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Toxicity of Insecticides against Second Instar Larvae of *Spodoptera frugiperda* Under Controlled Conditions

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ABSTRACT

Fall armyworm (Spodoptera frugiperda) attacks maize plants at all stages of development, from seedling to tasseling, causing defoliation, killing the young plant, causing grain damage, and reducing yield quantity and quality. The current study was conducted to check the toxicity of two insecticides, i.e. Emamectin benzoate and Lufenuron on 2nd instar larvae of Spodoptera frugiperda under laboratory conditions. The data showed that emamectin benzoate was more toxic insecticide than lufenuron. Emamectin benzoate required the least time to kill the 50% population than lufenuron. Lufenuron has recorded the least toxic insecticide and required a maximum time of 43 h to kill 50% of exposed insects. Fiducial (FL) values of both insecticides were non-significant to each other. The results can help future scientists. Further studies are needed to control this pest on maize crops in field and laboratory conditions.

Keywords: *Maize; Spodoptera frugiperda; Polyphagous pest; Insecticide toxicity; Control conditions.*

INTRODUCTION

The fall armyworm, *Spodoptera frugiperda*, belongs to the order Lepidoptera and the family Noctuidae. It is a destructive pest to several crops, especially maize. This pest has been distributed in America, Ethiopia; Africa (Goergen et al., 2016; & Stokstad, 2017), India (Sharanabasappa et al., 2018), Pakistan (Naeem-Ullah et al., 2019), Thailand, China, Bangladesh, Myanmar (Guo et al., 2018), and many other countries (Prasanna et al., 2018; & Ramzan et al., 2021). Many host plants of this pest have been reported around the globe, such as rice, maize, onion, potato, millet, cotton, cabbage, tomato, sorghum, soybean, beet, sugarcane etc. (Casmuz et al., 2010; & Kumela et al., 2019). *S. frugiperda* can cause up to 60 per cent crop losses and damage started at an early stage of crops. Cruz, (2008), Ahmad et al. (2021), and Cruz et al. (2013) had reported that pest attack on both stages of crop such as reproductive and vegetative stages.

Many control strategies are adopted to control insect pests on various agricultural and horticultural crops worldwide.

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The chemicals (insecticides) are widely used to control *Spodoptera frugiperda* on crops in several countries which cause not only environmental pollution but also insecticides resistance to insect pests and kill biological fauna such as predators, parasitoids and pest parasites (Michelotto et al., 2017; Wang et al., 2018; & Ahmad et al., 2018). The current research was conducted to evaluate the toxicity of insecticides against second instar larvae of *S. frugiperda* under controlled conditions.

MATERIALS AND METHODS

Larvae of different stages were collected from different areas of Faisalabad and reared at the Entomology laboratory at the University of Agriculture Faisalabad in 2021. Collected larvae were kept individually in Petri dishes with leaves of maize for food. Food was changed on a daily basis even larvae reached to pupation. The pupae were collected and transferred into plastic containers. Three pairs of emerged adults were shifted into adult rearing cage and given 10% honey solution for feeding. Tissue paper was installed inside the cage for egg lying. Eggs were collected and kept into perti dishes individually. The second generations equal size 2nd instar larvae were collected and used in the bioassay study. Two insecticides (Commercial formulations of different insecticides used for bioassays comprised emamectin benzoate (Proclaim 1.9EC, Syngenta, Pakistan), and lufenuron (Match 05EC, Syngenta, Pakistan) was tested to check their toxicity on 2nd instar larvae of *S. frugiperda*. The leaf dip method was used to calculate the LC_{50} and LT_{50} values. The maize leaves were detached from different plants, brought to the laboratory, and washed with running water. After drying, leaves were cut into 5 x 5 sq. cm and dipped in respective dilutions of insecticide for 20 seconds, then air dried for half an hour. After drying, one leaf disc was placed into Petri dishes and one larva pe petri dish released. There were three replications. Data was recorded at 24, 48, and 72 hours after exposure. Data were statistically analyzed by using probit analysis.

RESULTS AND DISCUSSION

Maize (*Zea mays*), which belongs to the grass family Poaceae, is the most significant cereal crop after wheat and rice in the world. It is called the "Queen of cereals" (Jeyaraman, 2017) globally. This crop is a rich source of vitamins, minerals, carbohydrates, protein, lipids etc. The production of maize is decreasing nowadays due to various biotic and abiotic factors such as insect pests and environmental factors. *S. frugiperda* is a cosmopolitan pest of several horticultural and agricultural crops worldwide. Maize is the most preferable host plant of this pest in the world as reported by many scientists (Poornima & Patil, 2018; De Groote et al., 2020; & Ramzan et al., 2021). All maize parts such as stem, leaves, cobs, and whorls are eaten by each instar of *S. frugiperda* (Trisyono et al., 2019).

The current study was conducted to check the toxicity of two insecticides against 2nd instar larvae of *S. frugiperda*. The data showed that mortality depends on the dose of insecticides. The mortality percentage increased with the increase in chemical concentration. Both, the slopes of the regression lines and the lethal concentration values were significantly different to each other. It was recorded that emamectin benzoate was most toxic insecticide than lufenuron as given in table 1. The time-mortality response of both tested insecticides was calculated. It was observed that emamectin benzoate required the least time to kill the 50% population than lufenuron. Lufenuron was recorded the least toxic insecticide and required a maximum time of 43 h to kill 50% exposed insects. Fiducial (FL) values of both insecticides were non-significant to each other (Table 2).

Table1. Dose-mortality response of different insecticides against larvae under laboratory conditions

Insecticide	LC50 (mg/l)	Fiducial limits (FL) at 95% level	Slope±SE	$\chi 2$
Emamectin benzoate	0.009	0.006–0.0013	2.09±0.77	1.97
Lufenuron	0.87	0.87–1.12	2.99±0.53	3.14

Table2. Time-mortality response of different insecticides against larvae under laboratory conditions

Insecticide	LC50 (mg/l)	Fiducial limits (FL) at 95% level	Slope±SE	$\chi 2$
Emamectin benzoate	33.11	30.10–58.54	5.35±0.54	2.57
Lufenuron	43.14	33.96–76.34	3.63±0.42	23.26

Many previous researchers have reported that emamectin benzoate is a toxic insecticide and give satisfactory results to control larvae of *S. frugiperda* under controlled and open conditions (Kushwaha, 2022). Two continuous sprays of emamectin benzoate were given the best and effective larval control in field conditions. The chemicals can't kill those larvae that hide inside the whorls or underside of the leaves because chemicals cannot be reached in these sites. The same was concluded by Babendreier et al. (2020). They tested insecticide (emamectin benzoate) in field conditions. Our results are in line with Deshmukh et al. (), who also reported the highest toxicity of emamectin benzoate in field conditions. Tumar et al. (2020), Bajracharya et al. (2020), and Bansode et al. (2020) had reported the similar findings about pest mortality.

CONCLUSION

Fall armyworm, *Spodoptera frugiperda*, is a destructive polyphagous agricultural and horticultural pest of global economic importance. Cultural control such as quality seed, early seed sowing, field sanitation, promoting biological fauna, and push-pull technology in all maize growing areas could help in pest reduction.

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Conflict of interest:

The authors declare no conflict of interest.

Authors contribution:

All authors have equal contributions in performing this research.

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