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Eco-friendly management of aphid (*Lipaphis erysimi* Kalt) in Indian mustard variety RB-50 under late sown conditions

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Abstract
Field experiment on efficacy of eight insecticides was conducted at RRS, Bawal, Rewari (Haryana) against mustard aphid, *Lipaphis erysimi* on Indian mustard variety RB-50 during *Rabi*, 2017-18, 2018-19 and 2019-20. The spray of treatment T8: Diamethoate 30EC @ 625 ml/ha was proved most effective treatment with pooled mean aphid population of 4.36, 3.85 and 2.83 aphids/10 cm on main apical shoot as against 29.43, 37.37 and 44.77 aphids/10 cm on main apical shoot in the T9: control after 3, 7 and 10 days of spray, respectively. Succeeding treatments, T6: Neem oil @ 5% after clipping of infested twigs,T4: *Beauveria bassiana* @ 10^8 cs/ml after clipping of infested twigs,T5: NSKE @ 5% after clipping of infested twigs,T2: *Beauveria bassiana* @ 10^8 cs/ml, T3: Neem oil @ 5%, T1: NSKE @ 5% and T7: clipping of infested twigs at ETL with pooled mean aphid population of 5.95, 6.32, 7.28, 7.87, 8.43, 8.87 and 32.92 aphids/10 cm of main apical shoot after 10 days of spray, respectively. The maximum seed yield was found in treatment T8: Diamethoate 30 EC @ 625 ml/ha (16.80 q/ha) followed by T6: Neem oil @ 5% after clipping of infested twigs (15.45 q/ha) in comparison to T9: control (8.31 q/ha). Thus, spray of treatment Diamethoate 30 EC @625 ml/ha can be suggested for the management of mustard aphid.

Keywords: *Brassica*, dimethoate, insecticides, *Lipaphis erysimi*, seed yield, treatment

Introduction
Brassica crops are the major *rabi* oilseed crops grown in India, which are collectively referred to as rapeseed & mustard and belonging to genus *Brassica* and family Cruciferae. India is one of the largest rapeseed & mustard growing country in the world, occupying the 1st position in area and 2nd position in production after China (Khavse *et al*., 2014) [5]. In India, rapeseed & mustard crops include traditional indigenous species, namely toria (*Brassica campestris* L. var. toria), brown sarson (*Brassica campestris* L. var. brown sarson), yellow sarson (*Brassica campestris* L. var. yellow sarson), Indian mustard (*Brassica juncea*), black mustard (*Brassica nigra*) and taramira (*Eruca sativa*), which have been growing since about 3,500 BC together with non-traditional species such as gobhi sarson (*Brassica napus*) and karan rai (*Brassica carinata*) (Singh *et al*., 2013) [15]. India accounts for 14.8 % of rapeseed production at global level and occupies prime position in the World (Singh, 2014) [19]. In India, during 2018-19, rapeseed & mustard were grown over an area of 6.23 million ha area with production and productivity of 9.34 m tonnes and 1499 kg/ha, respectively. In Haryana, during 2018-19, rapeseed & mustard were grown on 0.61 million ha area with production and productivity of 1.25 m tonnes and 2058 kg/ha, respectively (Anonymous, 2019) [1].

More than 43 species of insect-pests have been reported to infest rapeseed & mustard crop throughout the growing period in India, out of which about a dozen are considered as major pests (Purwar *et al*., 2004) [9]. Among these aphids [*Lipaphis erysimi* Kalt., *Brevicoryne brassicae* L. and *Myzus persicae* Sulzer (Hemiptera: Aphididae)] are the most destructive pests (Desh *et al*., 1996; Sarangdevot *et al*., 2006) [3, 11] which causes both qualitative and quantitative yield losses. Among the aphids, mustard aphid, *L. erysimi* is a key pest and it may cause a yield losses ranging from 35.4 to 96% in favourable conditions (Sahoo, 2012) [10] and can reduce 5-6% oil content (Shylesha *et al*., 2006) [14]. Such losses may go up to 100% in certain mustard growing region (Singh and Sachan, 1999) [16]. Both nymph and adult stages of this pest caused economic damage by sucking the cell sap from leaves, petioles, tender stems, inflorescence and pods (Srivastava, 2002) [20].

Management of aphid is a challenging task because of their rapid growth, mode of reproduction, polymorphic nature and ability to adopt different kinds of environment. A number of chemical insecticides have been found effective against mustard aphid in different parts of the country (Sharma *et al*., 2017; Vishal *et al*., 2019; Kumar and Sharma, 2020) [12, 21, 8]. But chemical insecticides are not only toxic to natural enemies of aphid such as *Diaeretiella rapae*, *Chrysoperla zastrowi arabica*, coccinellids and syrphid flies (Singh *et al*., 2007) [17] but are also responsible for environmental pollution, health hazards to human beings, toxicity to pollinators and residue in oil and cake (Singh and Sharma, 2002) [18]. Keeping the above facts in mind the present investigation was undertaken to evaluate the chemical and non- chemical insecticides against aphid.

Materials and Methods

A field experiment was laid out in randomized block design (RBD) to study the efficacy of various insecticides against mustard aphid on Indian mustard variety RB-50 during Rabi, 2017-18, 2018-19 and 2019-20 at RRS, Bawal, Rewari (Haryana) with eight treatments viz. T1: NSKE @ 5%, T2: *Beauveria bassiana* @ 10^8 cs/ml, T3: Neem oil @ 5%, T4: *Beauveria bassiana* @ 10^8 cs/ml after clipping of infested twigs, T5: NSKE @ 5% after clipping of infested twigs, T6: Neem oil @ 5% after clipping of infested twigs, T7: Clipping of infested twigs at ETL, T8: Dimethoate 30 EC @ 625 ml/ha and T9: control (untreated) and replicated thrice with plot size of 4.2×3m. The crop sowing was done on 15th November with row to row and plant to plant as 30cm and 15cm, respectively and all the recommended agronomic practices were followed to raise the good crop. The population of aphids was counted from ten randomly selected plants from each plot one day before and 3, 7, and 10 days after spray of insecticides. The aphids were counted from the top 10 cm main apical shoot of these selected plants with the help of a magnifying glass. Yield was recorded from each plot and converted in to quintal per ha and data were statistically analysed with the help of software OPSTAT (Sheoran *et al*., 1998) [13].

Results and Discussions

The pooled mean data revealed that before spray, aphid population was scattered homogenously all over the experimental field and varied from 21.37 to 25.16 aphids. Subsequent to spray, aphid population was decreased in all the treated plots, while increased in untreated plots (control). The pooled mean data registered on 3rd day after spray indicated that the minimum aphid population was found in treatment T8: Diamethoate 30 EC @ 625 ml/ha (4.36 aphids/10 cm of main apical shoot) and it was significantly superior over rest of the treatments followed by treatment T6: Neem oil @ 5% after clipping of infested twigs (9.36 aphids/10 cm of main apical shoot). Succeeding treatments, T4: *Beauveria bassiana* @ 10^8 cs/ml after clipping of infested twigs (11.17 aphids/10 cm of main apical shoot) and T5: NSKE @ 5% after clipping of infested twigs (12.07 aphids/10 cm of main apical shoot) were on par with each other. T2: *Beauveria bassiana* @ 10^8 cs/ml was the following best treatment with mean aphid population of 13.16 aphids/10 cm of main apical shoot. In all other treatments, T3: Neem oil @ 5% (14.44 aphids/10 cm of main apical shoot) and T1: NSKE @ 5% (14.84 aphids/10 cm of main apical shoot) were found at par with each other. The treatment T7: clipping of infested twigs at ETL was noticed least effective with mean aphid population of 16.29 aphids/10 cm of main apical shoot. Maximum aphid population was recorded in T9: control (29.43 aphids/10 cm of main apical shoot) (Table 4).

Pooled mean data recorded on 7th day after spray also showed the similar trend of effectiveness of different treatments and the mean aphid population ranges from 3.85 to 24.21 aphids/10 cm of main apical shoot (Table 4).

Similar results were noticed at 10th day after spray, the aphid population was once again registered minimum (2.83 aphids/10 cm of main apical shoot) with treatment T8: Diamethoate 30 EC @ 625 ml/ha and it was proved best treatment as comparison to rest of the treatments. It was followed by treatment T6: Neem oil @ 5% after clipping of infested twigs (5.95 aphids/10 cm of main apical shoot) and T4: *Beauveria bassiana* @ 10^8 cs/ml after clipping of infested twigs (6.32 aphids/10 cm of main apical shoot) and both were found at par with each other. In all other treatments, T5: NSKE @ 5% after clipping of infested twigs (7.28 aphids/10 cm of main apical shoot) and T2: *Beauveria bassiana* @ 10^8 cs/ml (7.87 aphids/10 cm of main apical shoot) were registered at par with each other. Next treatment in order of effectiveness were T3: Neem oil @ 5% (8.43 aphids/10 cm of main apical shoot) and T1: NSKE @ 5% (8.87 aphids/10 cm of main apical shoot) and were on par with each other. Likewise previous interpretations, T7: treatment clipping of infested twigs at ETL was found least effective in reduction of aphid population (32.92 aphids/10 cm of main apical shoot), whereas maximum aphid population was recorded in T9: control (44.77 aphids/10 cm of main apical shoot) (Table 4). However, all the treatments were found significantly superior to control. Similar trend of effectiveness of various insecticides were noticed during all the years (*Rabi*, 2017-18, 2018-19 and 2019-20) of experimentation as mentioned in table 1, 2 and 3.

The present results are in agreement with Kumar *et al*. (2020) [7] who found that the Diamethoate 30 EC @625 ml/ha was most effective against mustrad aphid with mean aphid population of 13.3, 7.0 and 5.3 aphids/10 cm of main apical shoot (first spray) and 7.1, 5.7 and 4.2 aphids/10 cm of main apical shoot (second spray) after 3, 7 and 10 days of spray, respectively. Earlier, Sharma *et al*. (2017) [12] also reported Dimethoate 30EC @ 250 ml/acre (1.97 aphids/10 cm of main apical shoot) was most effective treatment against aphid followed by treatments *V. lecanii* @ 10^8 CS/ml + NSKE @ 5% (4.56 aphids/10 cm of main apical shoot) and NSKE @ 5% + clipping of infested twigs (4.86 aphids/10 cm of main apical shoot) after 10 days of spray. Gour and Pareek (2003) [4], Konar and Paul (2005) [6] and Kumar and Sharma (2020) [8] also found that dimethoate was the most effective treatment against mustard aphid. Bunker *et al*. (2006) [2] have also reported neem oil 2% and NSKE 10% be effective against aphid. Vishal *et al*. (2019) [21] also recorded that treatment Dimethoate 30 EC, *Beauveria bassiana* CFU 1×10^8 and Neem oil 2.0% proved effective against mustard aphid.

The pooled mean data on yield of various treatments was mentioned in table 4 showed that all the treated plots resulted significantly higher yield in comparison to untreated control plot (8.31 q/ha), varied between 10.17 to 16.80 q/ha. Maximum seed yield (16.80 q/ha) was recorded with treatment T8: Diamethoate 30 EC @ 625 ml/ha and was found superior over rest of all other treatments. Succeeding treatments, T6: Neem oil @ 5% after clipping of infested twigs (15.45 q/ha) and it was found to be on par with

treatment T4: *Beauveria bassiana* @ 10^8 cs/ml after clipping of infested twigs (15.34 q/ha). It was followed by treatments T5: NSKE @ 5% after clipping of infested twigs (14.37 q/ha), T2: *Beauveria bassiana* @ 10^8 cs/ml (12.68 q/ha), T3: Neem oil @ 5% (12.33 q/ha) and T1: NSKE @ 5% (12.12 q/ha). The lowest seed yield (10.17q/ha) was registered in plots treated with treatment T7: clipping of infested twigs at ETL. The yield of all the treated plots was significantly higher to control. Earlier, Sharma *et al*. (2017) [12], Vishal *et al*. (2019) [21], Kumar and Sharma (2020) [8] and Kumar *et al*. (2020) [7] also reported highest seed yield in plots treated with treatment Diamethoate. These results are in confirmation with the current study.

Table 1: Efficacy of different chemical and non- chemical insecticides against aphid, *Lipaphis erysimi* (kalt) in Indian mustard (RB-50) during 2017-18.

S/No.	Treatment	Mean number of aphids /10 cm of main apical shoots				Yield (q/ha)
		DBS	3 DAS	7 DAS	10 DAS	
T_1	NSKE @5%	22.96 (4.88)	16.29 (4.15)	13.99 (3.86)	09.45 (3.22)	12.10
T_2	*Beauveria bassiana*@ 10^8 cs/ml	24.93 (5.08)	14.85 (3.97)	11.71 (3.55)	08.92 (3.14)	12.75
T_3	Neem oil @5%	26.93 (5.28)	16.25 (4.15)	13.92 (3.86)	09.19 (3.18)	12.35
T_4	*Beauveria bassiana*@ 10^8 cs/ml after clipping of infested twigs	26.43 (5.23)	12.92 (3.72)	10.59 (3.39)	07.29 (2.87)	15.22
T_5	NSKE @5% after clipping of infested twigs	25.68 (5.16)	13.75 (3.83)	11.05 (3.46)	08.35 (3.01)	14.25
T_6	Neem oil @5% after clipping of infested twigs	23.80 (4.97)	10.66 (3.40)	09.02 (3.16)	06.88 (2.79)	15.35
T_7	Clipping of infested twigs at ETL	21.84 (4.77)	17.86 (4.33)	25.28 (5.11)	36.63 (6.12)	10.07
T_8	Dimethoate 30 EC @625 ml/ha	24.10 (5.02)	5.95 (2.63)	05.33 (2.51)	03.99 (2.22)	16.15
T_9	Control	25.33 (5.12)	29.09 (5.47)	34.80 (5.97)	41.75 (6.53)	8.65
CD (P=0.05)		N/A	0.51	0.53	0.46	1.68

*Figures in parentheses are square root transformations

Table 2: Efficacy of different chemical and non- chemical insecticides against aphid, *Lipaphis erysimi* (kalt) in Indian mustard (RB-50) during 2018-19.

Sr. No.	Treatment	Mean number of aphids /10 cm of main apical shoots				Yield (q/ha)
		DBS	3 DAS	7 DAS	10 DAS	
T_1	NSKE @5%	20.90 (4.67)	14.27 (3.90)	11.97 (3.59)	7.73 (2.95)	13.01
T_2	*Beauveria bassiana*@ 10^8 cs/ml	22.80 (4.87)	12.83 (3.71)	9.69 (3.26)	6.90 (2.80)	13.39
T_3	Neem oil @5%	24.90 (5.08)	14.23 (3.98)	11.90 (3.58)	7.17 (2.84)	13.28
T_4	*Beauveria bassiana*@ 10^8 cs/ml after clipping of infested twigs	14.23 (3.88)	10.91 (3.44)	8.57 (3.08)	5.27 (2.49)	16.42
T_5	NSKE @5% after clipping of infested twigs	23.60 (4.95)	11.73 (3.56)	9.03 (3.16)	6.33 (2.69)	15.44
T_6	Neem oil @5% after clipping of infested twigs	21.80 (4.76)	8.81 (3.12)	7.00 (2.82)	4.86 (2.41)	16.52
T_7	Clipping of infested twigs at ETL	19.81 (4.55)	12.51 (3.64)	23.26 (4.92)	34.61 (5.96)	11.24
T_8	Dimethoate 30 EC @625 ml/ha	22.12 (4.80)	4.94 (2.43)	4.32 (2.30)	2.99 (1.99)	17.25
T_9	Control	23.3 (4.92)	27.07 (5.29)	32.78 (5.80)	39.00 (6.32)	9.16
CD (P=0.05)		0.547	0.48	0.40	0.36	2.461

*Figures in parentheses are square root transformations

Table 3: Efficacy of different chemical and non- chemical insecticides against aphid, *Lipaphis erysimi* (kalt) in Indian mustard (RB-50) during 2019-20.

S/No.	Treatment	Mean number of aphids /10 cm of main apical shoots				Yield (q/ha)
		DBS	3 DAS	7 DAS	10 DAS	
T_1	NSKE @ 5%	22.90 (4.88)	13.97 (3.86)	11.30 (3.50)	9.42 (3.22)	11.26
T_2	*Beauveria bassiana* @ 10^8 cs/ml	24.88 (5.06)	11.80 (3.57)	9.50 (3.24)	7.80 (2.96)	11.90
T_3	Neem oil @ 5%	23.65 (4.96)	12.85 (3.71)	10.65 (3.41)	8.94 (3.14)	11.37
T_4	*Beauveria bassiana* @ 10^8 cs/ml after clipping of infested twigs	26.35 (5.20)	9.68 (3.26)	7.95 (2.99)	6.40 (2.71)	14.40
T_5	NSKE @ 5% after clipping of infested twigs	25.30 (5.11)	10.72 (3.42)	8.20 (3.03)	7.16 (2.85)	13.42
T_6	Neem oil @ 5% after clipping of infested twigs	27.40 (5.31)	8.45 (3.07)	7.00 (2.82)	6.10 (2.64)	14.50
T_7	Clipping of infested twigs at ETL	22.45 (4.84)	18.50 (4.42)	24.10 (5.00)	27.52 (5.34)	9.22
T_8	Dimethoate 30 EC @ 625 ml/ha	28.95 (5.42)	2.20 (1.74)	1.90 (1.69)	1.60 (1.59)	17.10
T_9	Control	21.75 (4.77)	32.14 (5.75)	44.52 (6.74)	53.55 (7.38)	7.14
CD (P=0.05)		N/A	0.45	0.36	0.46	0.39

*Figures in parentheses are square root transformations

Table 4: Pooled mean on efficacy of different chemical and non- chemical insecticides against aphid, *Lipaphis erysimi* (kalt) in Indian mustard (RB-50).

S/No.	Treatment	Mean number of aphids /10 cm of main apical shoots				Yield (q/ha)
		DBS	3 DAS	7 DAS	10 DAS	
T_1	NSKE @ 5%	22.25 (4.82)	14.84 (3.97)	12.42 (3.66)	8.87 (3.13)	12.12
T_2	*Beauveria bassiana* @ 10^8 cs/ml	24.20 (5.01)	13.16 (3.75)	10.30 (3.35)	7.87 (2.97)	12.68
T_3	Neem oil @ 5%	25.16 (5.11)	14.44 (3.92)	12.16 (3.62)	8.43 (3.06)	12.33
T_4	*Beauveria bassiana* @ 10^8 cs/ml after clipping of infested twigs	22.34 (4.79)	11.17 (3.48)	9.04 (3.16)	6.32 (2.70)	15.34
T_5	NSKE @ 5% after clipping of infested twigs	24.86 (5.08)	12.07 (3.61)	9.43 (3.22)	7.28 (2.87)	14.37
T_6	Neem oil @ 5% after clipping of infested twigs	24.33 (5.03)	9.36 (3.21)	7.67 (2.94)	5.95 (2.63)	15.45
T_7	Clipping of infested twigs at ETL	21.37 (4.73)	16.29 (4.14)	24.21 (5.02)	32.92 (5.81)	10.17
T_8	Dimethoate 30 EC @ 625 ml/ha	25.06 (5.10)	4.36 (2.28)	3.85 (2.17)	2.83 (1.94)	16.80
T_9	Control	23.46 (4.94)	29.43 (5.51)	37.37 (6.18)	44.77 (6.75)	8.31
CD (P=0.05)		NS	0.38	0.42	0.47	0.68

*Figures in parentheses are square root transformations

Conclusion

From the current study it may be concluded that Diamethoate 30 EC @ 625 ml/ha was most effective insecticide for control of *Lipaphis erysimi* but urgent need to adopt eco-friendly management methods to avoid human health hazard and environmental pollution. Among non-chemical insecticides, Neem oil @ 5% after clipping of infested twigs and NSKE @ 5% after clipping of infested twigs may be recommended as eco-friendly and effective alternative to chemical insecticides for the management of aphid on Indian mustard variety RB-50.

References

1. Anonymous. Agricultural statistics at a glance. Government of India, Ministry of Agriculture, Department of Agriculture & Cooperation, Directorate of Economics & Statistics, Krishi Bhawan, New Delhi, 2019.
2. Bunker GK, Rana BS, Ameto OP. Efficacy of some plant products against mustard aphid, *Lipaphis erysimi* (Kalt.) under different intercropping systems. Pestology 2006;30(6):28-32.
3. Desh R, Devi N, Singh AB, Verma SC. Relative susceptibility of germplasms of three cruciferous oilseed crops to three different aphid species and chemical basis of their differential reactions. Journal of Entomological Research 1996;20:115-120.
4. Gour IS, Pareek BL. Field evaluation of insecticides against mustard aphid, *Lipaphis erysimi* (Kalt.) under semi-arid region of Rajasthan. Indian Journal Plant Protection 2003;31:25-27.
5. Khavse R, Singh R, Manikandan N, Chaudhar JL.

Influence of temperature on rapeseed-mustard yield at selected locations in Chhattisgarh state. Current World Environment 2014;9(3):1034-1036.
6. Konar A, Paul S. Comparative field efficacy of synthetic insecticides and biopesticides against aphid on potato. Annual of Plant Protection Science 2005;13:34-36.
7. Kumar A, Yadav S, Kumar Y, Yadav J. Evaluation of different botanicals for the management of mustard aphid, *Lipaphis erysimi* (Kaltenbach). Journal of Oilseed Brassica 2020;11(1):42-48.
8. Kumar S, Sharma R. Field efficacy of insecticides against two different feeding guilds: the sap sucking *Lipaphis erysimi* (Kaltenbach) and foliage feeder *Pieris brassicae* (L.) infesting Indian mustard. Journal of Oilseed Brassica 2020;11(1):29-33.
9. Purwar JP, Singh RK, Mal P. Eco-friendly management of Insect pests in rapeseed-mustard. Indian Farmers Digest 2004;37:34-35.
10. Sahoo SK. Incidence and management of mustard aphid (*Lipaphis erysimi* Kaltenbach) in West Bengal. The Journal of Plant Protection Sciences 2012;4(1):20-26.
11. Sarangdevot SS, Kumar A, Chundawat GS. Field bio-efficacy of some newer insecticides against aphids infesting tomato crop. Pestology 2006;30:20-22.
12. Sharma D, Yadav SP, Yadav S. Biointensive integrated management of *Lipaphis erysimi* Kalt. (Homoptera: Aphididae) in *Brassica* spp. Journal of Applied and Natural Science 2017;9(4):2132 -2136.
13. Sheoran OP, Tonk DS, Kaushik LS, Hasija RC, Pannu RS. Statistical Software Package for Agricultural Research Workers. In: DS Hooda & RC Hasija. Recent advances in information theory, statistics and computer applications, Department of Mathematics and Statistics, CCS HAU, Hisar 1998, 139-143.
14. Shylesha AN, Azad Thakur NS, Pathak KA, Rao KR, Saikia K, Surose S *et al*. Integrated management of insect pest of crops in north eastern hill region. Technical Bulletin No. 19. ICAR RC for NEH Region, Umiam 2006, 50.
15. Singh A, Avtar R, Singh D, Sangwan O, Thakral NK, Malik VS *et al*. Combining Ability Analysis for Seed Yield and Component Traits in Indian Mustard [*Brassica juncea*(L.) Czern and Coss]. Research in Plant Biology 2013;3(2):26-31.
16. Singh CP, Sachan GC. Eco-friendly management of *Lipaphis erysimi* Kalt. in *Brassica carinata*. In: Proc. 10th Intl Rapeseed Conf, Canberra, Australia 1999.
17. Singh TR, Singh MP, Singh KI, Devi TB, Singh NG. Comparative efficacy of certain neem products and conventional insecticides against *Lipaphis erysimi* (Kalt.) and their safety to its natural enemies in rapeseed. Indian Journal of Entomology 2007;69(3):259-264.
18. Singh YP, Sharma KC. Integrated approach to manage the mustard aphid *Lipaphis erysimi* K. (Homotera: Aphididae) in oilseed *Brassica* crops-a review. Journal of Amphibiology 2002;16:77-88.
19. Singh D. Genetic enhancement of mustard for seed yield and its sustainability. Paper presented in 2nd National Brassica Conference held at PAU Ludhiana from 2014, 18.
20. Srivastava A. Nefarious pests of rapeseed-mustard. The tribune (On line edition) Chandigarh. India 2002.
21. Vishal, Singh H, Kumar A. Efficacy and economics of some newer insecticides against mustard aphid, *Lipaphis erysimi* (Kalt). Journal of Pharmacognosy and Phytochemistry 2019;8(3):785-788.