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RELATIVE TOXICITY OF SOME NEWER INSECTICIDES TO DIAMONDBACK MOTH, *PLUTELLA XYLOSTELLA* LINNAEUS

T. A. Nikam *et al.,*

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T. A. NIKAM*[1], A. G. CHANDELE[2], NIKITA S. AWASTHI[3]
[1*]Department of Agricultural Entomology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani - 431 402, Maharashtra, INDIA
[2]Department of Agricultural Entomology, Mahatma Phule Krishi Vidyapeeth, Rahuri - 413 722, Maharashtra, INDIA
[3]Department of Agricultural Entomology, Tamil Nadu Agriculture University, Coimbatore - 641 003, Tamil Nadu, INDIA
e-mail: tukaramnikam.agri@gmail.com

ABSTRACT

Experiments were conducted in laboratory to evaluate relative toxicity of different newer insecticides against different larval instars of diamondback moth. Amongst chemical insecticides tested for their larvicidal action revealed that Spinosad was found to be the most toxic, followed by Emamectin benzoate, Chlorantriniliprole, Flubendiamide and Lufenuron. Novaluron was the least toxic insecticide against 3rd and 4th instar larvae of *Plutella xylostella*. The order of toxicity was Spinosad > Emamectin benzoate > Chlorantriniliprole > Flubendiamide > Lufenuron > Novaluron. The LC_{50} values recorded were 0.00009 and 0.00011 for spinosad, 0.00016 and 0.00022 for Emamectin benzoate, 0.00076 and 0.00099 for Chlorantriniliprole, 0.00119 and 0.00148 for Flubendiamide, 0.00280 and 0.00284 for Lufenuron, 0.01557 and 0.01888 per cent for Novaluron, respectively against third and fourth instar larvae of *P. xylostella*.

***Corresponding author**

INTRODUCTION

Among vegetable crops, cruciferous (cole) crops are economically important throughout the world. Cabbage (*Brassica oleracea* var. *Capitata*) and cauliflower (*Brassica oleracea* var. *Botrytis*) assumes prime importance among cole crops while knol-khol, radish, mustard etc. occupies secondary position. More than 48.2 per cent of the area under this crop is contributed from Asian continent which accounts to 42.3 per cent of total world production. India is one of the important cabbage growing countries in Asia with an area of 369 thousand hectare and production of 7949 thousand metric tonnes with a productivity of 21.5 metric tonnes per hectare. India stands second in production of cabbage production whereas China stands first. Maharashtra is one of the cabbage growing states in India with an area of 18 thousand hectare and production of 360 thousand metric tonnes with productivity of 20 metric tonnes per hectare. (Anonymous, 2011).
Diamondback moth (*Plutella xylostella* Linnaeus), a cosmopolitan pest is a major defoliator which has threaten successful cultivation of crucifers in the world. Now the pest has been noticed all over India where Plant belonging to family Brassicaceae are grown (Devi *et al.*, 2004). This pest causes colossal loss to cabbage every year. It damages the crop by feeding on the foliage. Attack by a large number of larvae hinders the growth of the plant leading to significant reduction in yield. The infestation during the primordial stage of crop causes maximum yield loss within a very short period and needs immediately control of this pest. The crop loss is estimated to vary from 52 to 100 per cent and about one billion US dollar is spent annually for the management of this pest globally (Talekar, 1992). Due to various biochemical and behavioral mechanisms factors, it has developed resistance to virtually all insecticide groups and ranks in the top 20 most resistant insect species reported so far. Injudicious and indiscriminate use of insecticides makes some of most potent insecticides ineffective over time. The major concern in chemical control is the development of insecticidal resistance against most of the commonly used insecticides in the field. Although the present decade is witnessing an emphasis on integrated pest management (IPM) system, insecticides are the most common strategy to control *P. xylostella* on vegetable crops and farmers are always in need of new effective insecticides. Keeping this in view, the relative toxicity of some newer insecticides were evaluated under laboratory condition.

MATERIALS AND METHODS

Test Insect

The present investigation was undertaken on the evaluation of chemical insecticides against diamondback moth, *Plutella xylostella* (L.) on cabbage in the Department of Agricultural Entomology, MPKV, Rahuri during 2012-2013. *P. xylostella* was reared under laboratory conditions using mustard seedlings and cabbage leaves.

Larvae of diamondback moth were collected from infested field and maintained on tender cabbage leaves in laboratory under optimum light and dark requirement of 12:12 hrs and temperature 28 ± 4ºC. After pupation, pupae (30 per cage) were kept in a rearing cage (30 x 30 x 30 cm) size for emergence. Adult moths were provided with cotton swab dipped in honey and water solution (1: 9). Mustard seedlings grown in plastic cups (diameter 7 cm and height 4 cm) were used as ovipositional substrate. A day after emergence of adults, one mustard seedling (4-5 cm height) cup was kept inside the cage for egg collection. Eggs were laid on both the surfaces of the leaf and petiole. The neonates after hatching from eggs in 3-4 days feed initially by mining in to leaves. For second instar larvae, tender cabbage leaves with their petiole dipped in water in a glass vial, were provided as a food which was replenish daily. The larval stage lasts for 12 to 14 days and the pupation takes place on the leaf surface. The pupal period was about 5 to 7 days. For synchronized emergence, the pupae collected on different dates were stored in refrigerator and transferred to emergence cage on a particular day. For bioassay, laboratory reared first generation larvae (3rd and 4th instar) were used. Larvae of different instars weighing (mean ± S. E.m) 1.83 ± 0.28 and 4.15 ± 0.28 mg of third and fourth instars, respectively were used in bio-assay.

Preparation of insecticide solutions

Commercial formulations of insecticides were used for the laboratory bioassay. Insecticides tested were Flubendiamide 39.35 EC (Fame), Chlorantriniliprole18.5 SC (Coragen), Emamectin benzoate 5 SG (Proclaim), Spinosad 2.5 SC (Success), Novaluron 10 EC (Rimon) and Lufenuron 5.4 EC (Cigna). Serial dilutions as per cent of active ingredients of the test insecticides were prepared using distilled water.

Bioassays

Dose- Mortality response and relative toxicity of different insecticides to third and fourth instar larvae were evaluated by leaf- dip bioassay method. Leaf discs of 6 cm diameter were cut from fully expanded cabbage leaves. These leaf discs were treated with different concentrations of insecticides and were allowed to dry for half an hour in shade. 10 larvae pre starved for 6 hours were released on the treated leaf disc. Larvae were allowed to feed for 24 hours on the treated disc and after which fresh cabbage leaves were provided. For control, larvae were fed with leaves treated with distilled water. Each treatment was replicated four times. Observation on larval mortality was recorded upto 3 days after treatment at 24 hours interval.

Data Analysis

The data was subjected to Probit analysis (Finney, 1981) after correcting the per cent mortality data using Abbott's formula.

$$\text{Corrected mortality} = \frac{T - C}{100 - C} \times 100$$

Where,

T = per cent mortality in treatment

C = per cent mortality in control

Evaluation of relative toxicity of insecticides

The values of relative toxicity of different insecticides were calculated by formula,

$$\text{Relative Toxicity} = \frac{LC_{50} \text{ of less Toxic compound}}{LC_{50} \text{ of more Toxic compound}}$$

RESULTS

Relative toxicity of insecticides to 3rd instar larvae of *Plutella xylostella*

The data represented in table 1 shows the toxicity of different insecticides to 3rd instar larvae of *Plutella xylostella*. Maximum LC_{50} against 3rd instar larvae of p. xylostella was recorded in the treatment with Novaluron (0.00763 %) and was found to be the least toxic insecticide. Lowest LC_{50} (0.00009 %) was recorded for Spinosad, which implicates that Spinosad was the most toxic insecticide, followed by Emamectin benzoate (0.00016 %), Chlorantriniliprole (0.00076 %), Flubendiamide (0 .00119 %) and Lufenuron (0.01122 %). Based on LC_{50} values, the order of toxicity of these chemical insecticides against 3rd instar larvae of *P. xylostella* was Spinosad > Emamectin benzoate > Chlorantriniliprole > Flubendiamide > Lufenuron > Novaluron. The relative toxicity was calculated over Novaluron. It revealed that Spinosad was 84.78 times, Emamectin benzoate was 47.69 times, Chlorantaniliprole was 10.04 time, Flubendiamide was 6.41 times and Lufenuron was 2.73 times more toxic than Novaluron.

Relative toxicity of insecticides to 4th instar larvae of *Plutella xylostella*

The data represented in table 2. shows the toxicity of different insecticides to 4th instar larvae of *Plutella xylostella*. Maximum LC_{50} against 4th instar larvae of *p. xylostella* was recorded in the treatment with Novaluron (0.00944 %) and was found to be the least toxic insecticide. Lowest LC_{50} (0.00011 %) was recorded for Spinosad, and was the most toxic insecticide, followed by Emamectin benzoate (0.00022 %), Chlorantriniliprole (0.00099 %), Flubendiamide (0 .00148 %) and Lufenuron (0.00360 %). The order of toxicity was Spinosad > Emamectin benzoate > Chlorantriniliprole > Flubendiamide > Lufenuron > Novaluron. In case of relative toxicity, Spinosad was 85.82 times, Emamectin benzoate was 42.91 times, Chlorantaniliprole was 9.54 time, Flubendiamide was 6.38 times and Lufenuron was 2.62 times more toxic than Novaluron.

All the insecticide tested exhibited less LC_{50} for 3rd instar larva when compared to 4th instar. This indicates that 3rd instar larvae are more susceptible to the tested insecticides.

DISCUSSION

The lower LC_{50} values of spinosad for *P. xylostella* was reported earlier by Arora *et al.* (2003) and Maiti *et al.* (2007). Results of present investigations are also supported by Ranjbari *et al.* (2012) who reported higher toxicity of Spinosad to different instars of *Plutella xylostella* and suggested that spinosad could be an important agent in control of different larval instars of *P. xylostella*. Emamectin benzoate was also found to be more toxic to *P. xylostella* with lower LC_{50} value. These findings are in accordance with those of Gupta *et al.* (2008) who tested different insecticides against Plutella xylostella by leaf-dip bioassay. They reported that Emamectin benzoate (LC_{50} 0.0002 %) was the most toxic compound when compared to

Table 1: Relative toxicity of different insecticides to 3rd instar larvae of *P. xylostella*

Insecticides	LC_{50}(%)	Heterogeneity (÷ 2)*	Fiducial limits (%)	Regression equation	Relative toxicity
3rd Instar larvae of *Plutella xylostella*					
Spinosad 2.5 % SC	0.00009	0.22	0.00007 – 0.00012	y =3.1347 + 1.4592. x	84.78
Emamectin benzoate 5 % SG	0.00016	0.72	0.00012 – 0.00022	y = 3.2280+ 1.4474 x	47.69
Chlorantriniliprole 18.5 % SC	0.00076	0.22	0.00056 – 0.00010	y = 56.947 + 102.61 x	10.04
Flubendiamide 39.35 % SC	0.00119	1.43	0.00087 – 0.00161	y = 2.1766 + 1.3567 x	6.41
Lufenuron 5.4 % EC	0.00280	0.74	0.00211 – 0.00371	y = 1.2148 + 1.5433 x	2.73
Novaluron 10 % EC	0.00763	0.71	0.00563 – 0.01033	y = 0.9674 +1.4015 x	1

*In none of these cases, the data were found to be significant.

Table 2: Relative toxicity of different insecticides to 4th instar larvae of *P. xylostella*

Insecticides	LC_{50}(%)	Heterogeneity (÷ 2)*	Fiducial limits (%)	Regression equation	Relative toxicity
4th Instar larvae of *Plutella xylostella*					
Spinosad 2.5 % SC	0.00011	0.50	0.00008 – 0.00015	y = 3.3855 + 1.5104 x	85.82
Emamectin benzoate 5 % SG	0.00022	1.27	0.00016 – 0.00029	y = 3.0497 + 1.4628 x	42.91
Chlorantriniliprole 18.5 % SC	0.00099	0.38	0.00075 – 0.00131	y =1.8470 + 1.5848 x	9.54
Flubendiamide 39.35 % SC	0.00148	0.89	0.00112 – 0.00197	y = 1.5938 + 1.5709 x	6.38
Lufenuron 5.4 % EC	0.00360	0.31	0.00271 – 0.00479	y = 1.0884 + 1.5304 x	2.62
Novaluron 10 % EC	0.00944	0.50	0.00703 – 0.01266	y = 0.5152 +1.5091 x	1

*In none of these cases, the data were found to be significant.

other conventional insecticides. Silva *et al*. (2012) conducted laboratory bioassay of different insecticides against diamondback moth and showed that populations of this insect were highly susceptible to Chlorantraniliprole (LC_{50} 0.015 - 0.056 mg a.i. L^{-1} of water). Dhawan *et al*. (2007) reported the higher intrinsic toxicity of Emamectin benzoate, Flubendiamide and Chlorantaniliprole against *Spodoptera litura*. Jat and Ameta (2013) reported the effectiveness of Flubendaimide and Spinosad when tested against *Helicoverpa armigera* in tomato. The LC_{50} value of lufenuron found to be higher indicating its low toxicity to *P. xylostella*. Gadhiya *et al*. (2014) reported that Chlorantraniliprole, Spinosad and Emamectin benzoate were more effective and statistically at par with each other in protecting the groundnut crop from the infestation of *Helicoverpa armigera* and *Spodoptera litura*, whereas, Lufeneuron was poor in checking the incidence of *H. armigera* and *S. litura*. Novaluron was the least toxic compound on the basis of LC_{50}. But due to its mode of action as chitin synthesis inhibitor it shows sub-lethal effects. This result is supported by the results of Pramanik and Chatterjee (2004) reported that adult emergence of *P. xylostella* and *S. litura* was inhibited at 1250 ppm of novaluron in a laboratory study. Harish kumar *et al*. (2003) reported novaluron @ 0.75 ml L^{-1} to provide 90 per cent mortality of DBM larvae under laboratory condition. Present investigation suggests the potential of the novel insecticides against *Plutella xylostella*. Thus integration of these novel insecticides with novel modes of action in the insect pest management programme will certainly reduce the selection pressure in insect and thus help in increasing useful life of insecticide and delaying the development of resistance.

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