Effectiveness of Some Bio-insecticides on *Spodoptera frugiperda* (J. E. Smith) and *Sesamia cretica* Lederer (Lepidoptera: Noctuidae).

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ABSTRACT: In this study, different bio-insecticides treatments were evaluated for their influence against larvae of *Spodoptera frugiperda* (J. E. Smith) and *Sesamia cretica* Lederer (Lepidoptera: Noctuidae) under laboratory and field conditions. The tested bio-insecticides were Tracer 24% SC (Spinosad), Vertemic 18% EC (Abamectin), BioPower (*Beauveria bassiana*), Bio-Catch (*Lecanicillium lecanii*) and Priority (*Paecilomyces fumosoroseus*). The obtained results revealed that the tested treatments on *S. frugiperda* and *S. cretica* varied under laboratory conditions. The insecticidal efficiency of the entomopathogenic fungi BioPower showed the highest toxic effect against larvae of *S. frugiperda* and *S. cretica* while the Priority insecticide showed the lowest. Abamectin was more effective for both larval species than spinosad. As well as the larvae of *S. frugiperda* were more susceptible to the tested bio-insecticides than the larvae of *S. cretica*. In the field study, all the treatments were found effective in reducing the larvae of *S. frugiperda* and *S. cretica* population and protecting maize plants compared with the control. The insecticide Vertemic 18% EC was found to be the best, followed by Tracer 24% SC, BioPower, Bio-Catch and finally Priority.

***Keywords**: Spodoptera frugiperda; Sesamia cretica; Entomopathogenic fungi products; Spinosad; Abamectin*

INTRODUCTION

The family Noctuidae (order: Lepidoptera) is the second largest family in Noctuoidea, with about 1,089 genera and 11,772 species worldwide (Zhang, 2011).The Fall Armyworm (FAW), *Spodoptera frugiperda* (J. E. Smith) (Fam: Noctuidae) is a polyphagous insect pest that feeds on leaves and stems of more than 80 plant species such as maize, rice, sorghum, sugarcane, cotton and other vegetable crops (Pogue, 2002; Nagoshi, *et al*. 2007; Bueno *et al*., 2010; Barros, *et al*.,2010; Gamil, 2020). Maize is the preferred host for FAW in the countries where it has been recorded. In the absence of control methods, *S. frugiperda* can reduce the corn annual production by 21-53% (Huang *et al*., 2020). *S. frugiperda* has a high ability to spread to new areas (Mohamed *et al*., 2022), it was detected in the Nile Delta of the northern part of Egypt, since it was transferred from the Upper Egypt governorates (Rashed, *et al*., 2022). The greater sugarcane borer (GSB), *Sesamia cretica* (Fam: Noctuidae) is one of the most important sugarcane and corn borers species in Egypt. This insect pests attacks the maize plants at about 4 – 7 weeks old (Soliman & Mihim 1997; Ezzeldin, *et al*., 2009; Darwish, *et al*. , 2019). Its damage to young maize plants ranges from feeding on the whorl leaves (causing dead-heart) to feeding on older plants causing longitudinal tunnels (Soliman & Mihim 1997). To avoid harmful effects of the intensive use of chemical insecticides on environment and/or the non-target organisms, alternative materials have been initiated using safe and effective insect pathogens such as microbial insecticides (Crickmore 2006). Microbial pathogens such as bacteria and pathogenic fungi are good bio-control agents. Due to their eco-friendliness and bio-persistence behavior and their easy preference to kill insect pest species at different developmental stages, crop protection based on biological control of insect pests with microbial agent has been recognized as a valuable tool in integrated pest management programs and therefore utilization of bio-insecticides has increased day-by-day in the recent years (Lomer, *et al*. 2001; Bhattacharya *et al*., 2003, Goettel, *et al*. 2005; Pell, 2007; Hajek, *et al*., 2012). Keeping in view the above-mentioned information, the current experiment was undertaken to study the effect of five bio-insecticides on the larvae of FAW and GSB under laboratory and field conditions.

MATERIALS AND METHODS

1- Laboratory studies

The tested bio-insecticides includes:

- Spinosad (Tracer 24%SC) from Dow AgroSciences Co.,
- Abamectin (Vertemic 18% EC) from Syngenta Co.,
- BioPower (containing 1x10^9 *Beauveria bassiana* spores/ml) (T. Stanes Co. limited, India)

- Bio-Catch (containing $1x10^9$ *Lecanicillium lecanii* spores/ml) (T. Stanes Co, limited, India)
- Priority (containing $1x10^9$ *Paecilomyces fumosoroseus* spores/ml) (T. Stanes Company limited, India)

Insects used

The newly moulted 3rd instars larvae of *Spodoptera frugiperda* and *Sesamia cretica* were obtained from a sensitive reared culture for several generations under laboratory conditions and used in this experiment (27.0 ± 1.0 ºC & 70.0 ± 5.0%RH).

Bioassay

Serial concentrations were prepared for each bio-insecticides as follow; $0.25X10^9$, $0.5x10^9$, $1x10^9$ and $1.5x10^9$ spores / 1000 ml (in 1000 ml distilled water) from BioPower, Bio-Catch and Priority, 1, 5, 10 and 20 ppm of Spinosad and 1, 2, 4 and 8 ppm of Abamectin.

Concerning the entomopathogenic fungi (BioPower, Bio-Catch and Priority), ten newly moulted 3rd instar larvae of *S. frugiperda* and *S. cretica* were placed in a Petri dish (9 cm in diameter) lined with filter paper were sprayed with 2.0 ml from each concentration per treatment using hand sprayer. After air drying, the treated larvae were transferred carefully to a 2-L flask containing fresh new corn leaves. Each concentration was repeated three times. Ten larvae sprayed with distilled water served as a control. The leaf dip technique was used as described by Aydin *et al.* (2005) for spinosad and abamectin. Mortality percentages were measured after two, four and six days and they were corrected by Abott's formula (1925). The LC_{25}, LC_{50} and LC_{95} values and 95% confidence limits were calculated according to Finney (1971) by using LdP-line, Ehab Software (http://www.ehabsoft.com/ldpline/). Also, the percentage of pupation and moth emergence were recorded for each bio-insecticide and the different used concentrations.

The susceptibility indexes

In this study, the toxicity index method (Sun, 1950) which used to determine the degree of toxicity of different insecticides by comparing them with a standard one was adopted to find out the degree of susceptibility insect to an insecticide than the other insect to the same insecticides by dividing the LC_{25}, LC_{50} or LC_{90} for less susceptible insect by the LC_{25}, LC_{50} or LC_{90} for the more susceptible one.

2- Field studies

Efficacy of five bio-insecticides against the *Spodoptera frugiperda* and *Sesamia cretica*:

Field experiments were carried out in a private farm at El-Bostan, El-Delengat district, Beheira Governorate, Egypt throughout two successive seasons of 2021 and 2022. The experiments were planned to evaluate the efficacy of five bio-insecticides against *S. frugiperda* and *S. cretica* on maize plants (cv. yellow single cross 168). An area of about one feddan was divided into 48 plots of 60 m2 each (24 plots for each insect). Each treatment (bio-insecticide) was replicated four times in addition to four control plots. The replicates were separated from the adjacent ones by about one meter as a belt to minimize the interference of spray drift among them. The maize plants were sown in the beginning of May. The treatments for *S. cretica* were achieved after one month from the sowing date while the treatments for *S. frugiperda* were achieved in 24 separated plots after 45 days from the sowing date. The number of alive larvae of *S. frugiperda or S. cretica* on randomly selected ten maize plants from each plot were examined and recorded before treatment and after 1, 4, 7 and 14 days of the treatment. Tracer 24%SC and Vertemic 18% EC were applied at a rate of 0.5 ml/l, while both BioPower, Bio-Catch and Priority were applied at rates of 5ml/L. The reduction percentages of population of *S. frugiperda* larvae or *S. cretica* were calculated according to the Henderson and Tilton equation (1955) as follows:

% reduction = 100*1- ((n in Co before treatment*n in T after treatment) / (n in Co after treatment*n in T before treatment))

Data analysis:

The collected data were statistically analyzed using analysis of variance (ANOVA) and the means were separated by the Least Significant Difference (LSD test) (SAS Statistical, 1988).

RESULTS AND DISCUSSION

Laboratory studies:

Data presented in Table (1) show the lab effectiveness of five bio-insecticides on the 3rd instar of *Spodoptera frugiperda*. After 48 h, the most effective entomopathogenic fungus was Bio-Power insecticide where LC_{50} and LC_{90} values were $0.764x10^9$ and $5.662\ x10^9$ spores/1000ml, respectively. Followed by the entomopathogenic fungi Priority ($LC_{50} = 1.503\ x10^9$) while Bio-Catch was the least and achieved LC_{50}=$1.78x10^9$ spores/1000ml. On the other hand, LC_{50} and LC_{90} values of spinosad were 6.982 and 49.801 ppm, respectively while these values for the abamectin insecticide were 3.038 and 20.607 ppm. After 96 h exposure time (Table 2), the toxicity of the entomopathogenic fungi was increased and recorded $0.463\ x10^9$, $1.474\ x10^9$ and $1.229\ x10^9$ as LC_{50} for Bio-Power, Bio-Catch and Priority, respectively. The toxicity of spinosad and abamectin also increased after 96 h and recorded LC_{50} of 4.885 and 2.327 ppm, respectively. After 144 h (Table 3), the toxicity of the bio-insecticides significantly increased with increasing exposure time whereas the LC_{50} values were $0.487\ x10^9$, $0.659\ x10^9$, $1.108\ x10^9$, 3.537 ppm and 1.966 ppm for Bio-Power , Priority, Bio-Catch, spinosad and abamectin, respectively.

Concerning the GSB, as shown in Table (1) the effectiveness of the five bio-insecticides on the 3rd instar after 48 h, clearly demonstrated that the most effective entomopathogenic fungus was Bio-Power whereas the LC_{50} and LC_{90} values were $1.277x10^9$ and $7.288x10^9$ spores/1000ml, respectively. Followed by the entomopathogenic fungi, Priority (LC_{50} = $2.412x10^9$) while Bio-Catch was the least and achieved LC_{50}=$2.627x10^9$ spores/1000ml. On the other hand, the $LC_{25,}$ LC_{50} and LC_{90} values of Tracer were 3.598, 9.962 and 68.96 ppm, respectively. These values for the Vertemic insecticide were 1.615, 5.19 and 47.73 ppm. After four days post treatment (Table 2), the toxicity of the entomopathogenic fungi was increased and recorded $0.822x10^9$, $1.655x10^9$and $3.055x10^9$ as LC_{50} for Bio-Power, Priority and Bio-Catch respectively. The toxicity of spinosad and abamectin also increased after four days and recorded LC_{50} of 8.079 and 4.446 ppm, respectively. After 144 h (Table 3), the toxicity of the bio-insecticides significantly increased with increasing of the exposure time whereas the LC_{50} values were $0.578x10^9$, 1.199 $x10^9$, 2.164 $x10^9$, 4.913 ppm and 2.927 ppm for Bio-Power, Priority, Bio-Catch, Tracer and Vertemic, respectively.

Table 1. Lab effectiveness of five bio-insecticides against *Spodoptera frugiperda* and *Sesamia cretica* 3rd instar larvae at 48 h post treatment.

Treatments		***Spodoptera frugiperda***					***Sesamia cretica***				
	LC_{50} Values		**Confidence limits**		**Slope**	**X^2**	**LC_{50}**	**Confidence limits**		**Slope**	**X^2**
			Lower	**Upper**				**Lower**	**Upper**		
Biopower (Spore/1000 ml distilled water)	LC_{90}	5.662	2.532	76.24			7.288	3.211	85.785		
	$1C_{50}$	0.764	0.516	1.252	1.473	1.3	1.277	0.905	2.651	1.694	0.929
	$1C_{25}$	0.266	0.077	0.418			0.511	0.278	0.711		
Biocatch (Spore/1000 ml distilled water)	LC_{90}	8.75	3.662	122.045			12.1	4.353	732.076		
	$1C_{50}$	1.78	1.217	4.725	1.878	0.258	2.627	1.603	15.339	1.932	0.244
	$1C_{25}$	0.779	0.522	1.113			1.176	0.83	2.291		
Priority (Spore/1000ml distilled water)	LC_{90}	20.08	5.236	1316.76			17.99	5.067	5538. 73		
	$1C_{50}$	1.503	0.76	3.12	1.138	0.153	2.412	1.394	20.584	1.469	0.092
	$1C_{25}$	0.384	0.14	0.717			0.838	0.511	1.494		
Spinosad ppm	LC_{90}	49.8	26.15	189.48			68.96	33.703	337.45		
	$1C_{50}$	6.982	4.682	10.574	1.502	0.0094	9.962	6.835	16.249	1.525	0.225
	$1C_{25}$	2.483	1.146	3.825			3.598	1.813	5.36		
Abamectin ppm	LC_{90}	20.61	10.29	125.54			47.73	17.166	1349.37		
	$1C_{50}$	3.04	2.071	4.605	1.541	0.143	5.19	3.428	12.217	1.33	0.022
	$1C_{25}$	1.11	0.423	1.702			1.615	0.609	2.476		

Table 2. Lab effectiveness of five bio-insecticides against *Spodoptera frugiperda* and *Sesamia cretica* 3rd instar larvae at 96 h post treatment.

Treatments	*Spodoptera frugiperda*						Sesamia cretica				
	LC_{50} Values		Confidence limits		Slope	X^2	LC_{50}	Confidence limits		Slope	X^2
			Lower	Upper				Lower	Upper		
Biopower (Spore/1000 ml distilled water)	LC_{90}	4.228	1.949	71.804			6.492	2.733	124.34		
	$1C_{50}$	0.463	0.218	0.694	1.334	1.096	0.822	0.555	0.443	1.428	1.168
	$1C_{25}$	0.145	0.015	0.275			0.277	0.076	0.435		
Biocatch (Spore/1000 ml distilled water)	LC_{90}	10.498	3.817	395.88			35.34	5.56	1978.7		
	$1C_{50}$	1.474	0.983	4.346	1.503	0.275	3.055	1.74	22.59	1.205	0.056
	$1C_{25}$	0.524	0.256	0.761			0.842	0.29	2.62		
Priority (Spore/1000 ml distilled water)	LC_{90}	19.74	4.62	712.15			14.58	4.393	2540.28		
	$1C_{50}$	1.229	0.4	3.56	1.063	1.371	1.655	1.04	7.704	1.356	0.056
	$1C_{25}$	0.285	0.01	0.91			0.527	0.223	0.797		
Spinosad ppm	LC_{90}	44.281	22.497	186.78			54.65	28.442	215.791		
	$1C_{50}$	4.885	2.974	7.484	1.339	0.672	8.079	5.524	12.394	1.544	0.651
	$1C_{25}$	1.531	0.544	2.596			2.954	1.445	4.447		
Abamectin ppm	LC_{90}	19.355	9.286	162.113			43.71	15.888	1275.52		
	$1C_{50}$	2.327	1.379	3.491	1.393	0.459	4.446	2.926	9.548	1.291	0.019
	$1C_{25}$	0.763	0.179	1.311			1.335	0.412	2.117		

Table 3. Lab effectiveness of five bio-insecticides against *Spodoptera frugiperda* and *Sesamia cretica* 3rd instar larvae at 144 h post treatment.

Treatments	*Spodoptera frugiperda*						*Sesamia cretica*				
	LC_{50} Values		Confidence limits		Slope	X^2	LC_{50}	Confidence limits		Slope	X^2
			Lower	Upper				Lower	Upper		
Biopower (Spore/1000 ml distilled water)	LC_{90}	2.571	1.482	32.02			7.158	2.582	917.88		
	$1C_{50}$	0.487	0.181	0.666	1.773	1.032	0.578	0.25	0.975	1.173	0.85
	$1C_{25}$	0.203	0.014	0.359			0.154	0.0076	0.304		
Biocatch (Spore/1000 ml distilled water)	LC_{90}	13.15	3.832	5741.96			23.61	5.417	92144.4		
	$1C_{50}$	1.108	0.708	3.751	1.193	0.459	2.164	1.217	31.492	1.235	0.094
	$1C_{25}$	0.302	0.046	0.498			0.615	0.255	1.027		
Priority (Spore/1000 ml distilled water)	LC_{90}	7.425	2.714	629.191			8.524	3.519	90.254		
	$1C_{50}$	0.659	0.372	1.158	1.218	0.524	1.199	0.833	2.518	1.504	0.226
	$1C_{25}$	0.184	0.016	0.34			0.427	0.25	0.596		
Spinosad ppm	LC_{90}	45.01	21.005	266.656			39.43	21.064	141.731		
	$1C_{50}$	3.537	1.79	5.692	1.16	1.621	4.913	3.075	7.364	1.417	1.773
	$1C_{25}$	0.927	0.202	1.822			1.642	0.643	2.699		
Abamectin ppm	LC_{90}	12.47	7.054	51.08			22.43	10.607	179.9		
	$1C_{50}$	1.966	1.191	2.775	1.597	0.466	2.927	1.925	4.533	1.449	0.434
	$1C_{25}$	0.744	0.23	1.218			1.002	0.32	1.6		

The current results concluded that the Biopower insecticide (*Beauveria bassiana*) was the most effective entomopathogenic fungi insecticides on FAW and GSB larvae than Bio-Catch (*Lecanicillium lecanii*) and Priority (*Paecilomyces fumosoroseus*). The results of **El-Hawary and Abd El-Salam**, **2009** are in agreement with our results, they found that *B. bassiana* (Bio-Power) was more effective against the larvae of *Spodoptera littoralis* and *P. fumosoroseus* (Priority) was more potent against the larvae of *Agrotis ipsilon*. Also, **Metwally, 2010** investigate the effect of *B. bassiana* on the three corn borers, *Ostrinia nubilalis* (Hbn.), *Sesamia cretica* (Led.) and *Chilo agamemnon* (Bles.), and found that all the tested concentrations induced different mortalities. **Idrees, *et al*, 2022** tested the pathogenicity of 12 isolates of *B. bassiana* in the immature stages and feeding efficacy of the FAW, *S. frugiperda*, they found that the *B. bassiana* isolates caused significant mortality rates ranging from 71.3 to 93.3% at two weeks' post-treatment and reduced the efficacy of larval feeding consumption from 69.4 to 77.8% at two days' post-treatment. **Sabbour and Singer, 2014**, found that the LC_{50} of *Paecilomyces fumosoroseus* and *Paecilomyces lilaceous* recorded $122X10^4$ and $106X10^4$ conidia/ml, respectively against *Phthorimaea operculella* under laboratory conditions. On the other side, **Abd El-Salam, *et al.*, 2012** investigated the effect of *Beauveria bassiana*, *Verticillium lecanii*, *Metarhizium anisopliae* and *Paecilomyces fumosoroseus* compared with Nimbecidine against the cowpea aphid, *Aphis craccivora* in broad bean field and found that *V. lecanii* was the most effective insecticide followed by Nimbecidine, Bio-Magic, Priority and the least effective was *B. bassiana*.

The susceptibility indexes

As shown in Tables (4) the 3rd instar FAW larvae were more susceptible to the five bio-insecticides than the 3rd instar larvae of GSB. Concerning the entomopathogenic fungi, the FAW was more susceptible by 1.19, and 1.95 and 1.82 fold than the GSB according to the LC_{50} after 144 h for Biopower, Biocatch and Priority. These ratios reach 1.39 and 1.49 for Tracer and Vertemic, respectively.

Table 4. The susceptibility index of *Spodoptera frugiperda* compared with *Sesamia cretica* 3rd instar larvae to the tested bio-insecticides:

Treatments		After 48 h	After 96 h	After 144 h
Biopower	LC_{90}	1.29	1.54	2.78
	$1C_{50}$	**1.67**	**1.78**	**1.19**
	$1C_{25}$	1.92	1.91	0.76
Biocatch	LC_{90}	1.38	3.37	1.8
	$1C_{50}$	**1.48**	**2.07**	**1.95**
	$1C_{25}$	1.51	1.61	2.04
Priority	LC_{90}	0.9	0.74	1.15
	$1C_{50}$	**1.6**	**1.35**	**1.82**
	$1C_{25}$	2.18	1.85	2.32
Spinosad	LC_{90}	1.38	1.23	0.88
	$1C_{50}$	**1.43**	**1.65**	**1.39**
	$1C_{25}$	1.45	1.93	1.77
Abamectin	LC_{90}	2.32	2.26	1.8
	$1C_{50}$	**1.71**	**1.91**	**1.49**
	$1C_{25}$	1.45	1.75	1.35

The effectiveness of the tested insecticides on the development of *S. frugiperda* and *S. cretica*:

Data in Tables 5 and 6 showed the effect of five bio-insecticides with serial concentrations on the 3rd instar larvae and the effect on the developmental (pupation and moth emergencies) of *S. frugiperda* and *S. cretica* under laboratory conditions. The obtained results showed that for all bio-insecticides used there was a regular direct relationship for each concentration between the percentage of mortality and the increase in the period of exposure. For the effect on insect developmental, the five bio-insecticides showed fluctuations in both the percentage of pupation and the percentage of moth emergency, all the treated FAW larvae died before pupation in the case of treating by each of Biopower ($1x10^9$ and $1.5x10^9$ spores / 1000ml), Tracer (10 and 20 ppm) and Vertemic (8 ppm). Also, all the GSB larvae treated with Biopower ($1.5x10^9$ spores / 1000ml), spinosad (20 ppm) and abamectin (8 ppm) died before pupation.

Table (5): Effect of five bio-insecticides on 3rd instar larvae of the fall army worm, *Spodoptera frugiperda* **under laboratory conditions.**

Insecticides	Concentration	% Mortality after			Development effect	
		2 days	4 days	6 days	% Pupation	% Moth emergency
Biopower (Spore/1000 ml distilled water)	0.25	30	40	46.67	20	6.67
	0.5	36.67	46.67	56.67	6.67	3.33
	1	53.33	63.33	66.67	0	0
	1.5	73.33	80	83.33	0	0
Biocatch (Spore/1000 ml distilled water)	0.25	6.67	13.33	23.33	26.67	13.33
	0.5	13.33	23.33	33.33	20	10
	1	30	36.67	43.33	13.33	6. 67
	1.5	46.67	53.33	60	3.33	0
Priority (Spore/1000 ml distilled water)	0.25	20	26.67	33.33	26.67	16. 7
	0.5	26.67	30	40	16.67	10
	1	43.33	40	56.67	6.67	6. 67
	1.5	50	60	70	3.33	0
Tracer (ppm)	1	13.33	20	30	33.33	23.33
	5	43.33	46.67	50	20	6.67
	10	60	63.33	66.67	0	0
	20	76.67	83.33	86.67	0	0
Vertemic (ppm)	1	26.67	33.33	36.67	30	6.67
	2	40	43.33	50	10	3.33
	4	56.67	60	66.67	6.67	0
	8	76.67	80	86.67	0	0

Table (6): Effect of five bio-insecticides on 3rd instar larvae of the greater sugarcane borer, *Sesamia cretica* **under laboratory conditions.**

Insecticides	Concentration	% Mortality after			Development effect	
		2 days	4 days	6 days	% Pupation	% Moth emergency
Biopower (Spore/1000ml distilled water)	0.25	13. 33	26.67	36.67	33.33	13.33
	0.5	23.33	33.33	43.33	23.33	6.67
	1	36.67	50	56.67	13.33	3.33
	1.5	60	70	73.33	3.33	0
Biocatch (Spore/1000 ml distilled water)	0.25	3.33	10	13.33	50	20
	0.5	6.67	16.67	20	33.33	10
	1	20	26.67	33.33	23.33	3.33
	1.5	33.33	36.67	43.33	16.67	3.33
Priority (Spore/1000 ml distilled water)	0.25	6.67	13.33	16.67	26.67	10
	0.5	16.67	23.33	30	26.67	10
	1	30	40	43.33	16.67	6.67
	1.5	40	46.67	56.67	13.33	3.33
Tracer (ppm)	1	6.67	13.33	20	43.33	23.33
	5	30	33.33	43.33	30	10
	10	53.33	53.33	63.33	6.67	3.33
	20	66.67	76.67	86.67	0	0
Vertemic (ppm)	1	16.67	20	26.67	33.33	13.33
	2	30	33.33	40	20	6.67
	4	43.333	46.67	53.33	13.33	3.33
	8	60	63.33	76.67	0	0

Field studies:

Data presented in Tables 7 and 8 showed the efficacy of five bio-insecticides on the numbers of larvae of FAM which were recorded before and after treatment 1, 4, 7 and 14 days in 2021 and 2022. There were significant differences between the treatments with respect to the reduction percentages of FAW larvae. The general means of reduction percentages of FAW larvae could be arranged in descending order as follows: Vertemic 18% EC (87.26), Tracer 24%SC (82.49), BioPower (76.92), Bio-Catch (71.87) and Priority

(67.59) in the 2021 season. These reduction percentages were increased in the 2nd season 2022 and recorded 90.48, 88.01, 80.29, 75.49 and 71.15 %, respectively. Among the tested insecticides, Vertemic 18% EC and Tracer 24%SC gave the highest reduction percentages (lowest number of *S. frugiperda* per plant) after 1, 4, 7 and 14 days of application as compared to BioPower, Bio-Catch and Priority. The current results are in agreement with the results of Bajracharya, *et al*. 2020, who tested spinosad, chlorantraniliprole, emamectina benzoate, imidacloprid and azadirachtin against FAW, and found that the spinosad, chlorantraniliprole and emamectin benzoate were found promising for FAW management in maize. Mian *et al*., (2022), found that deltamethrin insecticide was recorded the most toxic insecticide followed by chlorantraniliprole and the bio-insecticides emamectin benzoate insecticides.

Table 7: Efficacy of the tested bio-insecticides on the fall army worm populations under field conditions during the 2021 season.

Bio-insecticides	Post spray (days)				General mean
	1	4	7	14	
Priority	55.54±2.62c	68.85±2.64c	80.27±2.5a	65.71±2.34c	67.59±2.54c
Bio-Catch	61.38±1.11bc	74.95±1.08bc	82.16±2.29a	68.99±2.19c	71.87±2.13bc
BioPower	68.1±1.49b	79.52±1.74b	85.22±2.01a	74.85±2.6bc	76.92±1.85b
Tracer 24%SC	82.97±6.22a	89.71±2.55a	79.44±2.73a	77.84±2.25ab	82.49±2.07ab
Vertemic 18% EC	89.46±2.27a	93.17±1.7a	83.74±2.43a	82.65±2.11a	87.26±1.46a
F values	19.008	24.879	.990	8.677	14.998
L. S. D.	9.91545	6.11885	7.24145	6.9429	5.74955

Means followed by the same letter(s) within the same column are not significantly differ ($P \leq 0.05$)

Table 8: Efficacy of the tested bio-insecticides on the fall army worm populations under field conditions during the 2022 season.

Bio-insecticides	Post spray (days)				General mean
	1	4	7	14	
Priority	64.96±4.59b	74.24±5.52c	76.98±4.59b	68.42±3.43c	71.15±2.39c
Bio-Catch	68.71±2.2b	78.72±1.01bc	79.89±2.22b	74.66±2.06bc	75.49±1.42c
BioPower	74.86±5.39b	83.48±2.21b	83.82±2.71a	79.04±2.02ab	80.29±1.78b
Tracer 24%SC	90.03±3.7a	93.63±1.27a	85.47±2.96a	82.88±2.01a	88.01±1.6a
Vertemic 18% EC	92.92±0.88a	94.09±1.68a	89.14±1.8a	85.76±2.18a	90.48±1.14a
F values	11.393	9.624	2.495	8.115	22.616
L. S. D.	11.23325	8.61795	9.07605	7.25185	4.8372

Means followed by the same letter(s) within the same column are not significantly differ ($P \leq 0.05$)

On the other hand, the data presented in Tables 8 and 9 illustrated the effect of the five bio-insecticides on the larvae of *S. cretica*. The GSB larvae were more resistant to the treatment than the larvae of FAW, whereas the recorded general means of reduction percentages were recorded 56.66, 65.31, 69.63, 76.89 and 81.17% during the first season (2021). During the 2nd season, 2022 these percentages recoded 58.81, 63.74, 67.81, 81.28 and 84% for Priority, Bio-Catch, BioPower, Tracer and Vertemic, respectively. The current results are in agreement with El- Sappagh, (2016) and Darwish, *et al*. (2019), who tested the effect of different bio and chemical insecticides on the GSB (*S. cretica*) and found that all the treatments were effective in reducing the infestation rates by this insect. The 1st author found that the chemical insecticide Neomyl was found the most effective insecticide against *S. cretica* followed by Bestban and Tempo Xl, respectively. While the 2nd author recorded that the emamectin benzoate was the most effective insecticide followed by chlorantraniliprole, lufenuron, *Bacillus thuringiensis* and finally spinetoram insecticide.

Table 8: Efficacy of the tested bio-insecticides on the greater sugarcane borer populations under field conditions during 2021 season.

Bio-insecticides	Post spray (days)				General mean
	1	4	7	14	
Priority	51.94±2.27[c]	56.97±1.23[c]	58.03±1.3[c]	59.72±1.66[c]	56.66±1.05[e]
Bio-Catch	56.99±2.42[c]	68.74±3.29[b]	69.83±1.43[b]	65.68±.63[b]	65.31±1.63[d]
BioPower	64.84±.47[b]	71.95±1.85[b]	73.7±2.31[b]	68.03±1.97[b]	69.63±1.2[c]
Tracer 24%SC	80.69±1.82[a]	79.49±.74[a]	81.09±1.65[a]	66.31±1.74[b]	76.89±1.73[b]
Vertemic 18% EC	81.94±1.99[a]	82.7±2.42[a]	84.74±2.29[a]	75.29±1.61[a]	81.17±1.31[a]
F values	50.167	22.986	32.109	12.364	46.961
L. S. D.	5.79615	6.34205	5.5598	4.79405	3.96585

Means followed by the same letter(s) within the same column are not significantly differ ($P \leq 0.05$)

Table 9: Efficacy of the tested bio-insecticides on the greater sugarcane borer populations under field conditions during 2022 season.

Bio-insecticides	Post spray (days)				General mean
	1	4	7	14	
Priority	55.14±.28[c]	57.71±3.11[c]	61.67±1.35[c]	60.7±3.54[b]	58.81±1.28[c]
Bio-Catch	54.01±.31[c]	62.98±2.93[bc]	65.04±.64[d]	72.95±2.55[ab]	63.74±1.95[b]
BioPower	62.39±2.61[b]	67.09±2.94[b]	73.27±1.37[c]	68.51±2.68[b]	67.81±1.49[b]
Tracer 24%SC	84.03±.72[a]	86.62±.65[a]	80.13±1.6[b]	74.34±.83[ab]	81.28±1.28[a]
Vertemic 18% EC	83.68±2.5[a]	86.18±.68[a]	87.51±1.88[a]	78.65±4.86[a]	84±1.57[a]
F values	81.476	32.546	55.210	4.592	51.602
L. S. D.	4.9958	7.11065	4.3111	9.58275	4.3237

Means followed by the same letter(s) within the same column are not significantly differ ($P \leq 0.05$)

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الملخص العربي

التأثير السام لبعض المبيدات الحشرية الحيوية علي حشرتي دودة الحشد الخريفية *Spodoptera frugiperda* ودودة القصب الكبيرة *Sesamia cretica*

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تم هذه الدراسة تقييم فعالية بعض المبيدات الحشرية الحيوية علي حشرتي دودة الحشد الخريفية *Spodoptera frugiperda* ودودة القصب الكبيرة *Sesamia cretica* تحت الظروف المعملية والحقلية. المبيدات الحشرية المختبرة كانت الاسبينوساد Tracer 24% SC، الابامكتين Vertemic 18% EC، بيوباور *Beauveria bassiana*، بيوكاتش *Lecanicillium lecanii* ، بريوريتي *Paecilomyces fumosoroseus* . أشارت النتائج الي ان التأثير السام للمبيدات المستخدمة اختلف من مبيد الي اخر ومن حشرة الي اخري. فكان مبيد بيوباور أعلي المبيدات الحشرية الحيوية الفطرية علي يرقات كلتا الحشرتين بينما كان أقلها هو المبيد بريوريتي. كما كان مبيد الابامكتين اكثر فعالية من الاسبينوساد. وأشارت النتائج أيضا الي أن يرقات دودة الحشد الخريفية كانت أكثر حساسية من يرقات دودة القصب الكبيرة لكل المبيدات الحشرية الحيوية المختبرة. كما كانت كل المبيدات المختبرة تحت الظروف الحقلية فعالة في خفض تعداد يرقات الحشرتين علي محصول الذرة الشامية مقارنة بالكنترول. وكان المبيد الحيوي ابامكتين الاكثر فعالية وتلاه مبيد الاسبينوساد ثم البيوباور ثم بيوكاتش واخيرا بريوريتي.