INSECTICIDAL ACTIVITY OF LINOLEIC ACID AGAINST *SPODOPTERA LITTORALIS* (BOISD.)

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Abstract

Toxicity and reduction in larval body weight studies were performed to determine the activity of linoleic acid against the 2nd and 4th instar larvae of *Spodoptera littoralis*. The tested fatty acid showed high significant toxic effect on the two instars, with LC_{50} values of 4.78 and 9.11 g/100 mL, respectively. Linoleic acid resulted in significant larval weight reduction. The percentage of larval body weight reduction against the 4th instar was higher than that of the 2nd instar larvae.

***Key words*:** Linoleic Acid, Insecticidal Activity, *Spodoptera littoralis.*

INTRODUCTION

The Egyptian cotton leafworm *S. littoralis* is considered as the major pest in a wide range of cultivation including cotton, corn, soybeans, peanuts, and vegetables. This pest is not only widely spread in Egypt but also in other Middle East countries in addition to temperate zones in Asia and Africa (Salama *et. al.,* 1990).

Great efforts have been made to control *S. littoralis* chemically. The extensive use of these synthetic pesticides has given rise to problems such as residuals toxicity (pollution), pesticide resistance and harmful effects on beneficial insects, such as natural enemies, honey bees and beneficial birds.

For the above mentioned reasons, the general trends in last three decade were the substitution of synthetic pesticides by natural products, which were used as crude or oil extracts.

Recently, Farag *et. al.*(2011) found that fatty acids and their esters were not only the main constituents of essential oil from the ripe fruits of *Melia azedarach*, but also mainly responsible for the insecticidal and growth inhibition activity against *S. littoralis*.

Ramsewak *et. al.*(2001) reported the insecticidal and insectistatic activities of linoleic acid against *Aedes aegyptii* (Diptera: Culicidae), *Helicoverpa zea* (Lepidoptera:

Noctuidae), *Lymantria dispar* (Lepidoptera: Lymantriidae), *Malacosoma disstria* (Lepidoptera: Lasiocampidae), and *Orgyia leucostigma* (Lepidoptera: Lymantriidae).

The aim of the present work is to study the insecticidal activity of linoleic acid against the 2nd and 4thinstars larvae of *S. littoralis*. The insecticidal activity of linoleic acid against *S. littoralis* is reported for first time in the present work.

MATERIAL AND METHODS

Chemicals

Linoleic acid was purchased from ABCR GmbH & Co KG, Im Schlehert 10, 76187 Karlsruhe, Germany.

Strain of cotton leafworm S. littoralis

The *S. littoralis* strain was obtained from the Faculty of Agriculture, Cairo University, Egypt, and was reared in the laboratory of the Physiology Department, Plant Protection Research Institute, Agricultural Research Center, Giza, Egypt, as described by El-Defrawi *et. al.*(1964), under constant laboratory conditions at (25 ± 1) °C, (70 ± 5)% relative humidity and a photoperiod of 16 h:8 h (L:D). Adults were fed with a 15% solution of honey. Filter paper was provided as an oviposition substrate, and it was replaced periodically.

Toxicity assay

The leaf-dipping technique, similar to that described by Tabashink *et. al.* (1987), was used to evaluate the toxicity of linoleic acid against the 2nd and 4th instar larvae using concentrations of 1.25, 2.50, 5.00, 10.00, and 20.00 g/100 mL of linoleic acid in acetone. Eight castor leaves were dipped for 5 s in each solution and then the treated leaves were left for natural air-drying and were distributed in four jars (2 leaves/jar). Ten of both 2nd and4th instar larvae were allowed to feed on treated leaves for 48 h, and then larvae were fed on untreated leaves for 24 h. Four replicates of ten larvae were fed on acetone-treated leaves for 72 h to serve as control. Larval weight and mortality were recorded after 72 h.

Statistical analysis

Mortality was calculated using the Abbott formula (Abbott, 1925) and subjected to probit analysis according to Finney (1971).

The toxic and larval weight reduction effect of linoleic acid were analysed using ANOVA and Duncan's multiple range tests (ANOVA of arcsine square root transformed percentages). Differences between the treatments were determined by Tukey's multiple range test ($P < 0.05$) (Snedecor and Cochran, 1989).

RESULTS AND DISCUSSION

Data represented in (Table I) revealed that the highest toxicity rates were 87.5% and 70% mortality with the 2nd and 4th instars, respectively were obtained at the highest concentration of 20 g/100 mL. Linoleic acid exhibited high toxicity rate with concentration dependent. The results indicated that LC_{50} values were 4.78 and 9.11 g/100 mL with the 2nd and 4th instar larvae, respectively.

As shown in (Table II), the percentages of larval weight reduction in *S. littoralis* treated with linoleic acid increase gradually with the increasing of concentrations against the 2nd and 4th instar larvae. Larval weight reduction percentages were 15.7, 34.95, 50.18, 66.68, 69.5% and 55.49, 59.15, 62.47, 69.12, 73.16% with 2nd and 4th instar larvae, respectively at concentrations of 1.25, 2.5, 5, 10, 20 g/100 mL respectively. In the fact, the reduction in larval body weight was positively correlated with linoleic acid concentration; the same observation was recorded with both 2nd and 4th instars*.* Approximately, the highest decrease of larval body weight recorded at concentration of 20 g/100 mL against the 4th instar larvae.

Our results about the insecticidal effectiveness of linoleic acid were in agreement with those obtained by Farlane and henneberry (1965) who found that, growth of the cricket, *Gryllodes sigillatus* (Walk.), was inhibited by fatty acids and their methyl esters. Similar results were reported by Juárez and Napolitano (2000). While, Andrews and Miskus (1972) mentioned that larvae and pupae of the western spruce budworm (*Choristoneura occidentalis*) differed in their response to applied oleic or linoleic acid or sweet almond oil. The acids were more toxic than the oils by factors of 15 for larvae and 3 for pupae. Fatty acids were found to exert profound physiological control over conidium development. Palmitoleic acid, linoleic acid and linolenic acid were toxic to conidia over a wide range of concentrations (Kerwin, 1982). Abdul Rahuman and Venkatesan (2008) found that oleic and linoleic acids were quite potent toxic against the 4th larvae of Aedes aegypti L., *Anopheles stephensi* Liston and Culex quinquefasciatus Say.

Plant fatty acids showed insecticidal activity against insects. Farag *et. al.* (2011) found that fatty acids and their esters were not only the main constituents of essential oil from the ripe fruits of *M. azedarach*, but also mainly responsible for the insecticidal and growth inhibition activity against *S. littoralis*. The potency of botanical fatty acids was reported by Abdallah *et. al.*(2009) against *Aphis craccivora*. Tare and Sharma (1991) compared the larvicidal properties of different fatty acids constituents against *Aedes aegypti* and found that oleic acid was the most effective one. Barakat *et. al.* (2004) reported that the ethanol and hexane crude extracts of *Cassia fistula* (L.) reduced pupation, egg production, and hatchability, and increased percent sterility; the dominant constituents were fatty acids, linoleic acid, hexadecanoic acid, and octadecanoic acid, and their alkyl esters. linolenic acid and linoleic acid were also found to have insectistatic and insecticidal activities against *Spodoptera frugiperda* as described by Ramos-López *et. al.* (2012).

In conclusion, linoleic acid could be considered as new effective insecticide for the cotton leafworm, *S. littoralis* control.

Table I. Toxic effect and LC50 of linoleic acid against 2nd and 4th instar larvae of S. littoralis.

Treatment	Corrected mortality (%) ± SD	
	2nd instar	4th instar
Control	0.00 ± 0.00	0.00 ± 0.00
1.25 [g/ 100 mL]	15.00 ± 0.10	10.00 ± 0.40
2.50 [g/ 100 mL]	37.50 ± 0.01	25.00 ± 0.05
5.00 [g/ 100 mL]	45.00 ± 0.00	37.50 ± 0.17
10.00 [g/ 100 mL]	70.00 ± 0.20	47.50 ± 0.10
20.00 [g/ 100 mL]	87.50 ± 0.03	70.00 ± 0.01
LC_{50}	4.78	9.11
F	15984.96***	24316.41***
LSD	0.72	0.33

Values in the same column are all significantly different (ANOVA, Duncan's multiple range test, $P < 0.05$).
SD: is standard deviation.
***: highly significant effect.

Table II. Effect of linoleic acid on mean larval weight (M. W.) and weight reduction (W. R.) of the 2nd and 4th instar larvae S. littoralis.

Treatment	Mean larval weight (mg) and weight reduction (%)			
	2nd instar		4th instar	
	M. W. [mg]	W. R. (%)	M. W. [mg]	W. R. (%)
Control	18.91	0.00	59.80	0.00
1.25 [g/ 100 mL]	15.91	15.70	26.66	55.49
2.50 [g/ 100 mL]	12.30	34.95	24.46	59.15
5.00 [g/ 100 mL]	9.42	50.18	22.48	62.47
10.00 [g/ 100 mL]	6.30	66.68	18.50	69.12
20.00 [g/ 100 mL]	5.76	69.50	16.11	73.16
F	178499.00***		13953.70***	
LSD	0.17		0.19	

Values in the same column are all significantly different (ANOVA, Duncan's multiple range test, $P < 0.05$).
Weight Reduction (%) = [(Control - M. W.) / Control].100.
***: highly significant effect.

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النشاط السام لحمض *اللينوليك* ضد دودة ورق القطن

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أجريت الدراسة فى هذا البحث بغرض تحديد نشاط حمض اللينوليك من حيث السمية والتأثير على وزن اليرقة بالنسبة لحشرة دودة ورق القطن العمر الثانى والرابع. أظهر الحمض الدهنى المختبر تأثير عالى السمية بالنسبة للعمرين.وجد ان قيم ال (Lc_{50}) بالنسبة للعمرين الثانى والرابع على التوالى هى (4.78) و (9.11) ج/ 100مل. كما اوضحت النتائج البيولوجية ايضا ان حمض اللينوليك له تأثير ملحوظ بالنسبة لتقليل وزن اليرقة. و كانت النسبة المؤية لتقليل وزن الحشرة فى العمر االرابع أعلى منه بالنسبة للعمر الثانى . . فى هذا البحث لاول مرة يتم دراسه النشاط السام لحمض اللينوليك على دوده ورق القطن.