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Short Communication

Toxicity of selected insecticides and biopesticides against *Spodoptera frugiperda* (J.E. Smith)

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Abstract

The toxicity of some insecticides and biopesticides evaluated against first instar larvae of *Spodoptera frugiperda* (J.E. Smith) revealed that emamectin benzoate 5 SG was the most effective (LC_{50} value being 0.052 ppm) followed by chlorantraniliprole 18.5 SC (0.646 ppm), spinetoram 11.7 SC (0.930 ppm), novaluron 5.25 + emamectin benzoate 0.9 SC (1.418 ppm), chlorantraniliprole 9.3 + lambda cyhalothrin 4.6 ZC (1.594 ppm), azadirachtin (2.217 ppm), *Bacillus thuringiensis* (3.5×10^7 cfu/g/L) and *Metarhizium anisopliae* (1.8×10^8 cfu/g/L). The order of relative toxicity of insecticides based on LC_{50} values in the descending order over chlorantraniliprole + lambda cyhalothrin was emamectin benzoate > chlorantraniliprole > spinetoram > novaluron + emamectin benzoate.

Key words: *Spodoptera frugiperda*, LC_{50}, emamectin benzoate, toxicity

Maize (*Zea mays* L.) is one of important cereal crops having wider adaptability under varied agroclimatic conditions. In India, it is grown on an area of 9.90 million hectare with production of 31.65 million tonnes and productivity of 3.20 t/ ha (Anonymous 2021a). In Himachal Pradesh, this crop occupies an area of 0.205 million hectare with production of 0.762 million tonnes and productivity of 3.71 t/ ha (Anonymous 2021b). Insect pests are the major bottleneck for the reduced productivity. As many as 141 insect pests cause a varying degree of damage from sowing to till harvest (Reddy and Trivedi, 2008).

Fall armyworm, *Spodoptera frugiperda* (J.E. Smith) is an exotic and one of the most destructive pest causing potential damage to maize in India. The incidence of fall armyworm as an invasive pest into Asia was first reported in India on maize crop during May 2018 (Sharanabasappa *et al*. 2018). In Himachal Pradesh, fall armyworm was first reported during 2019 by Ankita *et al*. (2020) and the incidence of fall armyworm (FAW) on maize crop was noticed in 2020 from various districts *viz*., Kangra, Bilaspur, Hamirpur, Una etc.

Fall armyworm larvae feed on all growth stages of maize but most frequently in the whorl of the young plants up to 45 days old crop. Ovipositional preference and larval behaviour of this pest within the host plants greatly reduces susceptibility to many insecticides. Adults deposit clusters of eggs throughout the plant canopy, but often prefer to oviposit in the whorls of maize plant. The early instars feed superficially, usually on the undersides of leaves. Feeding results in semi-transparent patches on the leaves called papery windows. Older instars begin to make holes in the leaf. Therefore, considering the ravaging nature of this pest, there is a need to study toxicity of insecticides and biopesticides against this pest to avoid the losses. Hence the present study was undertaken.

Toxicity of insecticides and biopesticides was evaluated against first instar larvae of *S. frugiperda* in the Department of Entomology, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur during 2022. Five working concentrations giving mortality between 20 and 80 per cent were prepared in distilled water. For each treatment, 10 larvae per replication were released into treated maize plant. An untreated control was also maintained by spraying the maize plants only with water. The mortality data were recorded at 24 hr in case of insecticides and after 72 hr in case of biopesticides. A larva was considered dead if it failed to move. Each treatment was replicated thrice. The corrected mortality was calculated as per Abbott (1925), and the data were subjected to probit analysis (Finney, 1977) and LC_{50} and LC_{90} values were calculated.

The mortality data of first instar larvae of *S. frugiperda* with treatments of insecticides and biopesticides are presented in Table 1. Chlorantraniliprole + lambda cyhalothrin concentration ranging from 0.437 to 7.000 ppm resulted in mortality of 10.7 to 89.3 per cent and LC_{50} and LC_{90} values were 1.594 and 7.891 ppm, respectively. Likewise, spinetoram concentration ranging from 0.225 to 3.600 ppm gave mortality of 13.8 to 86.2 per cent with the LC_{50} and LC_{90} values being 0.930 and 5.140 ppm, respectively. Chlorantraniliprole concentration ranging from 0.143 to 2.300 ppm gave mortality of 17.2 to 82.8 per cent and LC_{50} was 0.646 and LC_{90} was 4.451 ppm. Emamectin benzoate 0.016 to 0.250 ppm gave mortality of 17.2 to 89.7 per cent with LC_{50} and LC_{90} being 0.052 and 0.272 ppm. With novaluron + emamectin benzoate, there was 10.7 to 85.7% mortality at 0.362 to 5.800 ppm; LC_{50} and LC_{90} were 1.418 and 6.920 ppm. Mortality of 10.7 to 85.7 per cent was observed with 0.468 to 7.500 ppm concentration of azadirachtin, with LC_{50} and LC_{90} values being 2.217 and 9.806 ppm. Bt at a concentration range of 4.0×10^8 to 6.4×10^5 cfu/g/L gave mortality of 10.3 to 82.8%; and LC_{50} and LC_{90} values were 3.5×10^7 and 1.7×10^9, respectively. Mortality of 13.8 to 75.9 per cent was observed at 3.125×10^7 to 5.000×10^8 cfu/g/L concentration of *M. anisopliae*. The LC_{50} and LC_{90} values were 1.8×10^8 and 1.5×10^9 cfu/g/L.

The relative toxicity of insecticides against *S. frugiperda* revealed that the LC_{50} value varied from 0.052 to 1.594 ppm with the minimum and maximum corresponding to emamectin benzoate and chlorantraniliprole + lambda cyhalothrin, respectively (Table 2). LC_{90} values varied from 0.272 to 8.805 ppm with the minimum and maximum values corresponding to emamectin benzoate and novaluron

Table 1. Details of treatments evaluated against *S. frugiperda*

Treatment	Concentration range	Mortality range (%)
Chlorantraniliprole 9.3 % + Lambda cyhalothrin 4.6 % ZC	0.437 - 7.000 ppm	10.7 - 89.3
Spinetoram 11.7 % SC	0.225 - 3.600 ppm	13.8 - 86.2
Chlorantraniliprole 18.5% SC	0.143 - 2.300 ppm	17.2 - 82.8
Emamectin benzoate 5 % SG	0.016 - 0.250 ppm	17.2 - 89.7
Novaluron 5.25 %+ Emamectin benzoate 0.9 % SC	0.362 - 5.800 ppm	10.7 - 85.7
Azadirachtin 0.15 % EC	0.468 - 7.500 ppm	10.7 - 85.7
Bacillus thuringiensis 2×10^{11} cfu/g/L	4.0×10^8 - 6.4×10^5 cfu/g/L	10.3 - 82.8
Metarhizium anisopliae 2×10^8 cfu/g/L	3.125×10^7 - 5.000×10^8 cfu/g/L	13.8 - 75.9

Table 2. Relative toxicity of insecticides against first instar larvae of *S. frugiperda*

Treatment	LC_{50} (ppm)	Fiducial limits (ppm)	Relative Toxicity	LC_{90} (ppm)	Fiducial limits (ppm)	Relative toxicity
Chlorantraniliprole 9.3 + Lambda cyhalothrin 4.6 ZC	1.594	1.056 - 2.133	1.000	7.891	5.623 -10.159	1.115
Spinetoram 11.7 SC	0.930	0.602 - 1.258	1.713	5.140	3.465 - 6.744	1.379
Chlorantraniliprole 18.5 SC	0.646	0.383 - 0.909	2.467	4.451	2.672 - 6.231	1.299
Emamectin benzoate 5 SG	0.052	0.035 - 0.070	30.65	0.272	0.196 - 0.347	32.37
Novaluron 5.25% + Emamectin benzoate 0.9 SC	1.418	0.944 - 1.893	1.124	6.920	4.942 - 8.898	1.000

+ emamectin benzoate, respectively. The present findings are in close proximity with the results of Sharreef *et al*. (2022) who reported that emamectin benzoate was most toxic with least LC_{50} value (1ppm). Possible reason for higher value could be the third instar larvae that have been tested hence required higher dose for mortality. Deshmukh *et al*. (2020) studied intrinsic toxicity against FAW by leaf dip bioassay method and results revealed that LC_{50} values of emamectin benzoate (0.0051ppm), chlorantraniliprole (0.0159 ppm) and spinetoram (0.0411 ppm) were found to be very low. When compared to chlorantraniliprole + lambda cyhalothrin which was least toxic, emamectin benzoate was 30.65 times more toxic followed by chlorantraniliprole (2.467 times), spinetoram (1.713 times) and novaluron + emamectin benzoate (1.124 times).

Conclusion

From the present study, it was concluded that emamectin benzoate 5 SG proved to be highly toxic to first instar larvae of fall armyworm under laboratory conditions.

Conflict of interest: There is no conflict of interest in this research paper.

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