



## EFFICACY OF AMPLIGO AND CYPERFOS AGAINST FALL ARMY WORM *SPODOPTERA FRUGIPERDA* (J E SMITH) LARVAE

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### ABSTRACT

A laboratory study was conducted to determine the efficacy of Ampligo and Cyperfos insecticides at three concentrations each against fall army worm *Spodoptera frugiperda* (JE Smith) larvae on maize. Using three concentrations of Ampligo: 0.13, 0.23 and 0.3 ml/l water and Cyperfos 0.5, 1.0 and 1.5 ml/l water bioassays were conducted with third instar larvae at 30°C ± 5°C. Each treatment was replicated three times. The toxic effect was evaluated at 24, 48 and 72 hr following insecticides application. The results showed that both insecticides caused over 50% mortality; Ampligo caused 100% mortality at both recommended and higher concentrations in 48 hr similar to the higher concentration of Cyperfos. At 72 hr, 100% mortality was achieved by both Ampligo (lower concentration) and Cyperfos (recommended concentration); while Cyperfos lower concentration achieved 88.9% mortality. Ampligo outperformed Cyperfos in terms of overall effectiveness with time. This study found that Ampligo and Cyperfos can be used to effectively control *S. frugiperda* in Botswana.

**Key words:** Ampligo, cyperfos, chlorantraniliprole, lambdacyhalothrin, chlorpyrifos, cypermethrin, concentration, bioassay, *Spodoptera frugiperda*, efficacy, maize, mortality

The fall army worm *Spodoptera frugiperda* (J E Smith) (Lepidoptera: Noctuidae) is a devastating primary pest of maize (Mukanga, 2024; Guimapi et al., 2022). *S. frugiperda* is polyphagous and is documented to feed on crops including cabbage, sorghum, and groundnut (Ojumoola & Omoloye, 2023; Osae et al., 2022). *S. frugiperda* larvae primarily feed on maize leaves, whorls, tassels and kernels. The moths' dispersal capability, diverse host range, and lack of diapause make them difficult to manage (Anjorin et al., 2022). Weather conditions prevalent in Africa, and the perennial availability of host plants are favourable for *S. frugiperda* outbreaks (Osae et al., 2022). In the absence of appropriate control measures, *S. frugiperda* is capable of inflicting 100% yield loss (Kumar et al., 2022). It has been documented to cause yield losses of 8 to 20 mt in Africa alone (ICIPE, 2020). Insecticides are widely used as a main control method (Mukanga et al., 2024; FAO, 2022), but *S. frugiperda* continues to inflict substantial damage (Ojumoola and Omoloye, 2023; Joo and Hussein, 2023). Overreliance on insecticides can pose risks to human health, environmental contamination, biodiversity loss, and resistance development (Lykogianni et al., 2021). This presents a challenge to its effective management. Ampligo (a

binary formulation with 100 g/l chlorantraniliprole + 50 g/l lambda-cyhalothrin, and Cyperfos (40 g/l cypermethrin + 400 g/l chlorpyrifos) are among the most commonly used in Botswana. This study evaluated the efficacy of Ampligo and Cyperfos insecticides against *S. frugiperda* on maize in the laboratory in Botswana.

### MATERIALS AND METHODS

The bioassay was carried out in the Entomology Laboratory at the Botswana University of Agriculture and Natural Resources (BUAN) in Sebele (24°35'29.04" S, 25°56'29.40" E; 998 masl). Eggs from an unsprayed maize field (24°57'09.20" S, 26°03'62.70") in Kgatleng District were used to raise larvae, which were then kept in a controlled laboratory environment at room temperature, 80% RH, and a 12:12 (L:D) cycle. Maize (SC-506) was sown on 25 m<sup>2</sup> plot for leaf production, following standard agronomic practices. The two insecticides, tested at three concentrations include Ampligo at 0.13 ml/l, 0.23 ml/l and 0.3 ml/l water and Cyperfos at 0.5 ml/l, 1.0 ml/l and 1.5 ml/l water, following Legwaila et al. (2021). Control treatments used distilled water. Three 16 cm<sup>2</sup> untreated maize leaf discs were dipped in test solutions for 10 sec, air-dried

for 120 sec, and placed in rectangular ventilated plastic boxes (5 x 20 x 13.5 cm) with moistened paper towels. Three third-instar larvae were added/ box. Tests were maintained in a laminar flow cabinet and replicated three times. Each leaf disc was observed at 24, 48 and 72 hr post-treatment under a binocular microscope and the trial was repeated two times. Larvae that were unresponsive to gentle prodding with a camel - hair brush were recorded as dead. Mortality was expressed as a % and corrected using Abbott's formula (1925). Control mortality was also recorded. Microsoft Excel (Version 2504) was used for data entry. Mortality of larvae was subjected to ANOVA and means were separated using the Tukey's Honestly Significant Difference test at  $p=0.05$  (Zar, 1984) on SAS (version 9.4).

## RESULTS AND DISCUSSION

Table 1 shows the effect of insecticide concentrations on *S. frugiperda* larval mortality following different durations of exposure. At each exposure period, there was a significant difference ( $p < 0.05$ ) in the effect of the insecticides on *S. frugiperda* larval mortalities in comparison to the untreated control. No larval mortality was recorded in the untreated control throughout the duration of the bioassay. At 24 hrs following treatment the larval mortality ranged from 22.22 – 44.44% and 11.11% - 44.44% for Ampligo and Cyperfos concentrations, respectively. The recommended application rates of Ampligo and Cyperfos achieved 33.33% and 22.22% mortality, respectively during this exposure period. Ampligo at the recommended rate (0.23 ml/ l) resulted in 100% larval mortality after 48 hrs, whereas Cyperfos (1.0 ml/ L) caused 88.89%, and the difference was not statistically significant ( $F_{(13, 22)} = 24.35$ ;  $P < 0.0001$ ). Similarly, there was no significant difference ( $F_{(13, 22)} = 71.92$ ;  $P < 0.0001$ ) between the recommended and highest concentrations of Ampligo at 48 hrs, with both achieving 100% mortality. Ampligo at lowest concentration achieved 100% mortality at 72

hr, while the lowest concentration of Cyperfos achieved 88.89%, which was not significantly different ( $F_{(13, 22)} = 24.35$ ;  $P < 0.0001$ ). The results showed that Ampligo and Cyperfos insecticides were toxic and caused significant mortality to *S. frugiperda* third instar larvae, but their effectiveness varied with time. The toxic effect of both insecticides increased with increasing durations of exposure, suggesting that lower concentrations can be used provided long exposure periods are allowed. The study highlighted Ampligo's rapid activity which could be due to its mode of action. Ampligo contains chlorantraniliprole and lambda-cyhalothrin. Both active ingredients cause paralysis in insects entirely by different means: chlorantraniliprole triggers excessive calcium release through ryanodine receptors in insect muscles, while lambda-cyhalothrin disrupts normal sodium channels activity in the nervous system, causing paralysis and death in insects (Zhu et al., 2022). This difference in mode of action explained the rapid efficacy of Ampligo, thus, contributing to resistance management. The results of this study align with those of previous research. In India for example, Altaf et al. (2022) found that *S. frugiperda* mortality increased over time, with recommended dose of Ampligo causing high mortality within short durations of exposure. Mumtaz et al. (2023) found that insecticides containing chlorantraniliprole, lambda-cyhalothrin, and chlorpyrifos achieved very high mortalities of *S. frugiperda* over short durations of exposure. In Africa, application of excessive amounts of insecticide poses the risk of resistance development, environmental pollution and human poisoning (Prasanna et al., 2022). The study therefore suggest the use of lower concentrations of Ampligo and higher concentrations of Cyperfos together with other control options for the sustainable management of Fall Armyworm in Botswana.

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Table 1. Effect of insecticide concentrations on *S. frugiperda* larval mortality

| Ampligo    |                |               |             | Cyperfos  |               |               |               |
|------------|----------------|---------------|-------------|-----------|---------------|---------------|---------------|
| Conc.      | Means± SE      |               |             | Conc.     | Means± SE     |               |               |
|            | 24 hr          | 48 hr         | 72 hr       |           | 24 hr         | 48 hr         | 72 hr         |
| Control    | 0.00± 0.00D    | 0.00± 0.00D   | 0.00± 0.00D | Control   | 0.00± 0.00C   | 0.00± 0.00C   | 0.00± 0.00C   |
| 0.13 ml/ l | 22.22± 4.08CD  | 66.67± 0.00B  | 100± 0.00A  | 0.5 ml/ l | 11.11± 5.77BC | 44.44± 2.89B  | 88.89± 2.04A  |
| 0.23 ml/ l | 33.33± 0.00C   | 100.00± 0.00A | 100± 0.00A  | 1.0 ml/ l | 22.22± 4.08BC | 88.89± 2.04A  | 100.00± 0.00A |
| 0.3ml/ l   | 44.44± 19.25BC | 100± 0.00A    | 100± 0.00A  | 1.5 ml/ l | 44.44± 2.89A  | 100.00± 0.00A | 100.00± 0.00A |

Means in column followed by same letters not significantly different (Tukey's Honestly significant difference test ( $p < 0.05$ ))

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#### AUTHOR CONTRIBUTION STATEMENT

GAS and AAO conceived and designed the experiments. GAS and MML analysed the data. GAS wrote the first draft of the manuscript. GAS, BT and MML contributed to the writing of the manuscript. GAS, BT, AAO and MML agreed with the manuscript results and conclusions. GAS, BT and MML made critical revisions and approved final version. All authors reviewed and approved of the final manuscript.

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#### CONFLICT OF INTERESTS

No conflict of interest.

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