

Original Research Article

<https://doi.org/10.20546/ijcmas.2018.711.057>

Relative Toxicity of Some Newer Insecticides against Mustard aphid, *Lipaphis erysimi* (Kalt.) on *Gobhi sarson*

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ABSTRACT

The Relative toxicity of methyl-o-demeton, spinosad, acetamiprid, chlorfenapyr and fipronil were evaluated against mustard aphid, *Lipaphis erysimi* (Kalt.) on *Gobhi sarson* var. DGS-1 during 2017-18. The LC₅₀ values of insecticides viz., methyl-o-demeton, spinosad, acetamiprid, chlorfenapyr and fipronil were 4.772, 55.406, 4.657, 5.554 and 15.107 ppm, respectively by direct spray method indicating that acetamiprid exhibited greater toxicity among the tested insecticides. However, by leaf dip method, the LC50 values of insecticides were 6.034, 9.142, 6.487, 5.429 and 67.505 ppm, respectively, which indicated that chlorfenapyr, was the most toxic among the insecticides tested. The relative toxicity of acetamiprid, methyl-o-demeton, chlorfenapyr and fipronil over spinosad were found to be 11.89, 11.61, 9.97 and 3.66 times more effective, respectively. Whereas, in leaf dip method of bioassay the relative toxicity of chlorfenapyr, methyl-o-demeton, acetamiprid and spinosad over fipronil were found to be 12.43 11.18, 10.40 and 7.38 times more effective, respectively.

Keywords

Relative toxicity,
Insecticides, Direct spray,
Leaf dip, *Lipaphis*
erysimi

Article Info

Accepted:
07 October 2018
Available Online:
10 November 2018

Introduction

Oilseed crops are generally one of the most important crops in the world. Rapeseed-mustard is the major oilseed crop grown in various states of the country. This crop is the major source of income especially to the marginal and small farmers in rainfed areas. Because of its low water requirement (80-240 mm), rapeseed-mustard crop fits well in the rainfed cropping system. Rapeseed-mustard crop (*Brassica* spp.) is grown both in subtropical and temperate countries and it is the third most important oilseed crop in the world after soybean (*Glycine max*) and palm

oil, *Elaeis guineensis* (Jacq.). The share of oilseeds is 14.1% out of the total cropped area in India, Rapeseed-mustard accounts for 3% of it (Kapila *et al.*, 2012). In India, this crop is grown in diverse agro-climatic conditions ranging from north-eastern/north-western hills to down south under irrigated/rainfed, timely/late sown and mixed cropping. It is cultivated in 5.76 million hectares with an annual production of 6.82 million tones and average productivity of 1184 kg/ha which contributes 28.3% and 19.8% in world acreage and production (Anon., 2016a). India has the largest area and highest production of mustard. Currently, Rajasthan is the top

mustard producing state of India with an area of 2.55 million ha and production of 3.27 million tonnes, followed by Haryana and Madhya Pradesh (Anon., 2016b).

Aphids are important group of insects with worldwide distribution and a truly interesting group of herbivorous insects and can affect plants directly or indirectly by feeding on the plant sap. Mustard aphid, *L. erysimi* (Kalt.) have been reported as a major constraint responsible for this low yield level, which causes average yield losses ranging 27.3-94.5% in Indian mustard due to aphids (Singh *et al.*, 2000; Malik *et al.*, 2003). This species causes damage to plants in two ways, initially by sucking the plant sap and subsequently secreting a sticky substance (honeydew) on which 'sooty mold' develops, which interferes with photosynthesis (Raboudi *et al.*, 2002). Increase in aphid population beyond 25 aphids/10 cm terminal shoot/plant reduces seed yield by 1.5 kg/ha (Singh *et al.*, 1983). It has attained the key pest status in rapeseed-mustard because of its prolific multiplication and severe damage, resulting in curling of the leaf, stunting and drying up of the plants (Rana *et al.*, 2007).

The major problems associated with chemical control of mustard aphid are the development of insecticidal resistance, resurgence, pest outbreak etc., against most of the commonly used broad spectrum insecticides in the field. This has obliged the use of new eco-friendly, ecologically acceptable insecticides against mustard aphids and resistance build up problems against these traditional insecticides can be easily breakdown by using the newer group of molecules. In this context, the present study was conducted for assessing the relative toxicity of four newer insecticides along with a conventional insecticide methyl-o-demeton in laboratory conditions against mustard aphid. Therefore, efforts were made to determine the relative toxicity and

economics of some newer insecticides for the management of mustard aphid on Indian mustard in Jammu and Kashmir.

Materials and Methods

Studies on relative toxicity assessment of selected insecticides against mustard aphid, *L. erysimi* were conducted in the laboratory of Division of Entomology and Experimental Farm of Division of Entomology, SKUAST-Jammu. Mustard aphids were reared on potted *Gobhi sarson*, *Brassica napus* L. variety (DSH-1) plants. Mustard seeds were also sown in an area of 5 m² in Technology Park of SKUAST-Jammu for availing the leaf material. Aphids were collected from the sown mustard plants and released on these potted plants. Generations of these aphids on the potted plants were used for bioassay studies. Commercial formulations of methyl-o-demeton 35 EC (Metasystox®, United Phosphorous Limited), acetamiprid 20 SP (Pride®, Indo-Gulf Group), spinosad 45 SC (Tracer®, Dow Agro Sciences. India Pvt. Ltd.), fipronil 5 SC (Reagent®, Bayer Crop Science Limited) and chlorfenapyr (Interpid®, BASF India Limited.) were obtained from the respective manufacturers. Desired concentrations of these were prepared by dilution with water. Six concentrations of each insecticide including control were screened in the laboratory against the neonate mustard aphids *L. erysimi* to obtain the log concentration- probit mortality curve. Each treatment was replicated thrice. The relative toxicity of the insecticides was calculated based on the percentage of aphid mortality after 24 hrs of treatment.

Bioassay studies

Direct spray method

Leaf samples of untreated *Gobhi sarson*, *Brassica napus* L. (variety: DSH-1) crop were

brought to the laboratory from already sown mustard field in Technology Park of SKUAST-Jammu. These leaves were washed with tap water. After washing, leaf discs of 9 cm size were made. These leaf discs were dried for 5 minutes at room temperature. In preliminary tests reared apterous aphids were exposed to wider range of concentrations of all insecticides and on the basis of mortality recorded, a series of concentrations in narrow range were selected. Finally aphids were exposed to narrow range of concentrations of each insecticide for bioassay studies.

Twenty apterous neonate aphids of same size were released in each Petriplate by using soft camel hair brush and sprayed directly with 3 ml (1ml/ Petriplate) of predetermined insecticidal solutions in the batches of three Petriplates by using Burkardo Computer controlled spraying apparatus at a pressure of 10-15 g/cm². For control only distilled water was used for spraying. Then the treated aphids were transferred to clean Petriplates containing fresh leaf discs (upside down) of *Gobhi sarson* as food. In order to maintain moisture a moist filter paper was placed in each Petriplate under the leaf disc. These petriplates were kept in B.O.D. incubator at 26 ± 10 C. For assessment of LC₅₀ values, mortalities were recorded after 24 hours of the treatment. The moribund aphids were also considered as dead.

Leaf dip method

To study the residual bio efficacy potential, the apterous neonate aphids were exposed to insecticidal residues on mustard leaves. The fresh uninfected untreated fully-grown *Gobhi sarson* leaves with petiole were brought to the laboratory and thoroughly washed with water. After washing, leaf discs of 9 cm Petriplate size were prepared. These leaf discs were dried for 5 minutes at room temperature. Later, these leaf discs were dipped in desired

concentrations of each insecticide for 30 seconds in the 250 ml beaker and shade dried. Then the treated leaf discs were transferred to clean Petriplates. Later, twenty apterous neonate aphids of same size were carefully released on the treated leaf by using a soft camel hair brush. Each treatment including control was replicated thrice. For control, the *Gobhi sarson* leaves were dipped only in water, dried and used. The Petriplates were kept in B.O. D. incubator at 26 ± 10 C.

For assessment of LC₅₀ values, mortalities were recorded after 24 hours of the treatment. The moribund aphids were also considered as dead. The concentrations giving the mortality ranging from 15 to 95 per cent were selected. The mortality was converted to percent mortality and corrected mortality was calculated as per Abbott's (1925) formula.

$$\text{Corrected \% mortality} = \frac{\% \text{ mortality in treatment} - \% \text{ mortality in control}}{100 - \% \text{ mortality in control}} \times 100$$

The data were further subjected to probit analysis for calculating LC₅₀ and LC₉₀ values. The LC₅₀ values of insecticides against aphids were expressed as parts per million (ppm). The relative toxicity values for different insecticides were calculated by using following formula.

$$\text{Relative toxicity} = \frac{\text{LC}_{50} \text{ of least toxic compound.}}{\text{LC}_{50} \text{ of most toxic compound.}}$$

Results and Discussion

The perusal data of LC₅₀ values revealed that acetamiprid 20 SP had the maximum toxicity (LC₅₀ 4.657 ppm) against mustard aphid *L. erysimi* after 24 hours exposure in direct spray method followed by methyl-o-demeton 25 EC (4.772 ppm), chlorfenapyr 10 SC (5.554 ppm), fipronil 5 SC (15.107 ppm) and spinosad

(55.406 ppm). The relative toxicity of acetamiprid, methyl-o-demeton, chlorfenapyr and fipronil over spinosad were found to be 11.89, 11.61, 9.97 and 3.66 times more effective, respectively and the order of relative toxicity was in the following order: acetamiprid, (11.89) > methyl-o-demeton (11.61) > chlorfenapyr (9.97) > and fipronil (3.66) after taking the relative toxicity of the spinosad as unity. Earlier, Awasthi *et al.*, (2013) also reported the higher toxicity of acetamiprid (87.95%) against *L. erysimi* (Kalt.) with the LC₅₀ value being 0.007 ppm followed by acephate (0.025 ppm), imidacloprid (0.036 ppm), emamectin benzoate (0.368 ppm), indoxacarb (0.397 ppm) and spinosad (0.576 ppm).

Direct application of acetamiprid, methyl-o-demeton, chlorfenapyr and fipronil were found to be more effective as evidenced by low LC₅₀ values as compared to leaf dip method. The LC₅₀ values of methyl-o-demeton, spinosad, acetamiprid, chlorfenapyr and fipronil were 4.772 ppm, 55.406, 4.657, 5.554 and 15.107 ppm, respectively indicating that acetamiprid was comparatively more toxic to mustard aphid, *L. erysimi* in direct spray method. Results of present study are in same line with the findings of Powar *et al.*, (2015), they noted that acetamiprid was most toxic insecticide (63.23 ppm) followed by imidacloprid (133.87), dimethoate (334.84) and methyl demeton (348.45 ppm).

Sharma *et al.*, (2006) also reported that acetamiprid was the most toxic insecticide and the order of toxicity of insecticides was acetamiprid > imidacloprid > quinalphos > monocrotophos > endosulfan > chlorpyrifos > dimethoate > spinosad > cypermethrin. Studies of Dhawan *et al.*, (2009) also determined the relative toxicity of imidacloprid, acetamiprid, quinalphos, endosulfan, novaluron, thiamethoxam, triazophos, chlorpyrifos and clothianidin

against cotton aphid, *Aphis gossypii* and the order of toxicity of insecticides was thiamethoxam > acetamiprid > novaluron > imidacloprid > triazophos = quinalphos > endosulfan > chlorpyrifos = clothianidin > ethion with LC₅₀ values 10000, 5500, 1250, 500, 250, 250, 120, 80, 80 and 70 ppm, respectively. Experimental results of Pandi *et al.*, (2013) also stated that acetamiprid was most toxic insecticide than other insecticides against grubs of *Cheilomenes sexmaculata* and the descending order of toxicity of based on LC₅₀ value was acetamiprid (50ppm) > thiamethoxam (60ppm) > imidacloprid (170 ppm). However studies of Devi *et al.*, (2003) reported that methyl-demeton, dimethoate was highly toxic to *Diaeretiella rapae* a common parasitoid of mustard aphid *L. erysimi* with 50- 95% mortality under direct exposure conditions. The toxicity of neonicotinoids (acetamiprid) against *L. erysimi* was more pronounced than other class of insecticides due to direct toxicity as well as their avoidance behaviour as antifeedant/ repellent responses.

However leaf dip method was observed to be more effective as compared to direct spray in case of chlorfenapyr and spinosad. In leaf dip method the LC₅₀ values of methyl-o-demeton, spinosad, acetamiprid, chlorfenapyr and fipronil were 6.034, 9.142, 6.487, 5.429 and 67.505 ppm shown that chlorfenapyr was comparatively more toxic and the order of relative toxicity was chlorfenapyr (12.43) > methyl-o-demeton (11.18) acetamiprid (10.40) and spinosad (7.38) after taking the relative toxicity of the fipronil as unity. In the leaf dip method, the order of toxicity of insecticides changed perceptibly. In this method chlorfenapyr was the most toxic insecticide followed by methyl-o- demeton, acetamiprid, spinosad and fipronil. In the present studies, chlorfenapyr was found to be the most potent insecticide against mustard aphid followed by methyl-o- demeton (Table 1–6).

Table.1 Details of insecticides tested against *Lipaphis erysimi*

S. No	Common name	Chemical group/ Source	Trade name	Formulation	Manufacturer	Recommended dose (%)
11	Fipronil	Phenyl Pyrazoles	Regent	5 SC	Bayer Crop Science Limited.	0.005
22	Acetamiprid	Neo nicotinoids	Prize	20 SP	Indo-Gulf Group, India.	0.005
33	Spinosad	Actinomycetes derivative	Tracer	45 SC	Dow Agro Sciences. India Pvt. Ltd.	0.030
44	Chlorfenapyr	Halogenated pyrrole	Intrepid	10 SC	BASF India Limited.	0.015
55	Methyl-o-Demeton	Organo-phosphorus	Metasystox	25 EC	Union Phosphorus Limited, India.	0.030

Table.2 Concentrations of insecticides used in direct spray method

Insecticides	Method	Concentrations used (ppm)
Acetamiprid	Direct spray	100, 50, 10, 1, 0.1, 0.01.
	Leaf dip	100, 50, 10, 1, 0.1, 0.01.
Spinosad	Direct spray	1000, 500, 100, 50, 10, 5.
	Leaf dip	1000, 500, 100, 50, 10, 5.
Chlorfenapyr	Direct spray	100, 50, 10, 5, 2.5, 0.25.
	Leaf dip	100, 50, 10, 5, 2.5, 0.25.
Fipronil	Direct spray	1000, 500, 100, 10, 5, 1.
	Leaf dip	1000, 500, 100, 10, 5, 1.
Methyl-o-demeton	Direct spray	100, 50, 10, 5, 2.5, 1.25.
	Leaf dip	100, 50, 10, 5, 2.5, 1.25.

Table.3 Mortality response of insecticides against *Lipaphis erysimi* by direct spray method

Methyl-o-demeton		Spinosad		Acetamiprid		chlorfenapyr		Fipronil	
Conc. (ppm)	Corrected % mortality	Conc. (ppm)	Corrected % mortality	Conc. (ppm)	Corrected % mortality	Conc. (ppm)	Corrected % mortality	Conc. (ppm)	Corrected % mortality
100	91.37	1000	89.28	100	94.54	100	85.71	1000	87.71
50	84.48	500	78.57	50	83.63	50	76.78	500	77.19
10	72.41	100	60.71	10	70.90	10	67.85	100	61.40
5	55.17	50	44.64	5	56.36	5	55.35	10	56.14
2.5	39.65	10	32.14	1	34.54	2.5	23.21	5	42.10
1.25	17.24	5	12.50	0.1	16.36	0.25	14.28	1	19.29

Data are means of three replications.

Table.4 Relative toxicity of insecticides against *Lipaphis erysimi* by direct spray method

Insecticide	Heterogeneity		Regression Equation	LC ₅₀ (ppm)	Fiducial limits		Slope ± SE (b)	Relative Toxicity	Order of Toxicity	LC ₉₀ (ppm)	Fiducial limits	
	χ^2	d.f			Lower	Upper					Lower	Upper
Methyl-o-demeton	5.27	4	Y=0.833+1.133X	4.772	3.565	6.389	1.133±0.120	11.61	2	64.583	48.240	86.461
Spinosad	3.55	4	Y=0.656+0.916X	55.406	38.542	79.648	0.916±0.096	1	5	1390.023	966.948	1998.208
Acetamiprid	6.45	4	Y=1.143+1.051X	4.657	3.413	6.355	1.051±0.113	11.89	1	77.070	56.478	105.170
Chlorfenapyr	9.47	4	Y=1.752+0.867X	5.554	3.813	8.090	0.867±0.093	9.97	3	166.889	114.568	243.102
Fipronil	5.72	4	Y=2.650+0.560X	15.107	8.500	26.851	0.560±0.068	3.66	4	2936.680	1652.297	5219.455

Table.5 Mortality response of insecticides against *L. erysimi* by leaf dip method

Methyl-o-demeton		Spinosad		Acetamiprid		Chlorfenapyr		Fipronil	
Conc. (ppm)	Corrected % mortality	Conc. (ppm)	Corrected % mortality	Conc. (ppm)	Corrected% mortality	Conc. (ppm)	Corrected % mortality	Conc. (ppm)	Corrected % mortality
100	89.28	1000	84.48	100	91.07	100	86.20	1000	82.45
50	82.14	500	72.41	50	78.57	50	72.41	500	71.92
10	67.85	100	60.34	10	64.28	10	56.89	100	59.64
5	55.35	50	46.55	5	51.78	5	41.37	10	45.61
2.5	26.78	10	24.13	1	32.14	2.5	32.75	5	29.82
1.25	17.85	5	13.79	0.1	16.07	0.25	18.96	1	14.03

Data are means of three replications.

Table.6 Relative toxicity of insecticides based on LC₅₀ on *Lipaphis erysimi* by leaf dip method

Insecticide	Heterogeneity		Regression Equation	LC ₅₀ (ppm)	Fiducial limits		Slope ± SE (b)	Relative Toxicity	Order of Toxicity	LC ₉₀ (ppm)	Fiducial limits	
	χ ²	d.f			Lower	Upper					Lower	Upper
Methyl-o-demeton	6.23	4	Y=0.724+1.131X	6.034	4.513	8.069	1.131±0.118	11.18	2	81.989	61.315	109.634
Spinosad	5.80	4	Y=0.950+1.022X	9.142	6.678	12.515	1.022±1.112	7.38	4	163.896	119.725	224.363
Acetamiprid	4.20	4	Y=0.892+1.078X	6.487	4.784	8.796	1.078±0.117	10.40	3	100.296	73.965	135.999
Chlorfenapyr	2.79	4	Y=2.363+0.706X	5.429	3.463	8.513	0.706±0.088	12.43	1	354.508	226.094	555.857
Fipronil	2.30	4	Y=1.207+0.785X	67.505	44.801	101.715	0.785±0.090	1	5	2891.234	1918.816	4356.455

Earlier, Rawat *et al.*, (2013) also reported that chlorfenapyr (12.98 ppm), was the most toxic insecticide against green peach aphid, *M. persicae* by leaf dip method followed by thiamethoxam (48.75 ppm), spiromesifen (87.10 ppm) and oxydemeton methyl (338.02 ppm). Studies of Nidhi *et al.*, (2013) found that chlorfenapyr was most effective (12.98 ppm) insecticide against green peach aphid, *M. persicae* followed by thiamethoxam (48.75 ppm), spiromesifen (87.10 ppm). The LC₉₀ value of the insecticides *viz.*, methyl-o-demeton, spinosad, acetamiprid, chlorfenapyr and fipronil were 64.583, 1390.023, 77.070, 166.889 and 2936.680 ppm, respectively in direct spray method. Whereas in leaf dip method the LC₉₀ values were 81.989 ppm, 163.896, 100.296, 354.508 and 2891.234 ppm, respectively.

Based on the LC₅₀ values, acetamiprid was relatively more toxic insecticide against mustard aphid in direct spray method, whereas, chlorfenapyr was most toxic in leaf dip method. However, methyl-o-demeton was the second most toxic insecticide against aphids in both direct spray and leaf dip methods. Though acetamiprid was relatively most toxic to aphids in direct spray method but it was the third best insecticide in leaf dip method. Similarly, chlorfenapyr was the third best insecticide against aphids when it was directly sprayed. Fipronil was existed in moderate group of toxicity. Spinosad was the least effective insecticide in direct spray method. With respect to LC₅₀ values the order of relative toxicity of insecticides in direct spray method was acetamiprid (11.89) > methyl-o-demeton (11.61) > chlorfenapyr (9.97) > fipronil (3.66) and spinosad (1.0), but in leaf dip method order was changed perceptibly. The relatively low LC₅₀ values of acetamiprid, chlorfenapyr and methyl-o-demeton in direct spray method as compared to leaf dip method indicated more bioefficacy of these as direct spray. On the contrary, low

LC₅₀ values of spinosad and chlorfenapyr in leaf dip method indicated better residual effectiveness as compared to direct spray.

It is evident that the neonicotinoids (acetamiprid) was relatively more effective than the other insecticides against *L. erysimi*. The LC₅₀ values obtained would serve as yardstick for the selection of insecticides against field strains of *L. erysimi* in any IPM programme.

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How to cite this article:

Ramana, N., R.S. Bandral and Zahid Abass wazir. 2018. Relative Toxicity of Some Newer Insecticides against Mustard aphid, *Lipaphis erysimi* (Kalt.) on *Gobhi sarson*. *Int.J.Curr.Microbiol.App.Sci*. 7(11): 481-489. doi: <https://doi.org/10.20546/ijcmas.2018.711.057>