Indian Journal of Entomology 84(3): 680-682 (2022) DoI No.: 10.55446/IJE.2021.283

TOXICITY OF SOME INSECTICIDES TO THE FALL ARMY WORM *SPODOPTERA FRUGIPERDA*

S Mastan Shareef*, T Madhumathi, M Swathi and A K Patibanda

Department of Entomology, Agricultural College, Bapatla 522101, Andhra Pradesh, India
*Email: mastanshareefsyed91@gmail.com (corresponding author)

ABSTRACT

A laboratory bioassay (topical application) was conducted to evaluate the relative toxicity of ten insecticides against third instar larvae of fall army worm, *Spodoptera frugiperda* (J E Smith). Emamectin benzoate was found to be the most toxic with least LC_{50} value (1 ppm). The order of toxicity was emamectin benzoate (1 ppm)> spinetoram (1.2 ppm)> chlorantraniliprole (1.8 ppm)> novaluron+ emamectin benzoate (7.7 ppm)> novaluron (18 ppm)> novaluron+ indoxacarb (31.7 ppm)> flubendiamide (33.8 ppm)> indoxacarb (42.3 ppm)> lambda-cyhalothrin (77.2 ppm)> chlorpyriphos (184.7 ppm). Emamectin benzoate, spinetoram, chlorantraniliprole, novaluron+ emamectin benzoate, novaluron, novaluron+ indoxacarb, flubendiamide, indoxacarb and lambda-cyhalothrin showed 184.70, 153.92, 102.61, 23.99, 10.26, 5.83, 5.46, 4.37 and 2.39 folds toxicity over chlorpyriphos, respectively at 72 hr after treatment.

Key words: *Spodoptera frugiperda*, bioassay, topical application, novaluron, emamectin benzoate, indoxacarb and spinetoram, relative toxicity, LC_{50}

Fall army worm (FAW) *Spodoptera frugiperda* (J E Smith) is an invasive pest, which was first reported from Karnataka, in maize fields during mid-May 2018 (Sharanabasappa et al., 2018a). Since then, it has spread to different southern states of India on maize (Mahadevaswamy et al., 2018; Sharanabasappa et al., 2018b). It is a severe polyphagous pest with a wide host range of 186 plant species including many economically important crops such as maize, sorghum, sugarcane, rice, wheat, cowpea, groundnut, potato, soybean and cotton (Casmuz et al., 2010). Adult moths can travel up to 500 km during a single season to seek out oviposition sites and can fly over 100 km for seeking the host plants. It is capable of causing 34% yield losses in maize. In America and Africa, insecticides are used widely for its management (Hardke et al., 2011; Gutierrez-Moreno et al., 2019; Sisay et al., 2020). The present study evaluates the toxicity of some new molecules with a different mode of action against *S. frugiperda* through laboratory bioassay.

MATERIALS AND METHODS

The present study was carried out under laboratory conditions during 2019-2020 at the Department of Entomology, College of Agriculture, Bapatla. The egg mass of *S. frugiperda* was collected from the maize fields of Agricultural College Farm, Bapatla and reared on maize leaves under laboratory condition until pupation (27±2˚C; 70±2% RH). The commercial formulations viz., emamectin benzoate (Proclaim 5 SG; Syngenta Private Limited), spinetoram (Largo 11.7SC; Dhanuka Agritech Limited), chlorantraniliprole (Coragen 18.5SC; DuPont India Private Limited), novaluron (Rimon 10EC; Gharda Chemicals Limited), lambdacyhalothrin (Karate 5EC; Syngenta Private Limited), flubendiamide (Fame 39.35SC; Bayer Crop Science Limited), novaluron+ indoxacarb (Plethora 5.25EC+ 4.5SC; Adama India Private limited), novaluron+ emamectin benzoate (Barazide 5.25EC+ 0.9SC; Adama India Private Limited), indoxacarb (Kingdoxa 14.5SC; Gharda Chemicals Limited) and chlorpyriphos (Lethal 20EC; Insecticides India Limited) were evaluated. The third instar larvae were used for bioassay with the topical application method. 10000 ppm stock solution of 100 ml was prepared for each insecticide by dissolving in distilled water. From this stock solution the desired concentration was prepared by serial dilution using distilled water as a solvent. Initially, a broad range of concentrations was tested and depending on the mortality narrow range were tested until larval mortality could be obtained to a range of 10 to 90%.

Ten 3rd instar larvae were used in each treatment and replicated thrice. 1µl of the insecticidal solution was applied on the thoracic dorsum of third instar larvae using Hamilton microsyringe and in control larvae were treated with distilled water only. A larva was considered dead if it could not turn itself right after being placed on its dorsal surface. The mortality at 72 hr after treatment was considered as the endpoint for the assessment of the toxicity and the corrected % mortality of larvae was calculated as per Abbott's (1925). Data on % corrected mortality was subjected to probit analysis (Finney, 1971) with SPSS (Statistical Package for Social Science) 21.0 version software. LC_{50}, LC_{75}, LC_{90}, heterogeneity (χ^2), intercept (a), slope of the regression line (b), regression equation and fiducial limits (at 95% C.L) were computed for each insecticide, and the relative toxicity was determined with the least toxic one taken as an unit.

RESULTS AND DISCUSSION

Among the ten insecticides evaluated against third instar larvae of *S. frugiperda* using topical application method, emamectin benzoate proved to be highly toxic to *S. frugiperda* with the least LC_{50} (1.0 ppm), LC_{75} (2.7 ppm) and LC_{90} (6.7 ppm) values followed by spinetoram, chlorantraniliprole, novaluron + emamectin benzoate, novaluron, novaluron + indoxacarb, flubendiamide, indoxacarb, lambdacyhalothrin and chlorpyriphos. The order of relative toxicity based on LC_{50}, LC_{75} and LC_{90} values in the descending order over chlorpyriphos was emamectin benzoate > spinetoram > chlorantraniliprole > novaluron + emamectin benzoate > novaluron > novaluron + indoxacarb > flubendiamide > indoxacarb > lambda-cyhalothrin (Table 1).

At 72 HAT, the LC_{50} value of emamectin benzoate was 1 ppm. The present findings are in agreement with observstions of Sharanabasappa et al. (2020) with second instar larvae of *S. frugiperda*; emamectin benzoate was the most toxic with LC_{50} value of 0.0051 ppm and novaluron was the least toxic with LC_{50} value of 0.061 ppm. Similarly, Dhawan et al. (2007) reported that emamectin benzoate was the most toxic against *S. litura*. Spinetoram also exerted toxicity with an LC_{50} value of 1.2 ppm and this corroborates with the the results of Sanjeevi Kumar and Muthukrishnan (2017) of spinetoram on third instar larvae of *Exelastis atomosa*. Karuppaiah et al. (2017) reported that chlorantraniliprole was found effective with LC_{50} values of 1-4 ppm against third instar larvae of *S. litura*. Dhawan et al. (2007) reported that novaluron was found effective against *S. litura* with an LC_{50} value of 0.0020%. At 72 HAT the LC_{50} value of novaluron + indoxacarb was 31.7 ppm and which is in agreement with the results of Patra et al. (2015) who evaluated the toxicity of novaluron + indoxacarb against third instar larvae of *Plutella xylostella.* Dhawan et al. (2007) found that the toxicity (LC_{50}) of flubendiamide was 0.0040%

Table 1. Relative toxicity of insecticides against 3rd instar larvae of *S. frugiperda* at 72 hr after treatment

Tr. No.	Insecticide	LC values (ppm)			Fiducial limits (ppm) (95% C. L)			Relative toxicity			Hetero-geneity (χ^2) d. f = 5	Slope (b) ± S. E	Regression equation (Y = a + bx)
		LC_{50}	LC_{75}	LC_{90}	LC_{50}	LC_{75}	LC_{90}	LC_{50}	LC_{75}	LC_{90}			
1	Emamectin benzoate	1.0	2.7	6.7	0.08-1.2	2.3-3.3	5.3-8.9	184.70	108.52	66.25	1.768	1.56±0.59	Y = 0.02+1.56x
2	Spinetoram	1.2	3.8	10.2	1.0-1.5	3.1-4.7	7.8-14.3	153.92	77.11	43.52	1.552	1.42±0.59	Y = 0.13+1.42x
3	Chlorantraniliprole	1.8	4.6	11.0	1.5-2.1	3.9-5.6	8.8-14.3	102.61	63.70	40.35	1.904	1.61±0.77	Y= 0.42+1.61x
4	Novaluron	18.0	33.8	59.8	16.1-20.0	30.1-38.6	51.2-72.1	10.26	8.67	7.42	0.380	2.45±0.21	Y = 3.07+2.45x
5	Lambda-cyhalothrin	77.2	132.0	213.7	70.2-84.6	119.3-148.3	186.1-253.9	2.39	2.22	2.08	1.332	2.80±0.39	Y = 5.30+2.80x
6	Flubendiamide	33.8	68.5	129.1	29.4-38.2	60.9-77.8	110.6-156.2	5.46	4.28	3.44	0.362	2.21±0.27	Y = 3.38+2.21x
7	Novaluron + Indoxacarb	31.7	56.0	93.4	28.7-34.9	56.0-62.8	81.7-109.0	5.83	5.23	4.75	0.113	2.72±0.27	Y = 4.09+2.72x
8	Novaluron + Emamectin benzoate	7.7	15.7	29.8	6.7-8.7	13.8-18.1	25.1-36.7	23.99	18.66	14.90	2.212	2.07±0.16	Y = 1.85+2.07x
9	Indoxacarb	42.3	72.4	117.3	38.3-46.4	60.0-80.1	104.0-135.5	4.37	4.05	3.78	1.949	2.87±0.33	Y = 4.67+2.87x
10	Chlorpyriphos	184.7	293.0	443.9	169.5-200.3	269.2-321.7	398.2-505.4	1.00	1.00	1.00	2.851	3.43±0.49	Y = 7.74+3.43x

LC_{50} = Concentration that confers 50% mortality (95% Confidence Intervals); LC_{75} = Concentration that confers 75% mortality (95% Confidence Intervals); LC_{90} = Concentration that confers 90% mortality (95% Confidence Intervals) against *S. litura*, whereas in the present study it is 33.8 ppm. The LC_{50} value at 72 HAT for indoxacarb was 42.3 ppm and a similar type of results was reported by Gupta et al. (2005) against *H. armigera.* Chlorpyriphos exerted the least toxicity with LC_{50} of 184.7 ppm and these results were in accordance with the reports of Mahesh et al. (2020) on *S. litura*.

ACKNOWLEDGEMENTS

The authors acknowledge the Acharya N G Ranga Agricultural University, Lam, Guntur for providing financial support. Authors thank the Agricultural College, Bapatla, for granting permission to publish the results.

REFERENCES

Abbott W S. 1925. A method of computing the effectiveness of an insecticide. Journal of Economic Entomology 18: 265-267.

Casmuz A, Juarez M L, Socias M G, Murua M G, Prieto S, Medina S. 2010. Review of the host plants of fall armyworm, *Spodoptera frugiperda* (Lepidoptera: Noctuidae). Revista de la Sociedade Entomologica Argentina 69(3&4): 209-231.

Dhawan A K, Sariika S, Bharati M, Kamaldeep S. 2007. Susceptibility of *Spodoptera litura* (Fabricius) to some novel insecticides. Pesticide Research Journal 19(2): 169-171.

Finney D J. 1971. Probit analysis (3rd edition). Cambridge University Press, Cambridge, UK. 333 p.

Gupta G P, Birah A, Raghuraman M. 2005. Relative toxicity of novel insecticides to american bollworm (*Helicoverpa armigera*). Indian Journal of Agricultural Sciences 75(4): 235-237.

Gutiérrez-Moreno R, Mota-Sanchez D, Blanco C, Whalon M, Terán H, Rodriguez C, DiFonzo C. 2019. Field evolved resistance of the fall armyworm (Lepidoptera: Noctuidae) to synthetic insecticides in Puerto Rico and Mexico. Journal of Economic Entomology 112(2): 792-802.

Hardke T J, Temple J H, Leonard B R, Ackson R J. 2011. Laboratory toxicity and field efficacy of selected insecticides against fall armyworm (Lepidoptera: Noctuidae). Florida Entomologist 94(2): 272-278.

Karuppaiah V, Srivastava C, Subramanian S. 2017. Toxicity and effectiveness of newer insecticides, conventional insecticides mixtures to field populations of *Spodoptera litura* (Noctuidae: Lepidoptera). Journal of Entomology and Zoology Studies 5(6): 1893-1897.

Mahadevaswamy H M, Asokan R, Kalleshwaraswamy C M, Sharanabasappa D, Prasad Y G, Maruthi M S, Shashank P R, Ibemu Ddevi N, Surakasula A, Adarsha S, Srinivas A, Rao S, Vidyasekhar, Shali R M, Shyam Sunder Reddy G, Nagesh S N. 2018. Prevalence of "R" strain and molecular diversity of fall armyworm, *Spodoptera frugiperda* (J E Smith) (Lepidoptera: Noctuidae) in India. 2018. Indian Journal of Entomology 80(3): 544-553.

Mahesh M, Sunitha V, Satyanarayana J, Singh T V K, Jagadeeshwar R. 2020. Relative toxicity of new insecticide molecules against field population of *Spodoptera litura* (Fab.). Journal of Entomology and Zoology Studies 8(1): 791-794.

Patra B, Das B C, Alam Sk F, Dhote V, Patra S, Chatterjee M L, Samanta A. 2015. Evaluation of new insecticides against diamondback moth, *Plutella xylostella* on red cabbage. International Journal of Bio-resource and Stress Management 6(2): 280-284.

Sanjeevi Kumar A, Muthukrishnan N. 2017. *In-vivo* and field evaluation of spinetoram 12 SC against *Exelastis atomosa* on pigeon pea. Journal of Entomology and Zoology Studies 5(6): 650-655.

Sharanabasappa D, Kalleshwaraswamy C M, Asokan R, Mahadeva Swamy H M, Maruthi M S, Pavithra H B, Hegde K, Navi S, Prabhu S T, Goergen G. 2018a. First report of the fall armyworm, *Spodoptera frugiperda* (J E Smith) (Lepidoptera: Noctuidae), an alien invasive pest on maize in India. Pest Mangement in Horticultural Ecosysytems 24: 23-29.

Sharanabasappa D, Kalleshwaraswamy C M, Maruthi M S, Pavithra H B. 2018b. Biology of invasive fall armyworm, *Spodoptera frugiperda* (J E Smith) (Lepidoptera: Noctuidae) on maize. Indian Journal of Entomology 80(3): 540-543.

Sharanabasappa D, Pavithra H B, Kalleshwaraswamy C M, Shivanna B K, Maruthi M S, Mota-Sanchez D. 2020. Field efficacy of insecticides for management of invasive fall armyworm, *Spodoptera frugiperda* (J E Smith) (Lepidoptera: Noctuidae) on maize in India. Florida Entomologist 103(2): 221-227.

Sisay B, Tadele T, Mulatu W, Gashawbeza A, Esayas M. 2020. The efficacy of selected synthetic insecticides and botanicals against Fall armyworm, *Spodoptera frugiperda*, in maize. Insects 10: 45.

(Manuscript Received: November, 2020; Revised: January, 2021;
Accepted: January, 2021; Online Published: May, 2021)
Online published (Preview) in www.entosocindia.org Ref. No. e20324