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BIOLOGICAL AND FEEDING ACTIVETIES OF THE PINK CORN BORER, SESAMIA CRETICALED.TREATED BY PLANT EXTRACTS

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ABSTRACT

Maize plants are infested with many insect pests. The corn borer, namely: the greater sugarcane borer (the pink borer), *Sesamia cretica* Led. is one of the most injurious insects infesting maize in Egypt and all over the world. The results illustrated that the mortality percentage within 48 hours of *S. cretica* after feeding 4th instar larvae on maize leaves treated with various plant extracts with alcohol or petroleum- ether shows varying degrees of mortality percentages. Petroleum ether extract of Cressa cretica was extremely effective, causing 87.5% mortality. Petroleum ether extracts of *Amborosia maritima*, *Calotropis procera*, and alcohol extract of *C. cretica*, causing 77.5% mortality. The effectiveness may be due to the presence of diverse chemical groups in these plant extracts with toxic to the larvae of the pink borer. On the other hand, extracts of *Lycopersicum esculentum*, Lotus glenoid, *Aerva javanica*, *Carpobrotus edulis*, *Capsium annum*, and *Cassia senna* have been minimum toxic effect and causing 7.5, 10.0, 12.5, and 12.5 % mortality, respectively. The influence of minimal toxic plant extracts as antifeedant to the pink borer (*S. cretica*) was studied. Food consumption varied depending on the feeding time and extracts tested. The feeding ratio of *S. cretica* on the different extracts was significantly different. The anti-feeding activity of extracts appears to have had a higher effect than its toxicity.

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INTRODUCTION

Maize (*Zea mays L.*) is a plant belonging to the family of grass (Gramineae). The global demand is constantly increasing for food, feed, and fuel. It have been cultivated in one hundred and twenty-five countries. Produced nearly 197 million hectares (ha =10000 m2) of maize. The most economical cereal crop in Egypt is maize. Egypt planted the equivalent of 2.3 million feddan of maize and produced 7.7 million tons.

Unfortunately, corn plants are attacked by pests. Infestation of corn considerable damage and significant yield loss in maize crops (El-Sherif, 1965, Kumar, *et al.* 2018.). Under field conditions, *S. cretica* begins to infesting maize seedlings within 1-2 weeks of germination and continues invading them until they are about 6 weeks old. Occasionally, however, *S. cretica* infestations may occur on older plants where the adult larvae dig relatively tunnels full of larval feces into the stems into the stems

Similar tunnels may also be seen in basal secondary roots, spikes and cobs. Infested young seedlings often die and show the characteristic symptomsof dead heart, while older plants suffer severe yield losses (El-Naggar, 1997; Ismail, *et al*. 2012 and El-Shazly, *et al*. 2013 Suby *et al*., 2020, Zhang, *et al*. 2022). Since the 1990s, the Ministry of Agriculture and Land Reclamation has emphasized the importance of spreading the philosophy of integrated pest management (IPM) among farmers, and couraging them to use all appropriate methods, techniques, and approaches to keep pest populations below those that cause economic losses., (El-Husseini *et al*., 2018) .

This pest is partially controlled with conventional chemical pesticides, but because of its high resistance to various agents new possible alternatives for using safer control methods have been explored. Plant extracts and/or their extracted active ingredients have been ingredients have been found to be effective against a number of insect species as potential acute or chronic insecticides, insect growth regulators, or antifeedants, (Shapiro *et al*. 1995, Vanichpakorn *et al*. 2010, Ladhari *et al*. 2013, Ahmed, *et al*. 2020, Yulia, 2022).

The aim of this study was to investigate the influence of some plant extracts on certain biological and feeding activities of the rose (Sesamia cretica).

MATERIALS AND METHODS

Plant material

Seventeen plants known to be medicinal were collected from natural habitats in various parts of Egypt. The identity of each of the plant species has been verified and confirmed.

Preparation of extracts

Samples were air-dried; the plants were separated and successive extracts were performed on each of the finely powdered (each 500g) with solvents with increasing polarity in the following order, petroleum ether and ethanol. The solvent from each extract was evaporated to dryness in a rotary evaporator under reduced pressure. The residue in each case was dried to constant weight and kept for biological tests. Aqueous emulsions of plant extracts were prepared by dissolving 2.5 g of each crude extract in 100 ml of distilled water (2.5% concentration) using Tween80 as an emulsifier.

Insect maintenance

A susceptible laboratory strain of *Sesamia cretica* away from insecticidal contamination, under laboratory temperatures 22oc ± 2 and 60± 5% R.H.

Biological test

The larvae were fed on treated maize leaves in a petri dish, each dish containing 10 larvae, and replicated four times. The leaves were dipped for 10 s in various extracts which were emulsified by adding tween – 80 (0.01 %) then water containing the same amount of tween only. The larvae were examined for mortality within two days. All mortality data were corrected for natural mortality using, (Abbott formula 1925).

Antifeedant activity

The antifeedant activity of the *S. cretica* on maize leaves treated by four plant

extracts, *Aerva javanica*, *Cassia senna*, *Halocnemum strobilaceum*, and *Zizyphus spinachristi* was conducted. The antifeeding bioassay was done by collecting one hundred newly ecdysed fourth-instar larvae from laboratory culture. Twenty leaf discs (5 cm diameter) of maize were punched out of leaves and used for feeding larvae (leaf disc/larva). The dipping method was used for 10 seconds under the same laboratory conditions. Then, after drying it under room conditions, it was placed in a Petri dish with a diameter of 15 cm and a depth of 2 cm, and a filter paper moistened with water was used. One treatment was performed at the start of the experiment. Leaf discs were replaced daily with untreated ones. After 4 hours of starvation, 20 pink corn borer 4th instar were placed in each treatment and fed 2, 4, 6, 12, 24, 48, 72, and 96 hours. After removing the larvae from each dish, the area consumed by the treated and untreated discs was measured using graph paper (1 mm scale). The feeding area of the test eaten compared to the untreated (test/control) was calculated as a ratio. The antifeedant activity is reported for each feeding ratio as follows: +4(0.00–0.10 feeding ratio), +3(0.10–0.30), +2(0.30–0.50) and +1< 0.50) Ismail, *et al*. 2001.

The data collected were subjected to statical analysis of variance (ANOVA) using the Instant V2.03 computer program test and differences were considered statically significant by the least significant difference (LSD) procedure (Snedecor and Cochran 1980) at probability = 1%.

RESULTS & DISCUSSION

Results in Table (1) illustrate the mortality percentage within 48 hours of *Sesamia cretica* after feeding 4th instar larvae on maize leaves treated with various plant extracts with alcohol or petroleum- ether, show varying degrees of mortality percentages.

Table (1): Mortality percentage of *Sesamia cretica* after feeding 4th instar larvae on maize leaves treated with extremely effective plant extracts (2.5%).

Treatments	Concentrations	Extract	Mortality percentage within 48h.
Condensed Tannin (CT)	2.5%	Alcohol	50.0
	2.5%	Pet. eth.	55.0
Ambrosia maritime	2.5%	Alcohol	62.5
	2.5%	Pet. eth.	77.5
Calotropis procera	2.5%	Alcohol	65.0
	2.5%	Pet. eth.	77.5
Chrozophora policata	2.5%	Alcohol	50.0
	2.5%	Pet. eth.	72.5
Chrozophora policata	2.5%	Alcohol	77.5
	2.5%	Pet. eth.	87.5
Mesembryanthemum forsskalei Alkaloid fraction	2.5%	Alcohol	37.5
	2.5%	Pet. eth.	67.5
	2.5%	----	62.5
Suaeda vermiculata	2.5%	Alcohol	40.0
	2.5%	Pet. eth.	67.5

Control	0.0	--	5.0

Petroleum ether extract of *Cressa cretica* was the most effective causing 87.5% mortality. Extracts of *Amborosia maritima, Calotropis procera* and alcohol extract of *C. cretica* causing 77.5 % mortality.

On the other hand, extracts of *Lycopersicum esculentum, Lotus glenoid, Aerva javanica, Capsium annum* and *Cassia senna* were mildly effective and caused 7.5, 10.0, 12.5 and 12.5 % mortality, respectively, Table (2). The efficacy might be due to the presence of different chemical groups in these plant extracts that are toxic to the larvae of *Sesamia cretica*.

Many authors reported that the presence of specific chemicals enhances the activity of many naturally occurring compounds, (Dimetry and Marei 1992, El-Gengaihi *et al* 1997, Saboon, *et al*. 2019, Bakshi and Ghosh, 2022, Singh, *et al*. 2022). Antifeedant activity, and toxic effects as insecticidal role proved in many different plant extracts (Ismail *et al*. 2015, 2016, Miedaner and Juroszek 2021).

Table (2): Mortality percentage of *Sesamia cretica* after feeding 4th instar larvae on maize leaves treated with a minimal effective plant extract (2.5%).

Treatments	Concentrations	Extract	Mortality percentage
Aerva javanica	2.5%	Alcohol	12.5
	2.5%	Pet. eth.	20.0
Capsium annum	2.5%	Alcohol	12.5
	2.5%	Pet. eth.	17.5
Carpobrotus edulis	2.5%	Alcohol	10.0
	2.5%	Pet. eth.	17.5
Cassia senna	2.5%	Alcohol	12.5
	2.5%	Pet. eth.	20.0
Diplotaxis acris hara	2.5%	Alcohol	40.0
	2.5%	Pet. eth.	32.5
Forsskalea tenacissima	2.5%	Alcohol	17.5
	2.5%	Pet. eth.	20.0
Halocnemum strobilaceum	2.5%	Alcohol	17.5
	2.5%	Pet. eth.	22.5
Lotus glenoid	2.5%	Alcohol	10.0
	2.5%	Pet. eth.	15.0
Lycopersicum esculentum	2.5%	Alcohol	07.5
	2.5%	Pet. eth.	10.0
Zizyphus spinachristi	2.5%	Alcohol	22.5
	2.5%	Pet. eth.	27.5
Control	0.0	--	5.0

Antifeedant activities of different extracts on *S. cretica*

The insecticidal properties of plant- derived that are active against specific target insect pests, biodegradable non-toxic, and potentially suitable for use in integrated management programmes have been demonstrated in recent studies. (Markouk et. al. 2000, Ateyyat *et al*. 2009, Weisheng, *et al*. 2019, Stéphane, *et al*.

2021).

In this experiment larvae of, the larvae of pink corn borer were fed on leaf discs of corn treated with the plant extracts, compared with untreated ones as a control. The mean area (mm2) of treated discs that consumed by the fourth larval stage of *S. creticaa* consumed after treatment with *Aerva javanica* and *Zizyphus spinachristi* ranged from 1.3±0.3 to 2.4±0.5 mm2 Table (3) and it was 2.7±0.8 mm2 when larvae were fed on *Halocnemum strobilaceum* compared with 9.0±1.3 mm2 when they were fed on untreated control for 2 hours. After treatment with *A. javanica* and *Z. spinachristi*, respectively. Its ranged from 2.1±0.6 to 2.4±0.7 mm2 after the treatment with *A. javanica* and *Z. spinachristi*, respectively compared with 14.7±2.6 mm2 when larvae were fed the untreated control for 12 hours. After 48 hours, larvae stopped feeding on different treatments with extracts compared with 15.7±2.3 mm2 when fed with the untreated control.

Table (3): Mean area (mm2) (± SE) of tested leaf discs consumed by the 4th larval instar of *S. cretica* after treated with plant extracts (2.5%) concerning feeding time.

Feeding time (hr.)	Untreated control	*Aerva javanica*	*Zizyphus spinachristi*	*Halocnemum strobilaceum*	*Cassia senna*	LSD (0.01)
	0.0	2.5%	2.5%	2.5%	2.5%	
2	9.0±1.3	1.3±0.3	2.4±0.5	2.7±0.8	2.8±0.6	2.4
4	4.5±0.8	0.4±0.1	0.7±0.4	0.9±0.4	2.9±0.7	1.7
6	5.7±0.9	0.2±0.1	0.5±0.1	1.6±0.4	3.2±0.4	1.2
12	14.7±2.6	2.1±0.6	2.4±0.7	4.4±0.6	4.5±1.2	3.6
24	26.3±3.9	0.5±0.2	1.5±0.3	3.5±0.5	3.9±0.9	4.1
48	15.7±2.3	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	3.2
72	16.5±0.9	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	2.9
96	15.3±2.6	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	3.9

From the results show in Table (4) it is clear that the feeding ratio of *A. javanica* had a greater effect than other treatments, it ranged from 0.1-0.3 after 2 hours for the *A. javanica* and *Z. spinachristi* treatments while it was 1.0 for the untreated control.

Table (4): Effect of different treatments on *S. cretica* feeding ratio concerning feeding time.

Feeding time (hr.)	Control	*Aerva javanica*	*Zizyphus spinachristi*	*Halocnemum strobilaceum*	*Cassia senna*
	0.0	2.5%	2.5%	2.5%	2.5%
2	1.0	0.1	0.3	0.3	0.3
4	1.0	0.1	0.2	0.2	0.6
6	1.0	0.04	0.1	0.3	0.6
12	1.0	0.1	0.2	0.3	0.3
24	1.0	0.02	0.1	0.1	0.2
48	1.0	0.0	0.0	0.0	0.0
72	1.0	0.0	0.0	0.0	0.0
96	1.0	0.0	0.0	0.0	0.0

The antifeedant activity of *A. javanica*, *Z. spinachristi* and *H. strobilaceum* was +4 after 24 h while it was +1 in the untreated control, (Table 5).

Table (5): Antifeedant activity* for the pink corn borer, *S. cretica* from different treatments concerning feeding time.

Feeding time (hr.)	Control	Aerva javanica	Zizyphus spinachristi	Halocnemum strobilaceum	Cassia senna
		2.5%	2.5%	2.5%	2.5%
2	+1	+4	+2	+2	+2
4	+1	+4	+3	+3	+1
6	+1	+4	+4	+2	+1
12	+1	+4	+3	+2	+2
24	+1	+4	+4	+4	+3
48	+1	+4	+4	+4	+4
72	+1	+4	+4	+4	+4
96	+1	+4	+4	+4	+4

*The extent of antifeedant activity was measured as follows: With a feeding ratio between, 0.0 - 0.1 were the most active and are denoted with antifeedant activity of +4, while + 3 for a feeding ratio of 0.1 – 0.3 then +2 for 0.3 – 0.5 and +1 for < 0.5.

Ismail *et al*. 2001 found that crude extract of Maclura pomifera completely inhibited feeding by *Ostrinia nubilalis* (Hbn.) at concentrations of 2.5% and 1.25%, while pomiferin completely inhibited feeding at 1 percent. According to Hiiesaar *et al*. 2009, Zhang, *et al*. 2019 the toxicity of the extract formulations gradually increased depending on the feeding duration and concentration. Also, it was known to possess insect antifeedant/growth-regulating activity against a variety of agricultural pests. Ismail *et al*. (2012) found that pink corn borer stopped feeding at the time when it was fed on untreated Bt. corn or/and non-Bt. corn treated with Neem Azal-T/S 0.5%. Also, Chinnamani and Jeyasankar (2018) also investigated plant extracts for their antifeedant activity against *Spodoptera litura* and *Helicoverpa armigera* (Lepidoptera: Noctuidae). *Pseudocalymma alliaceum* (81.55 and 79.44 %), *Solanum pseudocapsicum* (76.32 and 74.66 %), and *Barleria buxifolia* (73.23 and 70.66 %) showed considerable antifeedant activity extracts against Spodoptera *litura* and *Helicoverpa armigera*, respectively in ethyl acetate extracts. Abd El-Aziz, *et al*. (2019) found that methylene chloride of Zilla spinosa was the superior extract as a deterrent. Dolma and Reddy, (2022) and Sadeghnezhad, *et al*. (2022) stated that antifeedant activities of extracts, fractions, seed oil and isolated compounds against some insect pests with the effect on detoxifying enzymes.

It is hoped that the findings of this study will aid in the development of an effective integrated pest programme for the *Sesamia cretica* management in maize fields. Biocontrol should be emphasised over chemical control as a general feature of such a programme.

Abbreviations

Tannin, (condensed (CT) Hydrolysable (HT))

by the least significant difference (LSD)

petroleum- ether (Pet. eth.)

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Availability of data and materials

All data generated or analyzed during this study are included in this article.

Authors' contributions

IAI, RSA, and MAA designed experiments. IAI, RSA and MAA set up and conducted the biological experiments, and after that, they analyzed the data and wrote the article. All authors revised the article and read and approved the final manuscript.

Ethics approval and consent to participate

Not applicable (this study does not involve human participants, human data, or human tissue).

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests.

CONCLUSIONS

The tested plant extracts were evaluated against *S. cretica* as toxic effect and antifeeding activity. Can use extracts in integrated pest programme for the *S. cretica* management in maize. Biocontrol management should be emphasised over chemical control as a general feature of such a programme.

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CONFLICT OF INTEREST

There are no conflicts of interest with the publication of this work.

النشاط الحيوي والتغذوي لدودة القصب الكبيرة Sesamia cretica Led ومكافحتها بالمستخلصات النباتية

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الخلاصة

نباتات الذرة مصابه بالعديد من الآفات الحشرية ومنها حفار ساق الذرة والمعروفة بدودة القصب الكبيرة، Sesamia cretica Led. هي واحدة من أكثر الحشرات الضارة التي تصيب الذرة في مصر وجميع أنحاء العالم. أوضحت النتائج أن نسبة الموت خلال 48 ساعة من S. cretica بعد تغذية يرقات العمر الرابع على أوراق الذرة المعاملة بمستخلصات نباتية مختلفة بالكحول اظهرت درجات متفاوتة من نسب الموت. كان مستخلص الأثير البترولي من Cressa cretica فعالاً للغاية، حيث تسبب في موت 87.5٪. مستخلصات الأثير البترولي من Amborosia maritima و Calotropis procera ومستخلص كحول من C. cretica، مما تسبب في موت 77.5٪. قد تكون الفعالية بسبب وجود مجموعات كيميائية متنوعة في هذه المستخلصات النباتية سامة ليرقات دودة القصب الكبيرة. من ناحية أخرى، كانت مستخلصات Lycopersicum esculentum و Lotus glenoid و Aerva javanica و Carpobrotus edulis و Capsium annum و Cassia senna أقل سمية وتاثيرا فتسبب في موت 7.5 و 10.0 و 12.5 و 12.5٪ على التوالي. تمت دراسة تأثير المستخلصات النباتية السامة كمضاد للتغذية دودة القصب الكبيرة (S. cretica). يختلف استهلاك الغذاء حسب وقت التغذية والمستخلصات المختبرة. كانت نسبة تغذية S. cretica على المستخلصات المختلفة مختلفة معنويا. يبدو أن النشاط المضاد للتغذية للمستخلصات كان له تأثير أعلى من سميته. تم تقييم المستخلصات النباتية المختبرة ضد S. cretica كأثر سام ومضاد للتغذية. يمكن استخدام المستخلصات في برنامج المكافحة المتكاملة للافات لمكافحة حشرة S. cretica في الذرة.

الكلمات المفتاحية: نشاط مضاد للتغذية، مستخلصات نباتية، سمية، Sesamia cretica.

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