ₹ /q	116025	21749	2720	94276	24469	1:4.74
T7	Spinosad 45% SC	16.35	6500 ₹ /q	106275	21749	2100	84526	23849	1:4.45
T8	control	9.17	6500 ₹ /q	59605	21749	-	37856	21749	1:2.74

CONCLUSION

From the critical analysis of the present findings, it can be concluded that Imidacloprid 17.8% SL is more effective in controlling ~~per cent population reduction of~~ mustard aphids followed by Spinosad 240 EC + Neem oil 5%, Spinosad 45 SC, Neem oil 5%, *Metarhizium anisopilae*~~, in managing *Lipaphis erysimi*~~. Among the treatments studied, Imidacloprid 17.8% SL gave the highest cost benefit ratio (1: 5.19) and marketing yield (18.15 q/ha) followed by Spinosad 240 EC+ Neem oil 5% (1: 4.74 and 17.85 q/ha), Spinosad 45SC (1: 4.45 and 16.35 q/ha), Neem oil 5%, *Metarhizium anisopilae*, Nisco Sixer Plus, *Beauveria bassiana*respectively as such more trials are required in future to validate the findings. Hence more trails are needed to be conducted in future to validate the findings which can be useful 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.

Comment [st27]: Scientific name

Comment [st28]: Repeated. Try to write how best this data can be put into usage

Comment [st29]: rephrase

REFERENCE

Ahlawat, P., Singh, R., Singh, S. P., Sachan, S. K., Singh, D. V., Spoorthi, G. S. and Gautam, M. P. (2018). Efficacy of bio pesticides and novel insecticides for control of *Lipaphis erysimi* (Kalt) on mustard crop in western U.P. *Journal of Pharmacognosy and Phytochemistry,* SP1:1814-1820.

Akter, A., Hossain, M.D, Amin,A.K.M, and Liza.M. (2021). Efficacy of plant derived and synthetic insecticides against mustard aphid for quality seed production. *Journal of Entomology and Zoology*; 9(4): 48-53.

Aswitha, C. and Yadav, Y. (2023). Comparative efficacy of botanicals, imidacloprid and cow urine against mustard aphid (*Lipaphis erysimi* Kalt.) on mustard (*Brassica juncea L.*) *The Pharma Innovation Journal*, **12**(7):1275-1278.

Awaneesh, C., Malik, Y. P. and Anoop, K. (2014). Efficacy and economics of new insecticides for management of aphid *(Lipaphis erysimi*) in Indian mustard. *Current Advances in Agricultural Sciences*, **6**(1):88-90.

Badisa Sairam and Ashwani Kumar. (2022). Field efficacy of selected bio pesticides and Fipronil against mustard aphid, *Lipaphis erysimi* (Kalt.) *The Pharma Innovation Journal*; SP-11(8): 1640-1644.

Bandral, R. S.(2006) Field-weathered toxicity of insecticides to aphid predator, *Coccinella septempunctata* Linnaeus. *J. Bioi. Control*, **20**(I): 65-68.

Bhatta K, Chaulagain L, Kafle K and Shrestha J. (2019). Bio Efficacy of Plant Extracts against Mustard Aphid (*Lipaphis erysimi* Kalt.) on Rapeseed (*Brassica campestris* Linn.) under Field and Laboratory Conditions. *Syrian Journal of Agricultural Research*; 6(4):557-566.

Blackman, R. L. and Eastop, V. F. (1984). Aphids on the World's crops: An identification and information guide. *John Wiley and Sons: Chichester, New York, Brisbane, Toronto, Singapore*, 466.

Chodem Aswitha and Usha Yadav, (2023). Comparative efficacy of botanicals, imidacloprid and cow urine against mustard aphid (*Lipaphis erysimi* Kalt.) on mustard (*Brassica juncea* L.) *ThePharma Innovation Journal* 2023; 12(7): 1275-1278.

Chouraddi and Mallapur, C. P. (2017). Assessment of crop loss and economic injury level of maize stem borer, *Chilo partellus* (Swinhoe). *Journal of Entomology and Zoology Studies*, **5**(4):1530-1535.

Deshpande, V. G. (1937). Cabbage aphid – *Siphocoryneindo brassicae* - and its Control with home-made nicotine spray. *Agric and Live-Stock in India*, **7**(6):756-762.

Dharavat N, Mehera B, Nath S, Patra SS and Rout S. (2021). Effect of sowing dates on population dynamics of mustard aphid *(Lipaphis erysimi*) in mustard (*Brassica juncea*) under Allahabad climatic condition. *Advances in Life Sciences*.5(20):2278-3849.

Dotasara, S. K., Agrawal, N., Singh, N. and Swami, D. (2017). Efficacy of some newer insecticides against mustard aphid *Lipaphis erysimi* Kalt. in cauliflower. *Journal of entomology and zoology studies*,**5**(2):654-656.

Dukare, A., Paul, S., Mhatre, P.H. and Divekar, P.A. (2020). Biological Disease Control Agents in Organic Crop Production System. In book: Pesticide Contamination in Freshwater and Soil Environment: Impacts, Threats, and Sustainable Remediation 2020. Publisher: *Apple Academic Press.*, :388.

Dwivedi, S. A. and Singh, R. S. (2019). Evaluation of the new molecular insecticides and biopesticides against mustard aphid *Lipaphis erysimi* (Kalt.) on yield parameter in mustard. *Journal of Biopesticides*,**12**(2):203-214.

Dwivedi, Y. K., Rana, N. P., Jeyaraj, A., Clement, M. and Williams, M. D. (2019). Re-examining the unified theory of acceptance and use of technology (UTAUT): Towards a revised theoretical model. *Information Systems Frontiers*, **21**(3):719-734.

Gautam, M. P., Singh, S. N., Kumar, P., Yadav, S. K., Singh, D. P. and Pandey, M. K. (2019). Mustard aphid, *Lipaphis erysimi* (Kalt) (Hemiptera: Aphididae): *The Pharma Innovation Journal*,***8***(9):90-95.

Gayathri L and Kumar A, (2021). Field efficacy of certain insecticides against pod borer, *Helicoverpa armigera* (Hubner) on chick pea in Prayagraj. *Journal of Entomology and Zoology*; 9(3):280-283.

Gill, H.K., Garg, H. and Kaufman, J.L.G. (2013). Cabbage aphid *Brevicoryne brassicae* Linnaeus (Insecta: Hemiptera: Aphididae). *IFAS Extension*: 1-5.

Hegde, Manjunatha, M., Sharanabasappa, Kalleshwaraswamy, C. M and Adarsha S. K. (2017) Effect of Application of Bio pesticides and Insecticides. *International journal of Pure App. Biosci*,**5**(1):42-47.

Husain, M. and Begum, M.A. (2009) Number of insect pests attack mustard. *Journal ofAgriculture Research*. 46(1).

Jamir, R.L, Kumar A, (2022). Field efficacy and economics of some biopesticides against tomato fruit borer [*Helicoverpa armigera* (Hubner)]. *The Pharma Innovation Journal*; 11(6):1798-1802.

Jandial, Kumar, V. K. and Parihar, S. B. S. (2007). Efficacy of different insecticides against mustard aphid, *Lipaphis erysimi* (Kalt.) on mustard under field conditions. *International Journal of Agricultural Sciences,* **3**(2):90-91.

Janu, A., Yadav, G. S., Kaushik, H. D. and Jakhar, P. (2018). Bioefficacy of *Verticillium lecanii* and *Beauveria bassiana* against mustard aphid, *Lipaphis erysimi* under field conditions. *Plant Archives,* **18**(1):288-290.

Kafle, K. (2015). Management of Mustard Aphid *Lipaphis erysimi* (Kalt.) (Homoptera: Aphididae). *International Journal of Applied Sciences and Biotechnology*. **3**(3):537-540.

Kalasariya, R.L. (2019). Management of aphid, *Lipaphis erysimi* in mustard with different spray schedules. *Indian Journal of Plant Protection*.44(1):16-23.

Katyayan, A. (2010). Fundamentals of Agriculture, *Kushal Publication and Distributors Varanasi,***1**(2):215-216.

Kawada, K. and Murai, T. (1979). Short Communication. *Entomologia experimentalis et applicate,* 26:343-345.

Kessing,J.L.M. and Mau, R. F. L.(1991).Cabbage aphid, *Brevicoryne brassicae* (Linnaeus).Crop Knowledge Master. Department of Entomology, Honolulu, Hawaii.

Khan, I. A., Ahmad, M., Akbar, R., Hussain, S., Saeed, M. and Farid, A. (2015). Study on Aphids density and yield components of 12 brassica Geno. *Journal of Entomology and Zoology Studies,* **3**(6):11-15.

Khandelwal, R. and Kumar, A. (2022). Evaluation of chemical insecticides along with cypermethrin and biopesticides against mustard aphid [*Lipaphis erysimi*] (Kalt.) in mustard (*Brassica juncea*). *The Pharma Innovation Journal*, **11**(10):375-378.

Khedkar, A. A. (2012). Efficacy of different chemical insecticides against mustard aphid, *lipaphis erysimi* (kaltenbach) infesting mustard**.** *An international e-journal*,**6**(12):304-308.

Kumar, A, Srivastava, A, Rawal, R and Roy, N, (2018). Chemical evaluation against mustard aphid in Bundelkhand region. *Journal of Entomology and Zoology Studies*; 6(2):3195-3197.

Kumar, A., Jandial, V. K. And Parihar, S. B. S. (2007). Efficacy of different insecticides against mustard aphid, *Lipaphis erysimi* (Kalt.) on mustard under field conditions. *Internat. J. Agric. Sci*, **3**(2):90-91.

Kumar, A., Tomar, R. K. S., Kerketta, A., Pandey, D., Chaure, N. K. and Awasthi, A. K. (2022). Evaluation of efficacy of bio-pesticide and Insecticide combinations against mustard aphid, *Lipaphis erysimi* Kalt. *The Pharma Innovation Journal*, **11**(8):1781-1784.

Kumar, A., Yadav, S., Kumar, Y. and Yadav, J. (2020). Evaluation of different botanicals for the management of mustard aphid, *Lipaphis erysimi* (Kaltenbach). *Journal of OilseedBrassica.sp,* 11 (1): 42-48.

Kumar, N. and Kumar, A. (2023). Efficacy of Some Bio-pesticides against Mustard Aphid *Lipaphis erysimi* (Kalt) in Mustard (*Brassica juncea*). *International Journal of Plant and Soil Science*, **35**(16):121-127.

Kumar, S. (2021). Evaluation of bio-rational products against turnip aphid, *Lipaphis erysimi* (Kaltenbach) on Indian mustard. *Journal of Oilseed Brassica*, **12**(2):127-130.

Kumar, S. and Kumar, A. (2016). Bio-efficacy of biopesticides and certain chemical insecticides against mustard aphid (*Lipaphis erysimi* Kalt.) on mustard crop under field condition. *International journal of plant protection*, **9**(1):129-132.

Kumar, S., and Kumar, A. (2016). Economics of treatments for management of mustard aphid (*Lipaphis erysimi* Kalt) on mustard (*Brassica compestris* L.). *Asian Journal of Bio Science*, 11(1): 119-121.

Lal, B., Nayak, M. K., Tomar, D. S. and Thakur, S. R. (2018). Efficacy of newer insecticides against mustard aphid, *Lipaphis erysimi* (Kalt.) in Indian mustard under Bundelkhand Agro climatic zone of Madhya Pradesh. *Journal of Entomology and Zoology Studies*,**6**(6):400-403.

Mandal, D., Bhowmik, P. and Chatterjee, M. L. (2012). Evaluation of new and conventional insecticides for the management of mustard aphid, *Lipaphis erysimi* Kalt. (Homoptera: Aphididae) on rapeseed (*Brassica juncea* L.). *The Journal of Plant Protection Sciences*, **4**(2):37-42.

Mandal, P. (2019). Botanical based management of mustard aphid (*Lipaphis erysimi* Kalt.) population causing major damage of mustard (*Brassica juncea* L.). *Review of Research*, 8(4).

Meena, H., Singh, S. P. and Nagar, R. (2013). Evaluation of microbial agents and bio-products for the management of mustard aphid, *Lipaphis erysimi* (Kalt.). *The Bioscan* journals. **8**(3):747-750.

Meena, J., Pant, H. and Bahjan, R. (2015). Heterosis analysis for yield and yield attributed traits in Indian mustard [*Brassica juncea (L.*) Czern and Coss]. *Electronic Journal of Plant Breeding*, **6**(4):1103-1107.

Metcalf, R. L. (1962). Destructive and useful Insects: Their Habits and Control. McGraw-Hill Book Company, New York, San Francisco Toronto, London. 1087.

Muhammad, S., Haider N.B., Batool,Q.,Iqra, M., Bilal,M., Ameen,J.M., and Shahzad, M. (2017). In-vitro evaluation of biopesticides (*Beauveria bassiana, Metarhizium anisopliae, Bacillus thuringiensis*) against mustard aphid *Lipaphis erysimi* kalt. (Hemiptera: Aphididae). *Journal of Entomology and Zoology*; 5(6):331-335.

Nelson, E. H. and Rosenheim, J. A. (2006). Encounters between aphids and their predators: the relative frequencies of disturbance and consumption. *Entomologia Experimentalis et Applicata*, **11**(8):211-219.

Pal, D. S., Singh, D. K., Gautam, S. P. and Kumar, A. (2020). Bio rational management of mustard aphid, (*Lipaphis erysimi* Kalt.). *International Journal of Chemical Studies*, **8**(2):2554-2557.

Patel, S., Singh, C. P, and Hasan, W. (2020). efficacy of certain insecticides against mustard aphid in mustard ecosystem. *International Journal of Agricultural and Applied Sciences*,.1(1): 46-48.

Patel, S., Singh, C. P. and Hasan, W. (2020). Relative efficacy of certain insecticides against mustard aphid in mustard ecosystem. *International Journal of Agricultural and Applied Sciences*, **1**(1):46-48.

Pippal, S. S., Sharma, M. L., Jatav, P. K. and Mahore, P. (2022). Efficacy of newer insecticides against mustard aphid *Lipaphis erysimi* (Kalt.).*The Pharma Innovation Journal*, **11**(7):1070-1074.

Rahul, Singh, R. S. and Yadav, N. (2020). Integrated management of mustard aphid, *Lipaphiserysimi* Kaltenbach in mustard crop. *Journal of Entomology and Zoology Studies***, 8**(6):873-877.

Raju, C. E. P. and Tayde, A. R. (2022). Field Evaluation of Selected Insecticides and Botanical against Mustard Aphid, *Lipaphis erysimi* (Kalt.) on Mustard, *Brassicajuncea L. International Journal of Plant and Soil Science*, **34**(22):1188-1193.

Rashid, S., Mir, S. H., Yaqoob, M. and Ashraf, S. (2022). Efficacy of insecticides against mustard aphid *Brevicoryne brassicae* and their safety to coccinellid predators. *Indian Journal of Entomology*, **84**(4):872-874.

Sachan, J. N. and Bansal, O. P. (1975). Influence of Different Host Plants on the Biology of Mustard Aphid, *Lipaphis erysimi* Kalt. *Indian Journal of Entomology*, **37**(4):420-424.

Sachin, K. and Ashwani, K. (2016). Bio-efficacy of biopesticides and certain chemical insecticides against mustard aphid (*Lipaphis erysimi* Kalt.) on mustard crop under field condition. *International journal of plant protection*, **9**(1):129-132.

Saha, B., Rahman, M. M., Uddin, M. M., Shahjahan, M. and Roy, B. (2021). Management of mustard aphids using eco-friendly control approaches. *Fundamental and Applied Agriculture*, **6**(4):395–402.

Sairam, B. and Kumar, A. (2022). Field efficacy of selected bio pesticides and Fipronil against mustard aphid, *Lipaphis erysimi* (Kalt.). *The Pharma Innovation Journal*,**11**(8):1640-1644.

Saiteja, K and Tayde, A. R. (2022). Efficacy of Chemical Insecticides and Neem Products against Mustard Aphid, [*Lipaphis erysimi* (Kalt.)] on Mustard *Brassica juncea* (L.) *International Journal of Plant and Soil Science*, **34**(22):1118-1122.

Sajid, M. and Zia, K. (2017). In vitro efficacy of biopesticide (*Beauveria bassiana,Metarhizium anisopliae,Bacillus thuringiensis*) against mustard aphid *Lipaphis erysimi* Kalt. (Hemiptera: Aphididae). *Journal Plant Protection*,**1**(2):85-90.

Samala, S. and Kumar, A. (2022). Field efficacy of selected chemicals and biopesticides against mustard aphid [*Lipaphis erysimi* (Kaltenbach)] on mustard [*Brassica juncea* (L.)]. *The Pharma Innovation Journal*; 11(5): 1706-1710.

Sarkar, S. and Kumar, A. (2022). Comparative efficacy and cost benefit ratio of selected biopesticides and chemicals against mustard aphid, *Lipaphis erysimi* (Kaltenbach). *The Pharma Innovation Journal*; 11(7): 4671-4675.

Sekhon, B. S. (1989). Insect pests and their management in rapeseed mustard. *Journal of Oilseeds Research*, 6:269-299.

Sen, K., Samanta, A., Hansda, A., Dhar, P. P. And Samanta, A. (2017). Bioefficacy and economics of some insecticides against mustard aphid, *Lipaphis erysimi* (Kalt.) infesting mustard. *Journal of Crop and Weed*, **13**(2):235-237.

Sen, M. K., and Kumar,A. (2023). Comparative Efficacy and Economics of Biopesticides and Imidacloprid against Mustard Aphid [*Lipaphis erysimi* (Kalt.)] (Hemiptera: Aphididae). *International Journal of Plant & Soil Science*; 35(14):201-208.

Sharma, N., Upadhyaya, S. N., Singh, U. C., Dubey, M. and Ahmad, A. (2020). Bio efficacy of insecticides against mustard aphid. *Journal of Entomology and Zoology Studies*, **8**(4):97-102.

Sreeja, S. and Kumar, A. (2022). Field efficacy of selected chemicals and biopesticides against mustard aphid [*Lipaphis erysimi* (Kaltenbach)] on mustard [*Brassica juncea* (L.)] at Prayagraj (U.P.) *The Pharma Innovation Journal*, **11**(5):1706-1710.

Thaochan, N., Ngampongsai, A., Prabhakar, C. S. and Hu, Q. (2021).*Beauveria bassiana* PSUB01 simultaneously displays biocontrol activity against *Lipaphis erysimi* (Kalt.) (Hemiptera: Aphididae) and promotes plant growth in Chinese kale under

hydroponic growing conditions. *Bio control Science and Technology*,**31**(10):997-1015.

Tomar, M., Yadav, H.M., and Kumar, A. (2023). Efficacy of some insecticides and biopesticides against mustard aphid *lipaphis erysimi* kalt. *Indian Journal of Entomology*.

USDA. 2010. United States Department of Agriculture-Rapeseed area, yield and production Table No. 15. http: // www. fas. usda. gov/psd online/psd report. Asps.