



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

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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) > chlorpyrifos (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 chlorpyrifos, 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 ($27\pm 2^\circ\text{C}$; $70\pm 2\%$ 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), lambda-cyhalothrin (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 chlorpyrifos (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. 1 μ l 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, lambda-cyhalothrin and chlorpyrifos. The order of relative toxicity based on LC_{50} , LC_{75} and LC_{90} values in the descending order over chlorpyrifos 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 observations 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 results of Sanjeevi Kumar and Muthukrishnan (2017) of spinetoram on third instar larvae of *E. 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 *P. xylostella*. Dhawan et al. (2007) found that the toxicity (LC_{50}) of flubendiamide was 0.0040% against *S. litura*, whereas

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 (95% C. L)			Relative toxicity			Heterogeneity (χ^2) d. f = 5	Slope (b) \pm 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 \pm 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 \pm 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 \pm 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 \pm 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 \pm 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 \pm 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 \pm 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 \pm 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 \pm 0.33	Y = 4.67+2.87x
10	Chlorpyrifos	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 \pm 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)

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*. Chlorpyrifos 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*.

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