Insecticidal Efficiency of Some Pesticides Against *Spodoptera frugiperda* (J.E. Smith) (Noctuidae: Lepidoptera) Under Laboratory Conditions

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**ABSTRACT**

The "fall armyworm," also known as *Spodoptera frugiperda*, is a maize pest native to North America. It invaded Africa in 2019 and caused severe economic damage, forcing the continent's nations to take swift action to protect against this new invading pest. Various chemical insecticides were promoted in Egypt, but farmers quickly and repeatedly reported control failures. Fall armyworm samples were collected from five different maize-growing regions. Five widely available pesticide formulations, emamectin benzoate, chlorantraniliprole, indoxacarb, methomyl, and chlorpyriphos, were tested under laboratory conditions against the second and fourth instar larvae. The results demonstrated that *S. frugiperda* second-instar larvae were more vulnerable to all tested pesticides than fourth-instar larvae. Under laboratory circumstances, the LC50 values for the various substances were 0.090, 0.165, 0.243, 0.908, and 2.55 ppm, respectively. Furthermore, the insecticide emamectin benzoate was more effective than other pesticides. However, chlorpyriphos pesticide was the least harmful insecticide for controlling this bug. Further trials are required to determine how well these treatments perform against this pest.

**KEYWORDS**

Insecticidal bioefficacy, Emamectin benzoate, chlorantraniliprole, indoxacarb, methomyl, chlorpyriphos, *Spodoptera frugiperda*

**INTRODUCTION**

*Spodoptera frugiperda* (J.E. Smith), sometimes known as the fall armyworm (FAW), is a maize pest native to North America. It invaded Africa in 2019 and caused severe economic damage, forcing the continent's nations to take swift action to protect against this new invading pest. Various chemical insecticides were promoted in Egypt, but farmers quickly and repeatedly reported control failures. Fall armyworm samples were collected from five different maize-growing regions. Five widely available pesticide formulations, emamectin benzoate, chlorantraniliprole, indoxacarb, methomyl, and chlorpyriphos, were tested under laboratory conditions against the second and fourth instar larvae. The results demonstrated that *S. frugiperda* second-instar larvae were more vulnerable to all tested pesticides than fourth-instar larvae. Under laboratory circumstances, the LC50 values for the various substances were 0.090, 0.165, 0.243, 0.908, and 2.55 ppm, respectively. Furthermore, the insecticide emamectin benzoate was more effective than other pesticides. However, chlorpyriphos pesticide was the least harmful insecticide for controlling this bug. Further trials are required to determine how well these treatments perform against this pest.

Chemical pesticides are among the greatest sought-after control strategies for decreasing FAW numbers (Sharma et al., 2022). However, alternative management techniques are necessary since the pests under investigation have become resistant to various pesticides and because overusing pesticides can have detrimental impacts on the ecosystem and other benefits (Nagdy F. Abdel-Baky et al., 2019). Combining cultural approaches, biological control agents, and the proper use of efficient pesticides are all necessary for effective pest control of lepidopterous pests (Haddi et al., 2012; Kiran Bhural & Kamana Bhattrai, 2019).

The only effective method is Integrated Pest Management, which combines chemical, biological, physical, and agricultural controls (Cherif et al., 2018). In order to choose a suitable and successful pesticide and reduce pesticide expenses for farmers,
a laboratory bioassay was carried out to choose an effective insecticide for the FAW control.

METHODS

Insect Rearing:
The *S. frugiperda* autumn armyworms were cultured in a Plant Protection Research Institute Agriculture Research Center lab. The incubation period was kept constant at 25 °C, 60% RH, and a 14:10-h light: dark cycle. The larvae were raised on fresh castor leaves, and they were raised separately to prevent cannibalism in tiny cups (7 cm in diameter by 3.5 cm in height) filled with sawdust to cut down on moisture.

Tested Compound:
1- Speedo 60 gm/100L (emamectin benzoate 5.7%)
2- Coragen 30 cm/100L (chlorantraniliprole 20%)
3- Avaunt 25 gm 100L (indoxacarb 15%)
4- Lanate 100 gm/ 100L (methomyl)
5- Pestban 500 cm/100L (chlorpyriphos 48%)

Laboratory Bioassay:
The insecticidal activity of reference insecticides was measured via the leaf dip bioassay methods (Abdelhamid et al., 2019, 2022, 2023; Ali et al., 2022; Assefa & Ayalew, 2019; Bakhite et al., 2022; El-Gaby, Hussein, et al., 2023; Gad, Alqurashi, et al., 2023; Gad, Bakry, et al., 2023; Gad et al., 2021). The results of laboratory testing are reported here for the target compounds to determine the required concentrations demanded to kill 50% (LC50) of the second instar larvae and fourth instar larvae of *S. frugiperda* insects. In this work, five concentrations of each insecticide are used. Nearly the same size, 10 of second instar larvae and 5 of fourth instar larvae insects where put in disks (9 cm diameter) of castor bean leaves, which dipped in the tested concentration for 10 s, then left to dry and afforded to second and fourth instar larvae, nearly of the same size. The larvae were placed in glass jars (5 pounds), and every treatment was replicated three times (10 larvae per each). Control disks were dunked in distilled water then transferred to the untreated larvae, which were allowed to feed on castor beans for 48 h.

Mortality percentage was recovered after 72 h for all insecticides. Mortality was redressed by Abbott's formula (El-Gaby, Bakry, et al., 2023). The measurements of the mortality relapse line were dissected by probit analysis (Abbott, 1925). Harmfulness index was determined by sun equations (Wadley, 1952).

Sublethal Effects of Bioinsecticides:
The LC50 values of emamectin benzoate, Chlorantraniliprole, Indoxacarb, Methomyl, and Chlorpyriphos have applied to freshly moulted fourth instar *S. frugiperda* larvae. Each of the three replicates had ten larvae. Examine fresh castor bean leaves for any remaining larvae and note their lifespans, pupal lengths, percentages of pupation, and adult emergence rates.

RESULTS AND DISCUSSION

Insecticidal bio-efficacy screening under laboratory conditions.
All the target insecticidal compounds have been screened for insecticidal bioefficacy as explained as follows:

Toxicological activity test for nymphs of 2nd instar larvae of *S. frugiperda*.
The insecticidal test efficacy of emamectin benzoate, chlorantraniliprole, indoxacarb, methomyl, and chlorpyriphos under laboratory conditions against second instar larvae of *S. frugiperda* is shown in Table 1. The LC50 values were 0.090, 0.165, 0.243, 0.908, and 2.55 ppm for emamectin benzoate, chlorantraniliprole, indoxacarb, methomyl, and chlorpyriphos, respectively. In addition, each had slope values 0.425, 0.451, 0.505, 0.680, and 0.723 ppm demonstrating the homogeneity of the larvae, in which toxic ratio6 were 100, 45.54, 37.03, 9.91, and 3.52.

Results exhibited that emamectin benzoate was more toxic (LC50= 0.090 ppm) than the other formulations. The activity of emamectin benzoate was significantly high when second-instar larvae were treated with LC50 concentrations. These findings are consistent with those of Jansson et al. (1997) (Sun, 1950), who assessed the larval mortality of populations of *S. frugiperda* exposed to various insecticides and who discovered that *S. frugiperda* mortality was highest in populations exposed to (emamectin benzoate).

Table 1: Insecticidal effectiveness of emamectin benzoate, Chlorantraniliprole, Indoxacarb, Methomyl, and Chlorpyriphos as reference insecticides toward the second & fourth larvae instar of *S. frugiperda* under laboratory conditions

[https://doi.org/10.25077/aijent.1.01.16-22.2023](https://doi.org/10.25077/aijent.1.01.16-22.2023)
Comp. | 2nd instar larvae | 4th instar larvae |
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<tr>
<td></td>
<td>LC50 (ppm)</td>
<td>Slope</td>
</tr>
<tr>
<td>Emamectin benzoate</td>
<td>0.090</td>
<td>0.425±0.297</td>
</tr>
<tr>
<td>Chlorantraniliprole</td>
<td>0.165</td>
<td>0.451±0.292</td>
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<tr>
<td>Indoxacarb</td>
<td>0.243</td>
<td>0.505±0.296</td>
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<tr>
<td>Methomyl</td>
<td>0.908</td>
<td>0.680±0.296</td>
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<tr>
<td>Chlorpyriphos</td>
<td>2.555</td>
<td>0.723±0.273</td>
</tr>
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Notes: toxicity ratio is calculated as the ratio of the most effected LC50 value for baseline toxicity/the compounds’ LC50 value \( \times 100 \).

**Toxicological activity test for fourth instar larvae of S. frugiperda.**

Results of compounds emamectin benzoate, chlorantraniliprole, indoxacarb, methomyl, and chlorpyriphos were tested against fourth instar larvae of *S. frugiperda* under laboratory conditions are shown in Table 1. After 72h of treatment, bioefficacy results of compounds exhibit high to low toxicological activity in which LC50 values vary from 0.170 to 6.470 ppm. The value of LC50 for compounds emamectin benzoate, chlorantraniliprole, indoxacarb, methomyl, and chlorpyriphos under laboratory conditions were 0.170, 0.454, 0.878, 3.505, and 6.470 ppm, respectively. For this result, the toxicity of emamectin benzoate against fourth instar larvae of *S. frugiperda* was the most activity after 72 hrs of the test because the LC50 value of emamectin benzoate is 0.170 ppm.

Regular consumption of such insecticides in the field may lead to increased pest resistance, particularly FAW resistance (Jansson et al., n.d.), and create several problems, including environmental pollution and direct and indirect harm to humans (Osae et al., 2022). According to Abdel-Baky et al. (2019), emamectin benzoate pesticide 5.7% was the most potent insecticide against larval stages of *S. littoralis* on tomato leaves. Zhao et al. (2020) (Rizvi & Deole, 2022) mentioned that *S. frugiperda* is resistant to Lamdacyhalothrin since the pesticide is applied continuously in the maize field. The exposure period and dosage influence the death rate and toxicity of insects, including FAW. (Zhao et al., 2020)

**CONCLUSIONS**

The findings appeared that second instar larvae of *S. frugiperda* were more susceptible to the evaluated pesticides than fourth-instar larvae. Emamectin benzoate, chlorantraniliprole, indoxacarb, methomyl, and chlorpyriphos are five commercially available insecticide formulations we tested against the second and fourth instar larvae under laboratory and field conditions. Under laboratory conditions, LC50 values for compounds were 0.090, 0.165, 0.243, 0.908, and 2.55 ppm, respectively. Additionally, Emamectin benzoate pesticide was more effective than other pesticides.

However, the least dangerous insecticide for reducing this pest was chlorpyriphos pesticide. Several studies are necessary to understand how well these treatments work against this pest.
Figure 1. Insecticidal activity of compounds Emamectin benzoate, Chlorantraniliprole, Indoxacarb, Methomyl, and Chlorpyriphos as reference insecticide against the 2nd and 4th larvae of S. frugiperda under laboratory conditions.

Figure 2: Emamectin benzoate, Chlorantraniliprole, Indoxacarb, Methomyl, and Chlorpyriphos as reference insecticides against the second and fourth larvae of S. frugiperda under laboratory conditions. Note: (1) for 2nd instar larvae and (2) for 4th instar larvae.
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REFERENCES


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