

## Toxicity of Pyriproxyfen against Tobacco Caterpillar, *Spodoptera litura* (Fabricius)



### Agriculture

**KEYWORDS :** Spodoptera litura, pyriproxyfen, toxicity

**Kamalpreet Kaur**

Department of Entomology, Punjab Agricultural University, Ludhiana 141 004, Punjab, India

**Anureet Kaur Chandi**

Department of Entomology, Punjab Agricultural University, Ludhiana 141 004, Punjab, India

### ABSTRACT

Second instar larvae of *Spodoptera litura* were exposed to seven different concentrations of pyriproxyfen using leaf-disc dip method of bioassay to estimate the toxicity. The exposure of the second instar larvae of *S. litura* to the leaf-discs treated with the highest concentration of 0.05 per cent of pyriproxyfen for 24 and 48 hours resulted in the 30 and 54 per cent mortality against 96 per cent mortality recorded when the test-larvae were allowed to feed on the pyriproxyfen-treated leaf discs for 72 hours. The LC<sub>30</sub> and LC<sub>50</sub> were worked out to be 0.018 and 0.025 per cent of pyriproxyfen, respectively. Due to low mammalian toxicity and safety to non-target organisms coupled with its physiological influences against *S. litura*, pyriproxyfen can prove to be an effective tool for the management of *S. litura*.

The tobacco caterpillar, *Spodoptera litura* (Fabricius), (Lepidoptera: Noctuidae) is an ubiquitous, polyphagous, multivoltine lepidopterous pest and widely distributed throughout the world including India, causing damage to more than 150 species of host plants especially cole crops (Amin & Salam 2003, Murugesan & Dhingara 1995). It has been reported attacking cauliflower, mash, moong, cabbage, soybean, sunflower, arm, castor and cotton (Xue et al., 2010). It causes economic losses to crops ranging from 25.8 to 100 per cent based on crop stage and its infestation level in the field (Dhir et al., 1992). It ranks among the top 20 most resistant insect species (Whalon et al., 2008). The first case of insecticide resistance to benzene hexachloride (BHC) in *S. litura* was reported in 1965 (Srivastava & Joshi 1965). Now it has become very challenging to manage due to its ability to develop resistance to many commonly used insecticides. One strategy to conserve efficacy of insecticides for the field control of various insect pests of crops is adding diversity to the insecticidal pool by introducing new molecules with novel modes of action. A new approach towards this step is use of Insect Growth Regulators (IGRs). IGRs are biorational insecticides with novel modes of action which disrupt the physiology and development of the target pest and safety against non-target organisms as compared to conventional insecticides (Gurr et al., 1999, Schneider et al., 2008). IGRs have been shown to cause numerous sublethal effects viz. larval-pupal intermediate, adultoids, increase/decrease in fecundity and developmental rate as well as changes in sex ratio, diapause and morphology (Croft, 1990). The IGRs can be classified into two categories i.e. the ones which effect the endocrine system and the other which inhibit the synthesis of chitin in insects; juvenile hormone analogues (JHAs) belonging to the first category and chitin synthesis inhibitors (CSIs) to the second one. Pyriproxyfen is a pyridine based juvenile hormone analogue i.e. 4-phenoxyphenyl (*RS*)-2-(2-pyridyloxy) propyl ether that was first registered in Japan in 1991 for controlling public health pests (Yokoyama & Miller 1991). It is a broad-spectrum insect growth regulator with insecticidal activity against agricultural, horticultural, and public health insect pests and much less toxic to our ecosystem (Korrat et al., 2012). Pyriproxyfen is a relatively stable compound with very low mammalian toxicity (Mohandass et al., 2006). Today, any successful control of insect pests demands a pool of insecticides with different chemistry and modes of action. Keeping this fact in view, it was planned to evaluate the toxicity of pyriproxyfen on *S. litura*.

### MATERIALS AND METHODS

#### Insecticide

Seven concentrations (0.05, 0.04, 0.03, 0.02, 0.01, 0.005 and 0.0025 per cent) prepared from commercial formulation of Pyriproxyfen 10 EC (Admiral 10 EC, Sumitomo Chemical Company)

### Insects and their rearing

The initial culture of *S. litura* was developed by collecting a large number of larvae from cabbage/cauliflower plants. The field collected larvae were reared on fresh cabbage leaves in a B.O.D incubator maintained at 26±1°C and 65±5 per cent relative humidity. The larvae were placed in glass jars (10 x 15 cm) and covered with a piece of muslin fastened with rubber bands around its rim. Leaves were changed daily. The mature larvae were transferred to battery jars containing sieved and sterilized sand layer of about 6 cm for pupation. The pupae were then collected and transferred into separate glass jars covered with muslin and secured with rubber bands and kept till the moth emerge. The emerging adults were sexed and transferred into separate battery jars. A cotton swap dipped in 10 per cent honey solution was hung from top of the muslin covering the mouth of the jars. The glassware used in the experiments was thoroughly washed in detergent, treated with 2 per cent formalin and then dried in an oven at 30°C for 8 hours to check microbial contamination in the insect culture.

### Leaf-disc dip bioassay method

The standard 'Leaf-disc dip' method of bioassay (Tabashnik & Chushing 1987) was employed to determine toxicity of pyriproxyfen against second instar larvae of *S. litura*. Leaf-discs (4.8 cm diameter) were cut from centre of the middle leaves of cauliflower plants. Each disc was dipped in a concentration of the insecticide for 10 seconds and then allowed to dry at room temperature for about one hour by hanging it with the help of clips. Control leaf-discs were similarly treated with distilled water. The leaf-discs were then shifted to plastic petri plates (5 cm dia.). Ten test-larvae (second instar larvae) were then transferred to each petri plate containing a treated leaf-disc. Preliminary bioassay was carried to determine toxic levels of the treatments and based on this; seven serial dilutions were prepared to work out the toxicity values i.e. LC<sub>30</sub> and LC<sub>50</sub>. There were five replications each comprising ten larvae for each concentration. The larvae were allowed to feed on treated leaf discs for 72 hours and were then shifted to untreated ones.

The observations for mortality were recorded after 24, 48 and 72 hours of exposure of larvae to the treated leaf-discs.

### Data analysis

Probit analysis on dose-mortality data to compute toxicity values. The log concentration-mortality regression was worked out by log probit technique (Finney, 1971) employing the computer programme POLO (Robertson et al., 1980).

## RESULTS AND DISCUSSION

The  $LC_{50}$  value for test-insecticide against second instar larvae of *S. litura* has been worked out. The larvae of *S. litura* were allowed to feed for 72 hours on the leaf-discs treated with 7 different concentrations of pyriproxyfen i.e. 0.05, 0.04, 0.03, 0.02, 0.01, 0.005 and 0.0025 per cent prepared by serial dilutions using water employing the standard leaf-disc dip method of bioassay. Fifty larvae (5 replications each comprising 10 larvae) were treated with each concentration of the insecticide. It is obvious from the perusal of data contained in Table 1 that exposure of the test larvae (second instar larvae of *S. litura*) to the leaf-discs treated with the highest concentration of 0.05 per cent of pyriproxyfen for 24 and 48 hours resulted in the 30 and 54 per cent mortality against 96 per cent mortality recorded when the test-larvae were allowed to feed on the pyriproxyfen-treated discs for 72 hours. Similar trend was also observed with the other lower concentrations where nearly double mortality was recorded when the exposure period was extended to 72 hours. The corrected mortality percentage of *S. litoralis* after 72 hours of exposure was 89 per cent at the 400 ppm concentration of pyriproxyfen.

Various toxicity values i.e.  $LC_{30}$  and  $LC_{50}$  of pyriproxyfen computed for second instar larvae of *S. litura* are given in Table 2. These values were based on record of mortality till 72 hours after exposure to the treated leaf-discs. The  $LC_{30}$  and  $LC_{50}$  were worked out to be 0.018 and 0.025 per cent of pyriproxyfen, respectively (Reda et al., 2013).

**Table 1 Mortality of second instar larvae of *S. litura* following treatment with pyriproxyfen**

Concentration (%)	No. of larvae treated	Number of Larvae dead after (hours)			Per cent mortality after (hours)		
		24	48	72	24	48	72
0.05	50	15	27	48	30.0	54.0	96.0
0.04	50	13	24	37	26.0	48.0	74.0
0.03	50	10	18	28	20.0	36.0	56.0
0.02	50	08	12	21	16.0	24.0	42.0
0.01	50	06	07	09	12.0	14.0	18.0
0.005	50	03	04	05	06.0	08.0	10.0
0.0025	50	02	02	03	04.0	04.0	06.0
Control	50	00	00	01	0.0	0.0	02.0
CD (p=0.05)		0.631	0.621	0.766	6.307	6.207	7.656

**Table 2. Computation of toxicity values of pyriproxyfen against second instar larvae of *S. litura***

Toxicity value (%)	Fiducial limits		Slope
	Lower limit	Upper limit	
$LC_{30} = 0.018$	0.006	0.024	3.598±0.664
$LC_{50} = 0.025$	0.014	0.031	3.598±0.664

Similar trend were also observed when 4<sup>th</sup> instar larvae of *S. litoralis* were treated with chlorfluazuron, tebufenozoid and pyriproxyfen, the  $LC_{50}$  values were recorded as 0.166, 0.353 and 756.19 ppm, under laboratory conditions (Aziza & Abdel 2012).

In other study, the  $LC_{50}$  of the insecticides viz., abamectin, emamectin benzoate, novaluron and lufenuron against *S. litura* was determined as 210.23, 102.12, 350.45 and 453.78 ppm, respectively (Sharma & Pathania 2014). This relates well with the inference of the present study where toxicity values were worked out to be 0.018 and 0.025 per cent of pyriproxyfen against second instar larvae of *S. litura*. These results were in accordance with the observations that the  $LC_{50}$  of novaluron and spinosad by leaf dip method against fifth instar larvae of *S. litura* were calculated as 0.019 and 0.025 per cent, respectively (Sheikh et al., 2011). In other study, the  $LC_{50}$  value of lufenuron, flufenexuron and triflururon against 2<sup>nd</sup> larval instar of *S. litoralis* were 0.02, 0.05 and 0.19 per cent. Similar trend were also observed against second instar larvae of *S. litura* under laboratory conditions using leaf dip method that the  $LC_{50}$  of emamectin benzoate, chlorfluazuron and flubendamide were recorded as 0.08 and 0.06, 73.4 and 52.5, and 0.37 and 0.31 µl/ml, respectively after 48 and 72 hour exposure (Sufian et al., 2013).

Pyriproxyfen also has been found effective against many other insect pest species. The  $LC_{30}$  and  $LC_{50}$  values of pyriproxyfen against third instar larvae of elm leaf beetle, *Xanthogaleruca luteola* (Muller) were estimated to be 133 and 343 ppm per larvae after 72 hours, respectively (Valizadeh & Jalali 2014). The  $LC_{50}$  values of pyriproxyfen for males and females of Obliquebanded Leafroller, *Choristoneura rosaceana* were 2.4 and 4.8 ppm, respectively against fifth-instar larvae, determined using leaf-discs bioassay (Sial & Brunner 2010). A laboratory study was conducted to evaluate the toxicity of two insect growth regulators, pyriproxyfen and buprofezin on the stable fly, *Stomoxys calcitrans* that the  $LC_{50}$  values of both IGRs were 0.002 and 18.92 ppm, respectively (Liu, 2003). Hence, due to low mammalian toxicity and safety to non-target organisms coupled with its physiological influences against *S. litura*, pyriproxyfen can prove to be an effective tool for the management of *S. litura*.

## REFERENCE

- Amin, A., and Salam, I. (2003). Factors stimulating the outbreaks of the cotton leafworm in Assuit Governorate. *Trends in Bioscience*, 6, 1420-1422.
- Aziza, E., & Abdel, A. (2012). Effect of three insect growth regulators (Chlorfluazuron, Tebofenozoid and pyriproxyfen) on fecundity of *S. littoralis*, histopathological and some biochemical aspects of moth ovary. *Egyptian Academia Journal of Biological Science*, 4, 49-59.
- Croft, B.A. (1990). *Arthropod Biological Control Agents and Pesticides*. Pp 723. John Wiley and Sons Inc. New York.
- Dhir, B.C., Mohapatra, H.R., & Senapati, B. (1992). Assessment of crop loss in groundnut due to *Spodoptera litura* Fab. (Tobacco caterpillar). *Indian Journal of Plant Protection*, 20, 215-217.
- Finney, D.J. (1971). *Probit Analysis*. Pp 333. Cambridge University Press, Cambridge.
- Gurr, G.M., Thwaite, W.G., & Nicol, H.I. (1999). Field evaluation of the effects of the insect growth regulator tebufenozide on entomophagous arthropods and pests of apples. *Australian Journal of Entomology*, 38, 135-140.
- Korrat, E.E.E., Abdelmonem, A.E., Helalia, A.A.R., & Khalifa, H.M.S. (2012). Toxicological study of some conventional and non-conventional insecticides and their mixtures against cotton leafworm, *Spodoptera littoralis* (Boisd.) (Lepidoptera: Noctuidae). *Annals of Agricultural Science*, 57, 145-152.
- Liu, J. (2003). Effects of a juvenile hormone analog, pyriproxyfen, on *Thrips tabaci* (Thysanoptera: Thripidae). *Pesticide Management Science*, 59, 904-912.
- Mohandass, S.M., Arthur, F.H., Zhu, K.Y. & Throne, J.E. (2006). Hy-droprene: mode of action current status in stored-product pest management, insect resistance and future prospects. *Crop Protection*, 9, 902-09.
- Murugesan, K., & Dhingara, S. (1995). Variability in resistance pattern of various groups of insecticides evaluated against *Spodoptera litura* (Fabricius) during a period spanning over three decades. *Journal of Entomology Research*, 19, 313-319.
- Reda, F.A.B., Mona, F.A.E., Nehad, M., El-barky, M.H., Hisham, M.E., & Abd, E.H. (2013). The activity of some detoxification enzymes in *Spodoptera littoralis* (Boisd.) larvae (Lepidoptera: Noctuidae) treated with two different insect growth regulators. *Egyptian Academia Journal of Biological Science*, 5, 19-27.
- Robertson, J.L., Russel, R.M., & Savin, N.E. (1980). *POLO: A User's Guide to Probit or Logit Analysis*. Pacific South-West Forest and Range Experiment Station, Berkeley, U.S.A.
- Scheinder, M.L., Smagghe, G., Pineda, S., & Vinuela, E. (2008). Studies on ecological impact of four IGR insecticides in adult *Hyposoter didymator* (Hymenoptera: Ichneumonidae) pharmacokinetics approach. *Exotoxicology*, 17, 181-188.
- Shaila O and Rao S R K (2013) Efficacy of Avermectins, chitin synthesis inhibitor and fungicides against *Spodoptera litura* and *Aspergillus flavus*. *Cent Eur J Exp Biol* 2: 1-6.
- Sharma, S.C., & Pathania, A. (2014). Susceptibility of tobacco caterpillar, *Spodoptera litura* (Fabricius) to some insecticides and biopesticides. *Indian J Sci Res Technol* 2: 24-30.
- Sheikh, I., Sayed, A., & Mohamed, M., (2011). Comparative effectiveness and field persistence of insect growth regulators on a field strain of the cotton leafworm, *Spodoptera littoralis*, (Boisd) (Lepidoptera: Noctuidae). *Crop Prot* 30: 645-50.
- Sial, A.A., & Brunner, J.F. (2010). Lethal and sublethal effects of an insect growth regulator, pyriproxyfen, on obliquebanded leaf roller (Lepidoptera: Tortricidae). *Journal of Economic Entomology* 103: 340-47.
- Srivastava, B.K., & Joshi, H.C. (1965). Occurrence of resistance to BHC in *Predenia litura* Fab. (Lepidoptera: Noctuidae). *Indian Journal of Entomology*, 27, 102-104.
- Sufian, S.B., Munir, A., Kamran, Y., & Muhammad, N. (2013). Pyrethroids and new chemistry insecticides mixtures against *Spodoptera litura* (Noctuidae: Lepidoptera) under laboratory conditions. *Asian Journal of Agricultural Biology*, 1, 45-50.
- Tabashnik, B.E., & Chushing, N.L. (1987). Leaf residue vs topical bioassay for assessing resistance in diamondback moth (Lepidoptera: Plutellidae). *FAO Plant Protection Bulletin*, 35, 11-14.
- Valizadeh, B., & Jalali, S.J. (2014). Sublethal effects of pyriproxyfen on some biological and biochemical properties of elm leaf beetle, *Xanthogaleruca luteola* (Coleoptera: Chrysomelidae). *Journal of Entomological Society Iran*, 33, 59-70.
- Whalon, M.E., Mota- Sanchez, D., & Hollingworth, G. (2008). *Global Pesticide Resistance in Arthropods*. pp 1-39. CAB International, UK.
- Xue, H., Pang, Y.H., Li, Q.L., & Liu, T.X. (2010). Effects of four host plants on susceptibility of *Spodoptera litura* larvae to five insecticides and activities of detoxification. *Nature*, 8, 118-121.
- Yokoyama, V.Y., & Millar, G.T. (1991). Potential of pyriproxyfen as a quarantine treatment for codling moth and oriental fruit moth (Lepidoptera: Tortricidae). *Journal of Economic Entomology*, 84, 942-947.