Original Research Article

"Comparative efficacy and economics of biopesticides and Imidacloprid against mustard aphid[*Lipaphiserysimi*(Kalt.)] (Hemiptera: Aphididae)"

ABSTRACT

The present investigation was conducted during *rabi*season of 2022 at Crop Research farm, NAI,SHUATS, Prayagraj using Randomized Block Design (RBD) method in three replications.Results revealed that, among all the treatments combination insecticide *Metarhiziumanisopliae*(T_7)recorded lowest reduction percent of aphid (47.94%), followed by Nisco MECH 333(T_6) (53.00%),Nisco MECH 333 + Neem oil 5% (T_1) (54.63%),Neemoil5%(T_4)(55.33%),Spinosad 240 EC (T_3)(63.94%)andSpinosad 240 EC+ Neem oil 5%(T_2)(69.37%).Imidacloprid17.8SL(T_5)(74.77%)washighesteffectiveamongall thetreatments during 1st spray is also superiorly significant and moreeffective as compared to all other treatments. While, the highest yield 18.15 q/ha was obtained from the treatment Imidacloprid 17.8% SL.The best economics cost benefit ratio wasobtained with Imidacloprid 17.8 SL(T_5) (1:6.43) Followed by Spinosad 240 EC+ Neem oil 5%(T_2) (1:5.96), Spinosad 240 EC(T_3) (1:5.64), Neem oil 5% (T_4) (1:5.06), Nisco MECH 333 + Neem oil 5% (T_1) (1:4.87), *Metarhiziumanisopliae*(T_7) (1:4.65), Nisco MECH 333(T_6) (1:4.21), Least monetary return wasobtained with control(1:3.25).

Keywords: Comparative efficacy, Economics,Imidacloprid, Insecticides, *Lipaphiserysimi*, Mustard.

1.INTRODUCTION

Mustard is among the oldest recorded spices as seen in Sanskrit records dating back to about 3000 BC (**Mehra, 1968**) and was one of the first domesticated crops. Originally it was thecondimentthat wasknown asmustard andthewordwas derivedfrom the***Latinmustum***. Mustard, Brassica juncea (L.)CzernandCoss 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. The origin place of mustard is China, northeastern India from where it has extended up to Afghanistan via Punjab (**Kalasariya, 2016)**.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

Comment [U1]: Remove

Comment [U2]: Reconsider the sentence

Comment [U3]: Restructure the sentence

Comment [U4]: Remove

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 **(Daravath*et al.*, 2016)**.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**).

Comment [U5]: Reconsider the sentence

Mustard plays an important role in the oil seed economy of the country. It has 38 to 42% oil and 24% protein. **(Meena*et al.*, 2015)**. More than 43 species of insect pests infest rapeseed-mustard crop in India, out of which a dozen species are considered as major pests. The aphid species, viz., *Lipaphiserysimi*(Kaltenbach), *Brevicorynebrassicae* (Linnaeus) and *Myzuspersicae*(Sulzer) are the key pests **(Lal*et al.*, 2018)** resulting in both qualitative and quantitative losses. Among these, mustard Aphid, *Lipaphiserysimi*Kalt. (Hemiptera: Aphididae) is the most destructive insect pest of mustard **(Pragya*et al.*, 2017)**.

Comment [U6]: Delete

*Lipaphiserysimi*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 **(Nelson and Rosenheim, 2006)**. They suck sap from the hosts and infested plants become stunted and distorted. Their infestation causes wilting, yellowing and stunting of plants **(Khan *et al.*, 2015)**. 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 interfere in the photosynthetic activity of the leaves **(Sharma *et al.*, 2020)**. It is predominant and capable of causing up to 96per cent yield losses and 5-6per cent reduction in oil content **(Lal*et al.*, 2018)**. For the control of insects primarily mustard aphids, most of the mustard growing farmers of apply synthetic pesticides and even banned pesticides in some cases in a repeated manner with the higher doses. Due to the repeated doses of insecticide, aphid has gained resistance over pesticides and hazardous use of pesticide has induced Photo-toxicity, destruction of beneficial organism, disruption of agro-ecosystem and human health hazards. So, the alternative of chemical pesticide can be bio-insecticide, which is economically cheaper, environmentally sound and non-hazardous to human, animal and natural predator and pollinator but effective against harmful pest.

Comment [U7]: Delete

In order to preventing the infestation of the mustard aphid and to produce a quality crop production, it is essential to manage the pest population at proper time with suitable and appropriate measures. Keeping the above facts in mind the present investigation was undertaken to manage mustard aphid, *Lipaphiserysimi*(Kaltenbach) through eco-friendly bio-

pesticides and its comparison with some chemical insecticides. So that a pest management module may be devised with minimum input and maximum benefit to farmers

Comment [U8]: Restructure the sentences

2. MATERIALS AND METHODS

The experiment was conducted during Rabi season 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, kalasona seeds in a plot size of 2m×2m at a spacing of 15cm×20cm 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. The population of aphids was recorded in the field on the five randomly selected plants fromeachplotatonedaybeforesprayand3rd,7thand14thdaysaftersprayofinsecticides.Thenumbersof aphids/plant were converted into % reduction of aphid population over the control by theformulagiven below,

Comment [U9]: Break and restructure the sentence appropriately

Comment [U10]: Reconsider the sentence

Percentreductionovercontrol=

(Population recorded in control plot - Population recorded after spray)

population recorded in control plot

(Kumar *etal.*,2020)

The economicaland healthy marketable yield obtained from different treatments was collected separately and weighed. The cost of insecticides used in this experiment was recorded during Rabi season of 2022-23. The cost of botanicals used was obtained from nearby market. The economical total cost of plant protection consisted of cost of treatments, sprayer rent and labour charges for the spray. There were two sprays throughout the research period and the overall plant protection expenses were calculated. The B:Cratio can be calculated by formula:

Comment [U11]: Reconsider the period

Comment [U12]: Reconsider the sentence

Comment [U13]: Explain

B:C=Grossreturns/Totalcostsincurred

Where,

BCR = Benefit Cost Ratio Gross returns = Marketable yield × Market price1

3. RESULTS AND DISCUSSION

In the experiment, eight different treatments, consisting application of Control (T_0), Nisco MECH 333 + Neem oil 5% (T_1), Spinosad 240 EC+ Neem oil 5%(T_2), Spinosad 240 EC(T_3), Neem oil 5%(T_4), Imidacloprid 17.8 SL(T_5), Nisco MECH 333(T_6), *Metarhiziumanisopliae*(T_7) were tested to compare the efficacy against *Lipaphiserysimi*and their influences on yield of mustard. The results obtained are discussed in the light of available relevant literature in this chapter as before.

Comment [U14]: Delete the sentence

Result revealed that all the treatments except untreated control are effective and at par. Among all the treatments combination insecticide *Metarhiziumanisopliae*(T_7) recorded lowest reduction percent of aphid (47.94%), followed by Nisco MECH 333(T_6) (53.00%), Nisco MECH 333 + Neem oil 5% (T_1) (54.63%), Neem oil 5% (T_4) (55.33%), Spinosad 240 EC (T_3) (63.94%) and Spinosad 240 EC+ Neem oil 5%(T_2) (69.37%). Imidacloprid 17.8 SL (T_5) (74.77%) was highest effective among all the treatments during spray.

The data on the mean per cent population reduction of first spray overall mean revealed that all the treatments except untreated control are effective and at par. Among all the treatments lowest per cent reduction of mustard aphid as well as increasing the yield was recorded in Imidacloprid 17.8% SL (88.184%). Similar findings made by **Chandra *et al.* (2014), Aziz *et al.* (2014), Sen *et al.* (2017), Maurya *et al.* (2018), Patel *et al.* (2020) and Rashid *et al.* (2021).**Spinosad 45% SC (81.498%) is found to be the next best treatment which is in line with the findings of **Akter*et al.* (2021)**,**Khanal*et al.* (2020**) **Vishvendra*et al.* (2018)**they reported that was found most effective in reducing percent population of *Lipaphiserysimi.*

Comment [U15]: Add' were' appropriately

Comment [U16]: Consider as next sentence

Spinosad 45% SC is found to be the next best treatment which is in line with the findings of **Bhatta*et al.* (2019)**and **Shiva and Rajesh (2020)**. Neem oil 5% (72.976%) is found to be the next effective treatment which is in line with the findings of**Yadav*et al.* (2021), Kumar and Kumar (2016)** and Nisco MECH 333 (68.251%) is found to be the next effective treatment which is in line with the findings of **Zorempuii and Kumar (2019).** The result of Sixer plus (58.914%) which is at par with *Metarhiziumanisopilae* (53.123%) is found to be least effective but comparatively superior over the control, these findings are supported by**Meena*et al.* (2013), Kumar *et al.* (2020).**

The yields among the treatments were significant. The highest yield was recorded in Imidacloprid 17.8% SL (18.15q/ha) followed by Spinosad 240 EC (17.85q/ha), Spinosad 240

EC+ Neem oil 5% (16.35q/ha), Neem oil 5% (14.98q/ha), Nisco MECH 333+ Neem oil 5% (14.58q/ha), Nisco MECH 333 (13.03 q/ha),*Metarhiziumanisopilae* (12.55q/ha), as compared to control plot (9.17q/ha).These findings are supported by **Vishal *et al.* (2019), Bhatta *et al.* (2019), Akter *et al.* (2021), Yadav *et al.* (2021), Aziz *et al.* (2014), Meena*et al.* (2013),Sreejaand Kumar (2022).** Respectively.

When cost benefit ratio was worked out, interesting result was achieved. Among the treatmentstudied, the best and most economical treatment was Imidacloprid 17.8% SL (1: 5.20) followed by Spinosad 45% SC (1: 4.87), Spinosad 240 EC+ Neem oil 5 (1: 4.58), Neem oil 5% (1: 4.15), MECH 333 + Neem oil 5% (1: 3.98), Nisco MECH 333 (1: 3.46),*Metarhiziumanisopilae* (1:3.42), as compared to Control (1: 2.74). These findings are supported by **Ahlawat*et al.* (2018), Akter*et al.* (2021)**, **Sreejaand Kumar (2022).**

Comment [U17]: Delete

Comment [U18]: Delete the sentence

Comment [U19]: Replace with 'groups'

Table. 1 Efficacy of biopesticides and Imidacloprid against mustard aphid(*L. erysimi*Kalt.)on reduction per cent over controlduring*rabi*season 2022 (1st spray).

S. No.	Nameoftreatments	Dosages	Population of L. erysimi /top 10 cm central twig of plant	Per cent population reduction of L. erysimi /top 10 cm central twig of plant			
			(Day before spray)	3rdDAS	7thDAS	14thDAS	Mean
T_0	Control	-	256.73	0	0	0	0.00
T_1	Nisco MECH 333 +Neemoil 5%	2ml/ lit. + 5 ml/lit.	256.47	29.77	62.74	69.78	54.10
T_2	Spinosad240EC+ Neem oil5%	0.75ml/ lit + 5ml/lit	243.07	48.23	74.61	85.69	69.51
T_3	Spinosad240EC	0.75 ml/lit	269.00	37.8	71.97	83.02	64.26
T_4	Neem oil5%	5 ml/lit	251.73	31.38	64.87	71.52	55.92
T_5	Imidacloprid17.8SL	1ml/2.5 lit of water	254.47	53.45	78.27	91.71	74.48
T_6	Nisco MECH 333	2ml/lit.	249.27	27.6	60.7	71.25	53.18

T_7	*Metarhiziumanisopliae*	5gms/lit	245.40	21.02	55.32	67.78	48.04
Overall mean			NS	35.60	66.92	84.60	59.92
F-test				**S**	**S**	**S**	**S**
S.Ed (±)				**0.81**	**0.58**	**0.69**	**0.29**
C.D.(P=0.05)				**1.701**	**1.249**	**1.479**	**0.622**

Comment [U20]: Write values

Comment [U21]: Reconsider the word

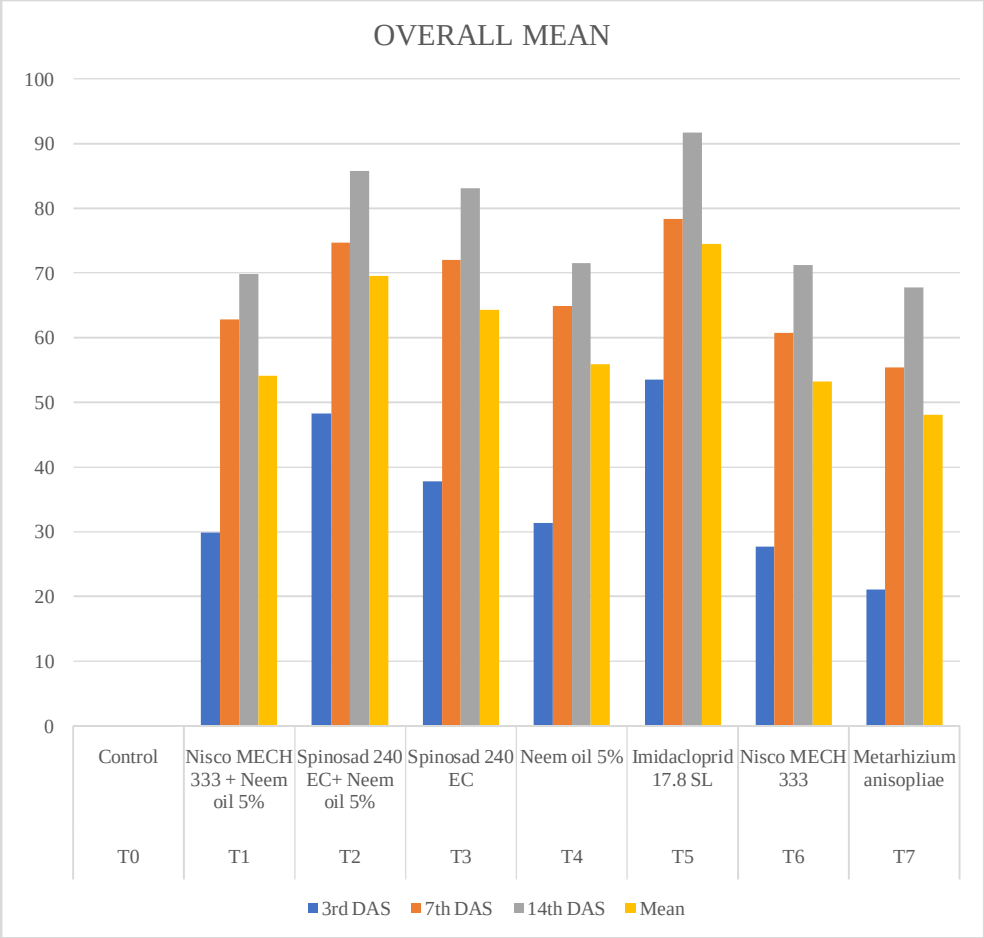

Fig. 1.The efficacy of biopesticides and Imidaclopridagainst mustard aphid, (*L. erysimi*Kalt.) (Mean)

Table.2EconomicsoftreatmentsandBenefit:costratiotakenupforthemanagementof mustardaphidduring*rabi*season2022

S. No	Treatments	Yield of q/ha	Cost of yield / ₹/q	Total cost of yield (₹)	Common cost (₹)	Treatment cost (₹)	Cost of cultivation	Net return	Total cost (₹)	B:C ratio
T_0	Control (Water spray)	9.17	6500	59605	21749	——	21749	37856	21749	1: 2.74
T_1	NiscoMECH 333 + Neem oil 5%	14.58	6500	94770	21749	2080	23829	70941	23829	1: 3.98
T_2	Spinosad 240 EC+ Neem oil 5%	16.35	6500	106275	21749	1472	23221	83054	23221	1: 4.58
T_3	Spinosad 240 EC	17.85	6500	116025	21749	2100	23849	92176	23849	1: 4.87
T_4	Neem oil 5%	14.98	6500	97370	21749	1700	23449	73921	23449	1: 4.15
T_5	Imidacloprid 17.8% SL	18.15	6500	117975	21749	960	22709	95266	22709	1: 5.20
T_6	Nisco MECH 333	13.03	6500	84695	21749	2720	24469	60226	24469	1: 3.46
T_7	*Metarhizium anisopilae* (10^8 spore load/gm)	12.55	6500	81575	21749	2088	23837	58126	23837	1: 3.42

4. 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, Spinosad 240 EC + Neem oil 5%, Neem oil 5%, Nisco MECH 333++ Neem oil 5%, in managing *Lipaphiserysimi*. Among the treatments studied, Imidacloprid 17.8% SL gave the highest economical cost benefit ratio (1: 5.20) and marketing yield (18.15 q/ha) followed by Spinosad 240 EC (1: 4.87 and 17.85 q/ha), Spinosad 240 EC+ Neem oil 5% (1: 4.58 and 16.35 q/ha), Neem oil 5%, Nisco MECH 333 + Neem oil 5%, Nisco MECH 333, *Metarhiziumanisopilae*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 [U22]: Delete

Comment [U23]: Delete

Comment [U24]: Reconsider in next sentence

5. REFERENCES

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 *Lipaphiserysimi*(Kalt) on mustard crop in western U.P. *Journal of Pharmacognosy and Phytochemistry*, **1**: 1814-1820

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

Aziz, M. A., Shahzad, A. R., Naeem, M. and Shabbir, G. (2014). Evaluation of different neem products in comparison with imidacloprid against different morphs of mustard aphid (*Lipaphiserysimi*Kalt.) on canola crop.*Asian Journal of Agriculture Biology*, **2**(3):191-201.

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

Chandra, A., Malik, Y. P. and Kumar, A. (2014). Efficacy and economics of new insecticides for management of aphid (*Lipaphiserysimi*) in Indian mustard.*Current Advances in Agricultural Sciences*, **6**(1):88-90.

Dharavat, N., Mehera, B., Nath, S., Patra, S. S. and Rout, S. (2016). Effect of sowing dates on population dynamics of mustard aphid (*Lipaphiserysimi*) in mustard (*brassica juncea*) under Allahabad climatic condition. *Advances in Life Sciences*, **5**(20): 2278-3849.

Kalasariya, R.L. (2016). Management of aphid, *Lipaphiserysimi*in mustard with different spray schedules. *Indian Journal of Plant Protection*, **44**(1): 16-23.

Kalia, A., Shukla, G., Mishra, D., Mishra, B.P. and Patel, R.R. (2021). Comparative trend analysis of mustard in Bundelkhand region, Uttar Pradesh, India.*Indian Journal of Extension Education*, **57**(1): 15-19.

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

Khanal, D., Maharajan, S.,Lamichhane, J., Neupane, P., Sharma.S. and Pandey, P. (2020). Efficacy of Biorational Compounds against Mustard Aphid (*Lipaphiserysimi*Kalt.) and English Grain Aphid (*Sitobionavenae* Fab.) under Laboratory Conditions in Nepal.*Advances in agriculture*, **7**(10): 11-55.

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

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

Maurya, N.K., Singh, R., Singh, J., Nigam, R., Hasan, W. and Kumar, A. (2018). Efficacy of novel insecticides against mustard aphid *Lipaphiserysimi*(Kaltenbach), *International Journal of Agricultural Invention*, **3**(1): 62-70.

Meena,H.,Singh,S.P.andNagar,R.(2013). Evaluationofmicrobialagentsandbio-productsforthemanagementofmustardaphid, *Lipaphiserysimi*(Kalt.).*The Bioscan*,**8**(3):747-750.

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

Mehra,K. L.(1968). Historyand ethiobotanyofmustardinIndia.*AdvanceFrontiersin PlantScience*.**19**:57.

Nelson, E. H. and Rosenheim, J. A. (2006). Encounters between aphids and their predators: the relative frequencies of disturbance and consumption. *EntomologiaExperimentalisetApplicata*, **118**: 211-219.

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.

Pragya, Das, D.K., Sehgal, V.K., Das, T.K. and Mukherjee, J. (2017). Impact of Conservation Agriculture on Aphid infestation in Mustard under Rice-Mustard Cropping System.*Journal of Agricultural Physics*, **17**(1): 129-136.

Rashid, S., Hussain, S., Mir, Yaqoob, M. and Ashraf, S. (2021). Efficacy of insecticides against mustard aphid, *Brevicorynebrassicae*and their safety to coccinellid predators.*Indian journal of entomology*, **67**(10): 44-55.

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

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.

Shivaleela, G. and Chowdary L. R. (2020). Field bio efficacy of insecticide premix (Chlorpyriphos 50% + Cypermethrin 5% EC) against major insect pests of cabbage. *Journal of Entomology and Zoology Studies*, **8**(1): 835-839.

Singh, S.N., Singh, V.K., Singh, R.K. and Singh, R. K. (2007). Evaluation of On-Farm Front Line Demonstrations on the Yield of Mustard in Central Plains Zone of Uttar Pradesh.*Indian Research Journal of Extension Education*, **7**(2 and 3): 79-81.

Sreeja,S.andKumar,A.(2022) Fieldefficacyofselectedchemicalsandbiopesticidesagainstmustardaphid[*Lipaphiserysimi*(Kaltenbach)]onmustard[*Brassicajuncea*(L.)]atPrayagraj(U.P.),*Journal of the pharma innovation*, **11**(5):1706-1710.

Vishal, Hem, S. and Ajay, K. (2019). Efficacy and economics of some newer insecticides against mustard aphid, *Lipaphiserysimi*(Kalt).*Journal of Pharmacognosy and Phytochemistry*, **8**(3): 785-788

Vishvendra, S. K., Sachan, S.K., Singh, G. and Singh, R. (2018). Bio-Efficacy of insecticides and biorational against *LipaphisErysimi*(Kalt.) in mustard crop, *Journal of Pharmacognosy and Phytochemistry*, SP**5**: 58-61.

Yadav, S.P., Singh, B., Satyajeet and Kumar, H. (2021). Eco-friendly management of aphid (*Lipaphiserysimi*Kalt) in Indian mustard variety RB-50 under late sown conditions.*Journal of Entomology and Zoology Studies*, **9**(1): 1882-1886.

Zorempuii, R. and Kumar, A. (2019). Efficacy of certain chemicals and botanicals against aphid, *Lipaphiserysimi*(Kaltenbach) on cabbage (*Brassica oleracea* L.).*Journal of Entomology and Zoology Studies*, **7**(5): 89-93.