Indian Journal of Entomology, 81 (4) Online published (Preview), IJE 19130/November 2019

Indian Journal of Entomology, 81(4): 000-000 (2019) DoI No.:

TOXICITY OF SOME INSECTICIDES AGAINST *AGROTIS* SPP. INFESTING CABBAGE

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ABSTRACT

Toxicity of seven insecticides viz., bifenthrin, chlorantraniliprole, cypermethrin, emamectin benzoate, flubendiamide, novaluron and spinosad was evaluated through leaf dip and topical methods of bioassay against third instar larvae of *Agrotisipsilon*(Hufnagel) and *A. segetum* (Denis andSchiffermuller). Based on LC_{50} values, chlorantraniliprole was found the most effective against third instar larvae of *A. ipsilon* (0.0298 ppm) as well as *A. segetum* (0.0321 ppm) while cypermethrin was the least effective, with LC_{50} values of 31.0706 and 33.4636 ppm, respectively. On the basis of LD_{50}, chlorantraniliprole was observed to be the most effective against third instar larvae of *A. ipsilon* (0.00086 µga.i./ larva) as well as *A. segetum* (0.00085 µga.i./ larva) while novaluron being the least effective with LD_{50} values 0.8382 and 0.7441 µga.i./ larva, respectively.

Key words:*Agrotisipsilon, A. segetum*, cabbage, bioassay, leaf dip, topical application, LC_{50}, LD_{50}, chlorantraniliprole, novaluron

Cutworms are polyphagous and attack a large number of crops. The larvae feed on variety of hosts viz., potato, barley, oats, mustard, linseed, cabbage, peas, gram, tobacco etc. Larvae spoil more than they consume and a severely infested field looks like as if it has been grazed (Johnson and Lewis, 1982; Showers, 1997).The common cutworm *Agrotis segetum* (Denis andSchiffermuller) is distributed throughout the temperate regions of Europe, Africa and Asia whereas, greasy or black cutworm, *Agrotisipsilon* (Hufnagel) is commonly found in Asia and North America. In Himachal Pradesh, *A. segetum* and *A. ipsilon*are the two cutworm species associated with various crops (Verma and Verma, 2002).The infestation of these range from 1.5 to 23.8% in vegetables/ field crops (Pathania, 2010).Broad spectrum insecticides are generallyused for cutworm control which cause environmental contamination. Continuous evaluation to find safer, selective and ecologically acceptable alternatives is required. Hence, the present study to generate information on the toxicity of novel insecticides.

MATERIALS AND METHODS

The initial culture of *A. ipsilon* and *A. segetum* was initiated by collecting the adults on the light source during their emergence. The collected adults were differentiated on the basis of antennae and transferred to glass chimneys (20 x 13 cm). In each chimney, one pair of moth was released. A crumpled paper was placed in each chimney for providing resting sites for the moths and the top of the chimney was covered with muslin cloth, which was tied with a rubber band. A piece of cotton soaked in honey solution (10%) was also kept in each chimney as food supplement to the moths in a small petri plate. The females mostly oviposit on the muslin cloth and the crumpled paper. The eggs laid on paper and muslin cloth were removed daily and replaced by new ones. The eggs laid occasionally on the walls of the chimney were moistened before separating them with the help of camel hair brush. The papers and muslin cloth bearing eggs were then transferred into plastic jars. The jars were examined daily for egg hatching, if any. The newly hatched larvae were then reared on cabbage leaves under controlled conditions at 25±1^{0}C temperature and 75±1% RH, under 16:8 (L:D) photoperiod. The third instar larvae (~10.08 mg) of *A. ipsilon* and *A. segetum*were used.

The insecticides evaluated include spinosad, novaluron,chlorantraniliprole, emamectin benzoate, flubendamide, bifenthrin and cypermethrin. The experiments were conducted by using five concentrations of each insecticide with three replications of each concentration.In experiments, involving 10 third instar larvae of both the species were used in each replicationalong with acontrol. Leaf dip method of bioassay was done with counted number of larvae of 3rd instar kept in clean and dry plastic jars having appropriate filter paper inside and starved for 2-3 hr. The fresh cabbage leaves were dipped in the solutions of different concentrations of each insecticide for 30 sec., shade dried and then placed in the plastic jars for feeding the larvae. A control experiment was also run simultaneously with equal number of replications. In control, the cabbage leaves were treated with distilled water alone, shade dried and given to the larvae for feeding. Water soaked cotton plugs were wrapped around the petioles of the cabbage leaves in order to keep the leaves fresh.

For topical application, larvae of approximately same size and weight were used. Acetone was used as a solvent to prepare different concentrations. A dose of 0.5 µl of each concentration was applied to the thoracic dorsum of the third instar larvae by using a 1ml glass syringe fixed into an electronic microapplicator (Precision Microapplicator 900 X model, Burkard Manufacturing Co. Ltd., England) with delivery range of 0.1 to 10 µl. The treated larvae were transferred to plastic jars containing healthy and fresh leaves of cabbage with their petioles covered with cotton plugs. In control, the larvae were treated with acetone alone. While using the microapplicator, the control treatment larvae were first treated with analytical reagent acetone then followed by the insecticide treatment from the lowest to the highest concentration. The syringe was rinsed properly with acetone after the application of each test insecticide in order to avoid their mixing. Five to six treated third instar larvae were kept in each jar containing fresh cabbage leaves as food. The containers were covered with perforated lids and held at 25 ± 1^{0}C and 75 ± 1 per cent relative humidity under 16:8 (L:D) photoperiod.

To workout the LC/ LD_{50} and LC/ LD_{90} values for 3rd instar larvae of cutworms, 5 working concentrations of each insecticide giving mortality between 10 and 90 per cent were determined. Mortality counts were made 24 h after treatment for all the insecticides except for novaluron where the mortality data were recorded after 72 h. The moribund larvae unable to move or larvae having uncoordinated movements were also considered as dead. The mortality data so obtained were transformed as corrected percent mortality using Abbott's formula (Abbott, 1925). The corrected percent mortality data thus obtained for different concentrations of each insecticide were subjected for probit analysis (Finney, 1971). The relative toxicity values of different insecticides by the different method of bioassay were worked out by taking LC/ LD_{50} values of the least toxic compound as unity.

RESULTS AND DISCUSSION

LC/ LD_{50}

Different insecticides evaluated by leaf dip and topical methods against the third instar larvae of *A. ipsilon* and *A. segetum* revealed different LC/LD_{50}values (Table 1).On the basis of LC_{50} values the order of toxicity against the third instar larvae of *A. ipsilon* was chlorantraniliprole > bifenthrin > flubendiamide > emamectin benzoate > spinosad > novaluron> cypermethrin with LC_{50} values 0.0298, 0.0395, 0.4361, 1.3062, 6.3172, 13.1825 and 31.0706 ppm, respectively. For the third instar larvae of *A. segetum*,the order of toxicity was chlorantraniliprole > bifenthrin > flubendiamide > emamectin benzoate > novaluron > spinosad >cypermethrin with LC_{50} values of 0.0321, 0.0501, 0.6075, 2.5802, 10.2966, 12.1891 and 33.4636 ppm, respectively(Table 1).

These findings are similar to the results reported by Gajanand and Verma (2015) against the third instar larvae of *S. litura.* Temple et al. (2009) also found chlorantraniliprole effective against the selected lepidopteran pests, and estimated its LC_{50} value as 0.02-0.09 ppm and in the present study the LC_{50} value ranged from 0.0213-0.0383 ppm against third instar larvae of *A. ipsilon*. In present study, LC_{50} value of 1.3062 ppm i.e. 0.00013% against third instar larvae of *A. ipsilon*are similar to the findings of Birah et al. (2008) who estimated the LC_{50} value of emamectin benzoate as 0.00017% against tobacco caterpillar, *S. litura* under laboratory conditions. The present findings are, thus, supported by these earlier studies although against other lepidopterans.

Different doses of insecticides were applied topically to the thoracic dorsum of third instar larvae *A. ipsilon* and *A. segetum* and the LD_{50} values were estimated using the probit analysis. The order of toxicity to *A. ipsilon* was recorded as chlorantraniliprole > bifenthrin > cypermethrin > emamectin benzoate > flubendiamide > spinosad > novaluron. The respective LD_{50} values were 0.0009, 0.0019, 0.0036, 0.2538, 0.2642, 0.4115 and 0.8382 µga.i./ larva.In case of *A. segetum*, the order of toxicity was recorded as chlorantraniliprole > cypermethrin > bifenthrin > emamectin benzoate > flubendiamide > spinosad > novaluron. The respective LD_{50} values were 0.0009, 0.0034, 0.0039, 0.2047, 0.3198, 0.3465 and 0.7441 µga.i./ larva (Table 1).Thus, chlorantraniliprole proved to be most effective against both the species, using both the methods of bioassay. Karaagac and Konus (2012) also recorded bifenthrin to be effective against wide range of lepidopterans. Huang et al. (2011) too found chlorantraniliprole effective against the larvae of insect belonged to same order as that of *Agrotis* spp. Sharma and Verma (2013) conducted bioassay of flubendiamide using topical method and recorded the LD_{50} value of 0.16 µg/ larva against the third instar larvae of *A. segetum*.

Relative toxicity

The relative toxicity of the insecticides for two specieswas worked outon the basis of the LC/ LD_{50} values by using the LC/ LD_{50} value of the least toxic insecticide as unity.In case of LC_{50} values, chlorantraniliprole was estimated to be 1042.64 times more toxic than cypermethrin (least effective), followed by bifenthrin (786.59 times) against the third instar larvae of *A. ipsilon.* On the other hand, for *A. segetum*, chlorantraniliprole was estimated to be 1042.48 times more toxic than cypermethrin (least effective) followed by bifenthrin (667.94 times) (Table 1).

In case of LD_{50} values,chlorantraniliprole was found to be 974.65 times more toxic than novaluron (least effective), followed by bifenthrin (441.16 times) against *A. ipsilon* larvae. While in case of *A. segetum*, chlorantraniliprole was 875.41 times more toxic than novaluron (least effective), followed by cypermethrin (218.85 times) (Table 1).

Table 1. Relative toxicity of insecticides to third instar larvae of *A. ipsilon* and *A. segetum*

S. No	Insecticides	*Agrotis*species	Leaf dip method			Topical application method		
			LC_{50} (ppm)	Regression equation	Relative toxicity	LD_{50} (ppm)	Regression equation	Relative toxicity
1.	Cypermethrin 25EC	*A. ipsilon*	31.0706	Y = 2.4747 + 1.6998 X	1.00	0.8382	Y = 2.3562 + 1.3936 X	1.00
		A. segetum	33.4636	Y = 2.5245 + 1.6345 X	1.00	0.7441	Y = 1.4823 + 1.8907 X	1.00
2.	Novaluron 10EC	*A. ipsilon*	13.1825	Y = 3.5295 + 1.3176 X	2.36	0.4115	Y = 2.5707 + 1.5147 X	2.04
		A. segetum	10.2966	Y = 3.3088 + 1.6595 X	3.25	0.3465	Y = 2.0612 + 1.9121 X	2.15
3.	Spinosad 45SC	*A. ipsilon*	6.3172	Y = 3.7184 + 1.5831 X	4.92	0.2642	Y = 2.9780 + 1.4241 X	3.17
		A. segetum	12.1891	Y = 3.1008 + 1.7692 X	2.75	0.3198	Y = 2.0307 + 1.9804 X	2.33
4.	Emamectin benzoate 5SG	*A. ipsilon*	1.3062	Y = 2.8209 + 1.9321 X	23.70	0.2538	Y = 2.8330 + 1.5628 X	3.30
		A. segetum	2.5802	Y = 2.6083 + 1.7046 X	12.97	0.2047	Y = 2.1069 + 2.2143 X	3.64
5.	Flubendiamide 39.35SC	*A. ipsilon*	0.4361	Y = 2.4552 + 1.5465 X	71.25	0.0036	Y = 2.8450 + 1.4042 X	232.84
		A. segetum	0.6075	Y = 1.9952 + 1.6912 X	55.08	0.0034	Y = 2.6971 + 1.5191 X	218.85
6.	Bifenthrin 10EC	*A. ipsilon*	0.0395	Y = 2.3579 + 1.6548 X	786.59	0.0019	Y = 3.0268 + 1.4763 X	441.16
		A. segetum	0.05	Y = 1.6992 + 1.9486 X	667.94	0.0039	Y = 2.5805 + 1.5109 X	190.80
7.	Chlorantraniliprole 18.5EC	*A. ipsilon*	0.0298	Y = 1.8462 + 2.1429 X	1042.64	0.0009	Y = 3.5896 + 1.5288 X	974.65
		A. segetum	0.0321	Y = 2.5218 + 1.6539 X	1042.48	0.0009	Y = 3.3518 + 1.7908 X	875.41

Based on the present studies, chlorantraniliprole was found as the best insecticide against *A. ipsilon*and *A. segetum* along with other new chemistry insecticides like flubendiamide, novaluron and bifenthrin under laboratory conditions.All these insecticides might require further testing to manage this pest under field conditions.

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(Manuscript Received: July, 2019; Revised: October, 2019;
Accepted: November, 2019; Online published: November, 2019)