Relative toxicity of newer insecticide molecules against *Spodoptera litura*

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ABSTRACT

On the basis of $LC_{50,}$ the order of toxicity was chlorantraniliprole > emamectin benzoate > indoxacarb > spinosad > pyridalyl > fluendiamide > bifenthrin > koranda and > polytrinC with the relative toxicity of 37.75, 37.75, 3.28, 1.91, 1.61, 1.24, 1, 0.83, 0.68 by direct spray method. LC_{50} obtained by leaf-dip method revealed that chlorantraniliprole (0.0001) was most effective followed by emamectin benzoate (0.0002) and indoxacarb (0.0012). The order of relative toxicity was 203, 101, 16.9, 2.86, 1.97, 1.83, 1.6, and 1.4 for chlorantraniliprole, emamectin benzoate, indoxacarb, spinosad, koranda, pyridalyl, polytrin C and flubendamide, respectively. Thus, irrespective of bioassay methods, chlorantraniliprole, emamectin benzoate and indoxacarb were most toxic to Sonepat strain of *Spodoptera litura*.

Key words: Baseline toxicity, *Spodoptera litura*.

The cutworm, *Spodoptera litura* Fab is an important pest of numerous economic crops in India. Recently, an outbreak of this pest has been reported on soybean in Kota region of Rajasthan and Vidharba region of Maharastra caused greater yield loss. Since, the pest has shown resistance to most of the conventional insecticide, it is essential to monitor the field level susceptibility change to new molecules, which are currently in extensive usage. This information would be helpful to monitor and choose right insecticides and can be incorporated for developing sound management strategy for this notorious pest. Therefore, keeping these facts in view, the present study was aimed to determine the relative toxicity of these new molecules to the field collected strain of *S. litura*.

Materials and Methods

The larvae of *S. litura* were collected from Palari Khurad Village of Sonepat District of Haryna in cauliflower field during September 2012 and study was conducted with the subsequent generation (F_1) of the field collected sample of *S. litura.* At first, the field collected larvae were fed on sterilized (0.002 % sodium hypochlorite solution for 2 min.) castor leaves. After two days, the larvae were slowly transferred to kidney bean based artificial diet. The culture was maintained at ambient temperature of 27±1, 60-65 % RH and 12: 12hrs. light and dark. Seven day old (third-instar) larvae were taken for the bioassay.

The commercial formulations of emamectin benzoate 5% SG, polytrin C 44% EC (profenofos 40% + cypermethrin 4%) (Syngenta Crop Protection), spinosad 45% SC (De-Nocil India), flubendiamide 20% WG (Tata Chemicals), chlorantraniliprole 18.5% SC and indoxacarb 15.8 EC (DuPont), bifenthrin 10 % EC (FMC), pyridalyl (Sumitomo), and koranda (chlorpyrifos 50% + cypermethrin 5%) 505 EC (Rallis India) were used for the study.

Fifteen, third instar larvae (7-day old) of *S. litura* were selected randomly and placed in a Petri-dishes and 1 ml of each concentration of the test emulsions prepared with distilled water was directly sprayed at a pressure of 340 g cm^{-2} under a Potters spray tower. For each insecticide, a series of 5 to 6 concentrations were simultaneously tested to obtain the mortality response of test insect. The sprayed Petri-dishes containing larvae were dried for about 5 min. and transferred to fresh untreated castor leaves.

The 7-day old *S. litura* larvae were exposed to insecticide residue on castor leaves. The leaf discs of approximately 6 cm dia. were cut from the castor leaves and dipped in the respective concentrations of different insecticides for 20 seconds and air-dried and transferred to Petri-dish (11×9 cm). Five larvae for a plate were taken and maintained under laboratory conditions with three replications. Mortality was recorded 24hrs. after treatment. The moribund insects were counted as dead and mortality was corrected using Abbot's formula. LC_{50} was calculated according to Finney (1971) using the Software Indostat.

Results and Discussion

The larval mortality of *S. litura* population from Sonepat exposed to different concentrations of insecticides. LC_{50} and LC_{90} values were calculated to compare the toxicity of various insecticides. (Pandi *et al*., 2013). The chi-squares values indicated good fit of probit regression and heterogeneity was absent in tested populations of *S. litura*. LC_{50} values (expressed in percentage) for all tested insecticide by direct spray method of bioassay (Table 1). Among the nine insecticides, emamectin benzoate, chlorantraniliprole and indoxacarb were found most effective against *S. litura*. The insecticides polytrin C (mixture of profenophos + cypermethrin), koranda (mixture of chlorpyriphos + cypermethrin) and bifenthrin were less toxic as compared to emamectin benzoate. Relative toxicity value based LC_{50} of bifenthrin indicated that except polytrin C and koranda, all showed better toxicity. The emamectin benzoate and chlorantraniliprole were 37.75 time more toxic than bifenthrin. spinosad, flubendiamide, indoxacarb, and recorded 1.19, 1.24, 3.28 and 1.68 fold higher toxicity in comparison to bifenthrin, whereas, polytrin C and koranda exhibited less toxicity 0.38 and 0.83, respectively. Dhawan *et al*. (2007) tested the susceptibility of *S. litura* populations which were collected from cotton field of Abohar and Fazilka Blocks of Ferozepur, Punjab. The % LC_{50} values of emamectin benzoate, pyridalyl, flubendiamide and chlorantraniliprole were 0.0001, 0.0037, 0.0040 and 0.0044, respectively. Relatively, LC_{50} values were found to be less when compared with the results that indicated a slight tolerance in Sonepat population. The difference in lethal dose might be due to local variation, host plant and insecticide usage pattern. This differential response was also conferred by the enhanced actions of insecticide detoxification enzymes, Stanley *et al.* (2006) reported that spinosad 0.018 % was found to be better and was on par with emamectin benzoate against *S. litura*. Similar results were reported by Kumar *et al.* (2008). The result obtained from the present study was similar with the earlier report. Perhaps, a marked difference in LC_{50} value was obtained.

The results of LC_{90} illustrated that; chlorantraniliprole when used against *S. litura,* 23.33 fold higher toxic when compared to bifenthrin. The change in the order of toxicity observed while working out with LC_{90} values. The toxicity trend was chlorantraniliprole > emamectin benzoate > indoxacarb > spinosad > bifenthrin > fluendiamide > pyridalyl > polytrinC > koranda. This emphasized that chlorantraniliprole was highly toxic when LC_{90} values were considered. Chlorantraniliprole, a novel insecticide activates the unregulated release of internal calcium stores leading to calcium depletion, feeding cessation, muscle paralysis and finally insect death (Lahm *et al.,* 2005).

Response of *S. litura* to different insecticides by leaf dip method is given in the Table 2. Of the nine insecticides, chlorantraniliprole was most effective followed by emamectin benzoate and indoxacarb. The order of relative toxicity based on LC_{50} value was 203, 101, 16.9, 2.86, 1.97, 1.83, 1.6, and 1.4 for chlorantraniliprole, emamectin benzoate, indoxacarb, spinosad, koranda, pyridalyl, polytrin C and flubendiamide, respectively. A similar trend of relative toxicity also observed with LC_{90} value.

Irrespective of test methods, the insecticides chlorantraniliprole, emamectin benzoate and

Table 1. Relative toxicity of novel insecticides to Sonepat strain of *S.litura* by direct spray method.

Chemical	df	χ2	Regression equation	LC_{50} %	Fiducial Limit (95% CI)	Relative toxicity*	LC 90%	Fiducial Limit (95% CI)	Relative toxicity
Emamectin benzoate 5% SG	4	3.1251	Y=7.8399+0.8421659x	0.0004	0.0003 to 0.0006	37.75	0.0141	0.0057 to 0.0352	6.00
Spinosad 45% SC	4	8.1072	Y=7.8658+1.3623803x	0.0079	0.0065 to 0.0095	1.19	0.0688	0.0457 to 0.1034	1.23
Flubendiamide 20% WG	4	6.8766	Y=7.8569+1.4929536	0.0122	0.0103 to 0.0144	1.24	0.0881	0.0594 to 0.2501	0.96
Chlorantraniliprole 18.5% SC	4	5.6301	Y=9.6309+1.3694923x	0.0004	0.0003 to 0.0005	37.75	0.0036	0.0022 to 0.0060	23.50
Indoxacarb 15.8EC	4	9.0355	Y=7.8627+1.2235564x	0.0046	0.0037 to 0.0057	3.28	0.0510	0.0271 to 0.0960	1.66
Bifenthrin 10 % EC	4	8.3437	Y=8.1193+1.732868x	0.0151	0.0130 to 0.0175	1.00	0.0846	0.0580 to 0.1235	1.00
Pyridalyl	4	6.3502	Y=7.633+1.2998031x	0.0094	0.0077 to 0.0155	1.61	0.0913	0.0526 to 0.1586	0.93
Polytrin C	4	8.4673	Y=6.107+0.7891908x	0.0396	0.0252 to 0.0622	0.38	1.6655	0.3950 to 7.0219	0.05
Koranda	4	3.4372	Y=6.7018+0.9782098x	0.0182	0.0143 to 0.0232	0.83	0.3721	0.1701 to 0.8141	0.23

*Relative toxicity= LC_{50} orLC_{90} of bifenthrin/ LC_{50} orLC_{90} of respective insecticide.

Table 2. Relative toxicity of novel insecticides to Sonepat strain of *S. litura* by leaf dip method.

Chemical	df	χ2	Regression equation	LC_{50} %	Fiducial Limit (95% CI)	Relative toxicity*	LC 90%	Fiducial Limit (95% CI)	Relative toxicity
Emamectin benzoate5% SG	4	3.9612	Y=8.817+1.04632228x	0.0002	0.0002 to 0.0003	101.50	0.0038	0.0018 to 0.0079	106.24
Spinosad 45% SC	3	7.0663	Y=7.7297+1.2716043x	0.0071	0.0058 to 0.0088	2.86	0.0727	0.0376 to 0.1406	5.55
Flubendiamide 20% WG	4	5.9325	Y=6.6664+0.9064793x	0.0145	0.0111 to 0.0190	1.40	0.3765	0.1608 to 0.8813	1.07
Chlorantraniliprole 18.5% SC	4	6.3338	Y=9.9253+1.1860413x	0.0001	0.0001 to 0.0001	203.00	0.0008	0.0005 to 0.0013	504.63
Indoxacarb 15.8EC	3	4.8721	Y=10.944+2.0251175x	0.0012	0.0010 to 0.0013	16.92	0.0050	0.0038 to 0.0066	80.74
Bifenthrin 10 % EC	4	0.8201	Y=6.671+0.9877502x	0.0203	0.0153 to 0.0270	1.00	0.4037	0.1598 to 1.0197	1.00
Pyridalyl	4	4.3352	Y=6.7649+0.9033232x	0.0111	0.0085 to 0.0146	1.83	0.2919	0.1374 to 0.6204	1.38
Polytrin C	4	6.3896	Y=6.6469+0.8687701x	0.0127	0.0096 to 0.0169	1.60	0.3800	0.1800 to 0.8024	1.06
Koranda	4	4.8023	Y=6.6741+0.8417355x	0.0103	0.0077 to 0.0137	1.97	0.3420	0.1560 to 0.7494	1.18

*Relative toxicity= LC_{50} orLC_{90} of bifenthrin/ LC_{50} orLC_{90} of respective insecticide.

indoxacarb were found to be superior over other treatments. Emamectin benzoate, a novel semi-synthetic derivative of the natural product was found to be most toxic. Boomathi *et al*. (2006) investigated the relative toxicity of different insecticides against the population of *Helicoverpa armigera*. Results revealed that relative toxicity was found to be 2, 375, 1500 and 3750 for spinosad, pyridalyl, indoxacarb and emamectin benzoate, was relatively high when compared to chlorpyrifos. Eventhough the insecticide mixture such as polytrin C and koranda were capable of potentiating their toxicity, they were found to be less toxic in comparison with novel insecticides. Synergistic activity of benzol compounds and pyrethroids was observed when evaluated against *S. litura* by Shankarganesh *et al.* (2009). Hence, application of conventional insecticides along with new molecules and in rotation would sustain the pest susceptibility and would delay the resistance to various insecticides. *S. litura* exhibited high degree of resistance to chlorpyrifos, cypermethrin and profenophos due to indiscriminate use of conventional insecticides was earlier reported by Chalam *et al.* (2003); and Prasad *et al.* (2007); and Pande *et al.* (2008) in Guntur and Prakasm districts of Andhra Pradesh.

The study clearly demonstrated the susceptibility difference in the field strain of *S. litura* to various novel insecticides. Out of nine insecticides tested, chlorantraniliprole, emamectin benzoate and indoxacarb were most effective. LC_{50} value obtained from this study would serve ready rekconer for the selection of insecticides for field strain. The base line data could be useful for comparisons of relative toxicity and monitoring resistance in *S. litura*.

References

Boomathi, N., P. Sivasubramanian and S. Ragnraman (2006). Toxic effects of spinosad and its combination with other microbial insecticides against *Helicoverpa armigera*. *Ann. Pl. Protect. Sci.* **14**: 228-229.

Chalam, M.S.V., G. Ramachander Rao and Ch. Chinuabha (2003). Insecticide resistance and its management of cotton aphid in Gunter District. *Ann. Pl. Protec. Sci.* **11**: 228-231.

Dhawan, A.K., A. Kaur and R. Kumar (2007). Relative toxicity of new insecticides against *Spodoptera litura*. *Ann. Pl. Protect. Sci.* **15**: 238-239.

Lahm, G.P., T.P. Selby., J.H. Freudenberger, D. Cordova., L. Flexner., C.A. bellin., C.M. Dubas., B.K. Smith, K.A. Hughes, G.J. Hollingshaus., C.E. Clark and E.A. Benner (2005). Rynaxypyr: a new insecticide anthranilic diamide that acts as a potent and selective ryanodine receptor activator. *Bioorg. Med. Chem. Lett.* **17**: 6274-6279.

Pande, Rachna, Dhayaneshwar, M. Firake and S.R. Yadav (2008). Effect of NSKE with additive, synthetic and biopesticides against *Spilarctia obliqua* defoliators of soybean. *Ann. Pl. Protect. Sci.* 1**6**: 488-490.

Pandi, G.G.P., Bishwajeet Paul, Shah Vivek and K. Shankarganesh (2013). Relative toxicity of insecticides against coccinellid beetle. *Ann. Pl. Protect. Sci.* **21**: 17-20.

Prasad, K. Dharma, T. Madhumati, P. Arjuna Rao and V. Srinivas Rao (2007). Toxicity of insecticides to resistant strain of *Spodoptera litura* on cotton. *Ann. Pl. Protect. Sci.* **15**: 77-82.

Shankarganesh, K., S. Walia and S. Dhigra (2009). Insecticidal synergism of benzol-3 dioxole compounds on larval of Guntur population of *Spodoptera litura*. *Ann. Pl. Protect. Sci.* **17**: 293-298.

Stanley, J., S. Chandrasekharan, A. Regupathy and R. Sheeba Jasmine (2006). Base line toxicity of emamectin and spinosad in *Spodoptera litura*. *Ann. Pl. Protect. Sci.* **14**: 346-349