Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2020; 8(1): 1390-1392

Received: 04-11-2019
Accepted: 08-12-2019

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Bioefficacy of some insecticides against tobacco caterpillar, *Spodoptera litura* (Fabricius) under lab conditions

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Abstract
The bioefficacy of five insecticides *viz*. Fipronil, Indoxacarb, Flubendiamide, Spinosad and Lambda cyhalothrin were conducted under lab condition by leaf dip method to determine their stomach toxicity against *Spodoptera litura* and the results revealed that at 24 HAE (hours after exposure) Indoxacarb (LC_{50} = 0.22 ppm) was the most toxic whereas Lambda cyhalothrin (LC_{50} = 350 ppm) was the least toxic and the order of toxicity was: Indoxacarb > Fipronil > Spinosad > Lambda cyhalothrin. Similar trends were observed at 48 HAE where the order of toxicity was Indoxacarb > Flubendiamide > Fipronil > Spinosad > Lambda cyhalothrin. The LC values indicated that Indoxacarb was most toxic (LC_{30} = 0.052 ppm; LC_{50} = 0.096 ppm; LC_{90} = 0.43 ppm) closely followed by Flubendiamide (LC_{30} = 0.3 ppm; LC_{50} = 0.8 ppm; LC_{90} = 7.2 ppm) whereas the least toxic insecticide was Lambda cyhalothrin (LC_{50} = 225 ppm). A comparative dose mortality response indicated in terms of relative toxicity (RT) indicated that at 72 HAE, Indoxacarb (RT 50 = 2960) was still the most toxic insecticide followed by Fipronil (RT 50 = 30.94) and Lambda cyhalothrin (RT 50 = 1.00).

Keywords: Bioefficacy, some insecticides, tobacco caterpillar, *Spodoptera litura*

Introduction
Spodoptera litura (Fabricius) (Lepidoptera: Noctuidae) commonly known as tobacco caterpillar is a voracious feeder of agricultural crops and considered as a most destructive pest in South-east Asia [1, 2, 3]. It is one of the major insect pests of agricultural crops and is listed as of quarantine significance by EPPO (European and Mediterranean Plant Protection Organization), CPPC (Caribbean Plant Protection Commission), NAPPO (North American Plant Protection Organization) and OIRSA (International Regional Agency for Agricultural Health). The host range of *S. litura* covers at least 120 species [3]. They are believed to be generalized feeders, feeding almost all plant parts hence they have diversified host range [4, 5]. Among the main crop species attacked by *S. litura* in the tropics are *Colocasia esculenta*, cotton, flax, groundnuts, jute, castor, lucerne, maize, rice, soyabeans, tea, tobacco and many vegetables (for example *Brassica*, *Capsicum*, cucurbit vegetables, *Phaseolus*, potatoes, sweet potatoes and species of *Vigna*). Other hosts include ornamentals, wild plants, weeds and shade trees (for example, *Leucaena leucocephala*, and the shade tree of cocoa plantations in Indonesia). *S. litura* is totally polyphagous [6, 7, 8]. The pest is cosmopolitan having maximum influence in tropical and temperate Asia, Australasia and the Pacific Islands [9] and have huge potential to invade new areas and/or to adapt to new climatic and/or ecological situations. Talking about control, chemical insecticides holds major portion for this pest, which leads *Spodoptera litura* exposed to insecticide throughout the year, resulting in the rapid development of resistance [10] which creates the need of periodical testing of insecticides for their LC_{50} against this insatiable pest, so that the insecticides or their recommended doses can be upgraded as and when needed (resistance developed). Keeping in mind the above mentioned facts following experiments were performed.

Materials and Methods
Culture of test insects
The egg mass of *Spodoptera litura* as well as wild populations were collected from N.E Borlaug crop research centre and vicinity of the university campus from different crops like soybean and castor during August to October, 2017.

Furthermore, adult moths of *S. litura* were also traced and collected from different light sources of the hostel premises. The bioassay experiments were conducted at the IPM laboratory of Department of Entomology, GBPUA&T, and Pantnagar. The insect collected were exposed to control atmosphere of temperature 25-28 °C and RH 70—80%. The insects were reared exclusively on Castor in plastic tubs (dia. 36 cm, ht. 14 cm) covered with moist muslin clothes to maintain the RH and to avoid escape of the larva. Seven day old larvae were selected for the bioassay.

Test insecticides
Commercial grades of insecticides *viz.* Fipronil (Mahaveer sc 5%SC; Gharda Chemicals), Indoxacarb (Kingdoxa 14.5 % SL; Gharda Chemicals), Spinosad (Spinner 45% SC; Modern Insecticides Limited), Flubendiamide (Fame 39.35 SC; Bayer Crop Science) and Lambda cyhalothrin (Karate 5 EC; Syngenta Crop Protection) were procured from the local market to carry out the study.

Insecticide bioassay
Based on the findings of preliminary experiments, three concentrations each for all four test insecticides were in prepared in tap water and the experiment was conducted to determine the stomach toxicity of the test insecticides against seven days old larvae of *S. litura* by leaf dip method [11,12] under laboratory conditions (Temp. 27 C, R.H. 80%). Fresh castor leaves (5 x 5 sq. cm) were then dipped in respective dilutions of insecticide for three minutes; air dried and offered to the ten larvae, placed in the petriplates (dia. 9 cm, ht. 1.5 cm) in three replications. The larvae were fed with freshly treated leaves up to 3 days. The observations on morbidity and mortality were recorded at 6,12,24,48 and 72 hours after exposure, where the moribund insects were regarded as dead.

Statistical analysis
The mortality percentage in each replication was pooled and was corrected by Abbott's formula [13] as given below

$$\text{Abbott's corrected mortality (\%)} = \frac{T - C}{100 - C} \times 100$$

The LC_{50} and LT_{50} values were determined using probit analysis [14] based computer programme STPR-718.

Results and Discussions
Indoxacarb was the most toxic insecticide at 24 h after exposure (LC_{30} = 0.095 ppm; LC_{50} = 0.22 ppm; LC_{90} = 2.5 ppm) whereas Lambda cyhalothrin was the least toxic as per the LC_{30} (170 ppm) and LC_{50} (350 ppm) values but Spinosad was least toxic at LC_{90} (2900 ppm) (Table 1). The order of toxicities of the 5 insecticides by leaf dip method at LC_{50} was Indoxacarb > Fipronil > Spinosad > Lambda cyhalothrin (Table 1). The toxicity of Indoxacarb (LC_{50} values) varied from 0.22 ppm to 0.096 ppm after 48 h of exposure making it the most toxic insecticide closely followed by Flubendiamide (LC_{30} = 0.3 ppm; LC_{50} = 0.8 ppm; LC_{90} = 7.2 ppm) whereas the least toxic insecticide was Lambda cyhalothrin (LC_{50} = 225 ppm). The order of toxicity aftet 48 h of exposure was Indoxacarb > Flubendiamide > Fipronil > Spinosad > Lambda cyhalothrin (Table 2). Similar experiments were conducted by Ramanagouda and Srivastava [15] who compared the toxicities of five insecticides and reported Indoxacarb (LC_{50} = 15 ppm and 8 ppm at 24 h and 48 h, respectively) to be the most toxic among them. Fipronil, the phenyl pyrazole insecticide, blocks the GABA-regulated chloride channel and disrupts proper functioning of the central nervous system of insects [16]. The present study showed that the LC_{50} values of fipronil varied from 3.8 to 26 ppm from 24 h to 72 h after exposure which is in line with Ramanagouda and Srivastava 2009. On the other hand Spinosad being a natural insecticides is derrieved from the actinomycetes, *Saccharopolyspora spinosa* which acts on insect nicotine acetylcholine receptors site. It was seen that the toxicity of spinosad (LC_{50} = 206 and 300 ppm at 24 & 48 HAE, respectively) which corborrates the findings of Karppaiah *et al.* [17] who conducted a resistance study among *S. litura* populations of Delhi, Sonepatat and Varanasi and found the LC_{50} of Spinosad varied from 19 to 181 ppm. However, in the present study it was seen that toxicity of Spinosad comparatively lesser to the other insecticides except Lambda cyhalothrin (LC_{50} = 225 and 350 ppm at 24 & 48 HAE, respectively). At 72 h after exposure, the order of toxicity was Indoxacarb > Fipronil > Lambda cyhalothrin (Table 3), Indoxacarb still being the most toxic insecticide (LC_{30} = 0.026 ppm; LC_{50} = 0.050 ppm; LC_{90} = 0.26 ppm).

Table 1: Dosage-mortality responses of insecticides against 7 d old larvae of tobacco caterpillar by leaf dip method at 24 h after exposure

Insecticides (Trade name)	LC values ppm %)			Relative toxicity*			Chi square	Regression equation Y=a+bx	Fiducial limits at LC_{50} ppm (%)	
	LC_{30}	LC_{50}	LC_{90}	RT_{30}	RT_{50}	RT_{90}			Lower	Upper
Fipronil 5 SC (Mahaveer sc 5 SC)	15 (0.0015)	26 (0.0026)	110 (0.011)	11.3	13.46	26.36	0.493	Y = 1.9307 + 0.5892X	16(0.0016)	570 (0.057)
Spinosad (Spinner 45 SC)	100 (0.01)	300 (0.03)	2900 (0.29)	1.7	1.17	1	5.229	Y = 3.735 + 0.539X	214 (0.0214)	546 (0.0546)
Indoxacarb (Kingdoxa 14.5 SL)	0.095 (0.0000095)	0.22 (0.000022)	2.5 (0.00025)	1789.5	1590.9	1160	0.0465	Y = 3.194 + 0.3522X	0.12 (0.000012)	2.8 (0.00028)
Lamda cyhalothrin (Karate 5 EC)	170 (0.017)	350 (0.035	2140 (0.214)	1	1	1.35	3.13	Y= 3.8932 + 0.2982X	265 (0.0265)	589 (0.0589)

*Relative toxicity (RT) = LC value of least toxic insecticide/LC value of candidate insecticide

Table 2: Dosage-mortality responses of insecticides against 7 d old larvae of tobacco caterpillar by leaf dip method at 48 h after exposure

Insecticides (Trade name)	LC values ppm %)			Relative toxicity*			Chi square	Regression equation Y=a+bx	Fiducial limits at LC_{50} ppm (%)	
	LC_{30}	LC_{50}	LC_{90}	RT_{30}	RT_{50}	RT_{90}			Lower	Upper
Fipronil 5 SC (Mahaveer sc 5 SC)	5.4 (0.00054)	12 (0.0012)	95 (0.0095)	20.74	18.75	38.35	2.79	Y = 3.613 + 0.337X	7.7 (0.00077)	37 (0.0037)
Spinosad (Spinner 45 SC)	64 (0.0064)	206 (0.0206)	3644 (0.3644)	1.75	1.09	1	12.7	Y = 3.4798 + 0.4179X	99 (0.0099)	611 (0.0611)

Indoxacarb (Kingdoxa 14.5 SL)	0.052 (0.0000052)	0.096 (0.0000096)	0.43 (0.000043)	2153.8	2343.7	8474.4	0.92	Y = 3.3453 + 0.4564X	0.066 (0.0000066)	0.16 (0.000016)
Flubendiamide (Fame 39.35 SC)	0.3 (0.00003)	0.8 (0.00008)	7.2 (0.00072)	373.33	281.25	506.11	2.634	Y= 3.880 + 0.336X	0.47 (0.000047)	0.19 (0.000019)
Lamda cyhalothrin (Karate 5 EC)	112 (0.0112)	225 (0.0225)	1240 (0.124)	1	1	2.94	3.88	Y= 3.8932 + 0.2982X	154 (0.0154)	300 (0.03)

Table 3: Dosage-mortality responses of insecticides against 7 d old larvae of tobacco caterpillar by leaf dip method at 72 h after exposure

Insecticides (Trade name)	LC values ppm %)			Relative toxicity*			Chi square	Regression equation Y=a+bx	Fiducial limits at LC_{50} ppm (%)	
	LC_{30}	LC_{50}	LC_{90}	RT_{30}	RT_{50}	RT_{90}			Lower	Upper
Fipronil 5 SC (Mahaveer sc 5 SC)	1.6 (0.00016)	3.8 (0.00038)	32 (0.0032)	50	38.94	21.12	2.12	Y = 4.248 + 0.360X	1.1 (0.00011)	6.4 (0.00064)
Indoxacarb (Kingdoxa 14.5 SL)	0.026 (0.0000026)	0.050 (0.0000050)	0.26 (0.000026)	3076.9	2960	2600	1.58	Y = 3.8684 + 0.4522X	0.075 (0.0000075)	900 (0.090)
Lamda cyhalothrin (Karate 5 EC)	80 (0.008)	148 (0.0148)	676 (0.0676)	1	1	1	2.50	Y= 4.3848 + 0.368X	87 (0.0087)	195 (0.0195)

Conclusion

Insecticides have proved itself to be very successful in pest management. Hence, there is an over dependence on these chemicals now-a-days. Due to their excessive and indiscriminate use, there is an emerging problem of resistance within numerous insects. *S. litura* being one of the most cosmopolite pest, have also developed resistance to many insecticides. So it required on a regular basis to check the bioefficacy of these insecticides. From the current study it was seen that Indoxacarb and Flubendiamide were the most suited insecticide to manage *S. litura* whereas Spinosad which was once a popular insecticide had lost its toxicity which might be due to development of resistance among the population.

References

1. Waterhouse D, Norris K. *Spodoptera litura* (Fabricius). In: Biological Control: Pacific Prospects. ACIAR publication. Australian Centre for International Agricultural Research, Canberra, 1987, 250-259.
2. Ahmad M, Arif MI, Ahmad M. Occurrence of insecticide resistance in field populations of *Spodoptera litura* (Lepidoptera: Noctuidae) in Pakistan. Crop Protection. 2007; 26:809-817.
3. Ahmad M, Ghaffar A, Rafiq M. Host plants of leaf worm, *Spodoptera litura* (Fabricius) (Lepidoptera: Noctuidae) in Pakistan. Asian Journal of Agricultural Biology. 2013; 1:23-28.
4. Schoonhoven LM, Jermy T, van Loon JJA. Insect-Plant Biology: From Physiology to Evolution. 1st Edition. Chapman and Hall, London, 1998, 409.
5. Suomela J. Within-tree variability of mountain birch leaves causes variation in performance for *Epirrita autumnata* larvae. Vegetation. 1996; 127:77-83.
6. Brown ES, Dewhurst CF. The genus *Spodoptera* (Lepidoptera, Noctuidae) in Africa and the near east. Bulletin of entomological research. 1975; 65(2):221-262.
7. Holloway JD. The moths of Borneo: family Noctuidae, trifine subfamilies: Noctuinae, Heliothinae, Hadeninae, Acronictinae, Amphipyrinae, Agaristinae. Malayan Nature Journal. 1989; 42(2-3):57-228.
8. Armes NJ, Wightman JA, Jadhav DR and Rao GVR. Status of insecticide resistance in *Spodoptera litura* in Andhra Pradesh, India. Pesticide Science. 1997; 50:240-248.
9. Kranz J, Schmutterer H, Koch W. Diseases, pests, and weeds in tropical crops. Soil Science. 1978; 125(4):272.
10. Ahmad M, Saleem MA, Sayyed AH. Efficacy of insecticide mixtures against pyrethroids and organophosphates on resistant populations of *Spodoptera litura* (Lepidoptera: Noctuidae). Pest Management Science. 2009; 65:266-274.
11. Kodandaram MH, Dhingra S. Variation in the toxicity of organophosphate insecticides to field population of *Spodoptera litura*. Indian Journal of Plant Protection. 2007; 35:53-56.
12. Karuppaiah V, Srivastava C. Relative toxicity of newer insecticide molecules against *Spodoptera litura*. Annals of Plant Protection Science. 2013; 21(2):305-308.
13. Abbott WS. A method for computing the effectiveness of an insecticide. Journal of Economic Entomology. 1925; 18:265-267.
14. Finney JC. Probit analysis. Cambridge University Press, London, 1971, 333.
15. Ramanagouda SH, Srivastava RP. Bioefficacy of insecticides against tobacco caterpillar, *Spodoptera litura*. Indian Journal of Plant Protection. 2009; 37(1/2):14-19.
16. Simon-Delso N, Amaral-Rogers V, Belzunces LP, Bonmatin JM, Chagnon M, Downs C *et al*. Systemic insecticides (neonicotinoids and fipronil): trends, uses, mode of action and metabolites. Environmental Science and Pollution Research. 2015; 22(1):5-34.
17. Karuppaiah V, Srivastava C, Subramanian S. Toxicity and effectiveness of newer insecticides, conventional insecticides mixtures to field populations of *Spodoptera litura* (Noctuidae: Lepidoptera). Journal of Entomology and Zoological studies. 2017; 5(6):1893-1897.