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COMPARATIVE BIOASSAY STUDIES OF SOME ACYLUREA DERIVATIVES AGAINST THE POTATO TUBER MOTH, *Phthorimaea operculella* (ZELLER).

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ABSTRACT

Laboratory studies were conducted through bioassay technique to evaluate the toxicity effect of some acylurea insect growth regulators on eggs, larvae, and pupae of potato tuber moth *Phthorimaea operculella* (Zeller). Results indicated that the tested acylureas: hexaflumuron, lufenuron, chlorfluazuron and flufenoxuron beside the conventional insecticide profenofos, as a standard agent, proved high insecticidal activities on *P. operculella*. Hexaflumuron and Lufenuron, however, were more toxic against the three tested stages than chlorfluazuron and flufenoxuron. Moreover, larvae stage, was more susceptible than pupal and egg stages with LC_{50} values ranged from 16.98 to 331.13, 102.33 to 562.34 and 478.63 to 1202.26 ppm, respectively.

INTRODUCTION

The potato tuber moth, *Phthorimaea operculella*(Zeller) is considered one of the most serious insect pests of potato crop in the field and during storage (Raman and Palacios, 1982 and Fenemore, 1988).

Currently, recommended control methods are based on the use of neuroactive broad-spectrum insecticides such as pyrethroids and organophosphates. However, while satisfactory control has been achieved using such compounds, concerns over operator safety and increasing environmental awareness have led to a search for more selective pesticides which possess lower mammalian toxicity and have fewer side effects on non-target organisms, including beneficial arthropods (Fisk *et al.*, 1993). Previous work on other lepidopteran pest species, including the Egyptian cotton leaf worm, *Spodoptera littoralis* (Boisd), has also demonstrated the effectiveness of acylureas as control agents, environmentally acceptable and being relatively inactive against predators, parasitoids and pollinators (Fisher and Hoffmann, 1989 and Retnakaren and Wrigh, 1987).

Therefore, the objective of this study was to evaluate the toxicity of certain acylurea derivatives against different stages of *Phthorimaea operculella*(Zeller) through bioassay technique under laboratory conditions. These compounds are known to be of low toxicity to mammals and less hazardous to the environment.

MATERIALS AND METHODS

Potato tuber moth, *Phthorimaea operculella* (Zeller), was obtained as egg batches on a weekly basis from the International Potato Center, Kafr Al-Zayate, Gharbia Governorate, Egypt. It was reared under laboratory

condition at 29 ± 2 °C and 65 ± 5 % RH according to the method described by Haiba (1991). The larvae were fed on potato tubers, whereas adults were fed through a piece of cotton soaked with 17% sugar solution.

1.Insecticides used:

Five insecticidal compounds were evaluated under laboratory conditions against larvae, pupal and egg stages of *Phthorimaea operculella* through bioassay technique. These compounds include four acylureas: chlorfluazuron (Atabron® 5% EC), flufenoxuron (Cascade® 10% EC), hexaflumuron (Consult® 10% EC) and lufenuron (Match® 5% EC) as well as profenofos (Selecron® 72% EC).

2. Bioassay Techniques:

a. Eggs and Pupae:

The insecticidal effect of the tested compounds was determined using dipping technique. A series of concentrations from each compound was prepared as ppm to establish the concentration – mortality regression lines. The examined concentrations were ranged between 100 and 2000 ppm. Except in case of hexaflumuron on pupae. as these concentrations were ranged from 25 to 300 ppm.

Batches of 50 eggs (fixed on filter paper) and 50 pupae (0–12 hours–old) were dipped in diffcrent prepared concentrations for 60 seconds, then transferred to Petri – dish and allowed to dry under laboratory conditions. Check treatments were conducted in the same manner but insecticide free water was used. All treatments were replicated three times.

b. Larvae:

This experiment was carried out to evaluate the insecticidal activity of different concentrations of the tested compounds against larval stage of the insect. The tested concentrations were ranged between 100 and 700 ppm. in case of chlorfluazuron and flufenoxuron, and between 1 to 50 ppm. in case of hexaflumuron and lufenuron.

Potato tubers (5 tubers / replicate) were dipped in each concentration for 60 seconds, then extruded and allowed to dry under laboratory conditions. Batches of 50 newly hatched larvae were put on the treated potato tuber moth and allowed to fed and continue their life cycle inside the tubers without disturbance. Check treatment was done in the same manner without insecticides - free water was used. All treatments were replicated three times. Pupated individuals were counted either in the sand or on the tuber surface near the tunnel exit. Mortality percentages of treated eggs, larvae and pupae were assessed and corrected when needed using Abbott's formula (1925). Calculations for determination of concentration – mortality regression lines and estimation of LC_{50} for each compound against certain tested stages were made by the standard probit method (Litchfield and Wilcoxon, 1949).

RESULTS AND DISCUSSION

Preliminary tests were performed with a wide range of concentrations to determine the LC_{50} values of each tested insecticides for eggs, larvae and pupae of *P. operculella*. The LC_{50} values as well as slopes of LC- p lines and confidence limits were calculated using the standard probit method of Litchfield and Wilcoxon (1949).

a. Effect on eggs:

Data listed in Table (1) and illustrated in Fig. (1) represent the LC_{50} values, confidence limits, and slope of LC- p lines of the tested compounds against eggs (0–12 hours - old) of the insect. According to the LC_{50} values representing the toxicity to eggs of used insecticides could be arranged in the following descending order: hexaflumuron, profenofos, lufenuron, flufenoxuron and chlorfluazuron with LC_{50} values of 478.63, 707.95, 1023.29, 1096.48 and 1202.26, respectively, (Table 1).

Table(1): Toxicity of certain insecticides against eggs of potato tuber moth, *Phthorimaea operculella* (Zeller) under laboratory conditions.

Tested insecticides	LC_{50} values (ppm)	Confidence limits		Slope of LC-p lines
		Upper	Lower	
hexaflumuron	478.63	502.28	455.84	5.00
lufenuron	1023.29	1084.69	965.37	3.57
chlorfluazuron	1202.26	1322.49	1092.96	1.96
flufenoxuron	1096.48	1151.30	1044.27	0.075
profenofos	707.95	870.78	575.57	0.85

b. Effect on larvae:

Data presented in Table (2) and show in Fig.(1) show the larvicidal effects of the tested compounds against *P.operculella* larvae that fed on treated potato tubers. Profenofos, lufenuron and hexaflumuron recorded highly larvicidal effect with LC_{50} values of 2.88, 16.98 and 23.99 ppm, respectively.

Flufenoxuron and chlorfluazuron , however, caused lower larvicidal effect since their LC_{50} values were 229.09 and 331.13 ppm, respectively. The type, structure and concentration of the tested insecticides and the stage as well as the age of the insect appeared to have important role in this respect. Similar results were reported by Fisk *et al.* (1993) about the acylurea insect growth regulators have shown that these compounds have excellent activity against different stages of *S. exempta*.

Table(2): Toxicity of certain insecticides against larvae of potato tuber moth, *Phthorimaea operculella* (Zeller) under laboratory conditions.

Tested insecticides	LC_{50} values (ppm)	Confidence limits		Slope of LC-p lines
		Upper	Lower	
hexaflumuron	23.99	27.59	20.86	1.41
Lufenuron	16.98	19.02	15.16	1.85
chlorfluazuron	331.13	354.31	309.47	2.50
flufenoxuron	229.09	256.58	204.54	1.76
Profenofos	2.88	3.20	2.59	1.82

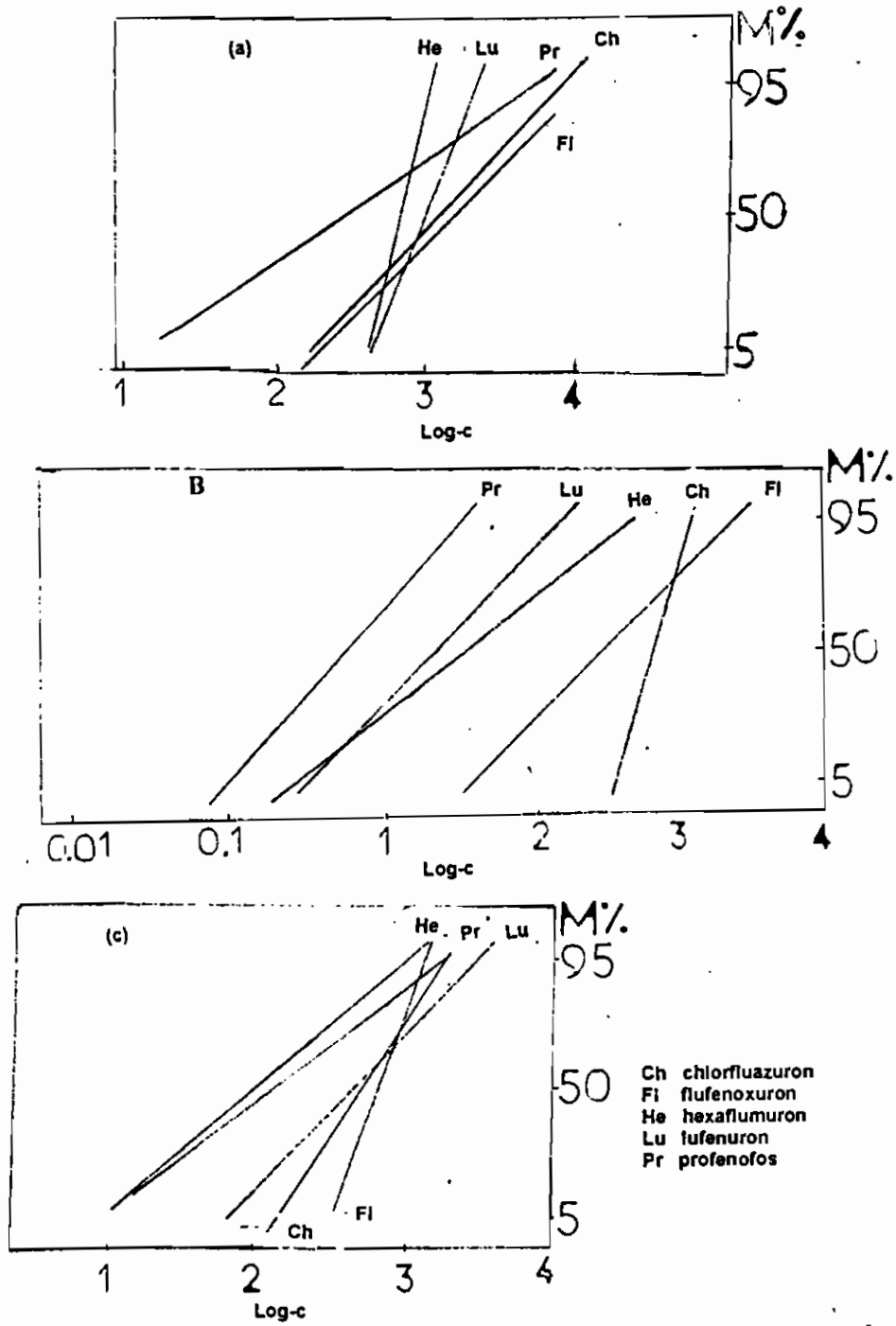

Fig. 1: The concentration-mortality lines of the tested compounds against (a) eggs, (b) larvae and (c) pupae of potato tuber moth, *P. Operculella* (Zeller).

c. Effect on pupae:

Data shown in Table (3) and Fig. (1) demonstrate the toxicity of the tested acylurea compounds and profenofos to pupae of *P.operculella* using dipping technique. Hexaflumuron was more potent insecticide to pupae than the other tested compounds. According to their LC_{50} values,
the tested compounds could be arranged in the following descending order: hexaflumuron, profenofos, lufenuron, chlorfluazuron, flufenoxuron. Similar finding, were recorded by Hamdy and Salem (1986), who stated that the application of methoprene either to potato tubers or to the sandy substrate satisfactorily suppressed the pupal and adult stages of *P.operculella* particularly at low and high concentrations.

Table(3): Toxicity of the tested insecticides against pupae of potato tuber moth, *Phthorimaea operculella* (Zeller) under laboratory conditions.

Tested Insecticides	LC_{50} alues (ppm)	Confidence limits		Slope of LC-p lines
		Upper	Lower	
hexaflumuron	102.33	120.75	86.72	1.64
Lufenuron	295.12	339.39	256.63	1.96
chlorfluazuron	501.18	541.27	464.06	3.85
flufenoxuron	562.34	612.95	515.91	3.57
Profenofos	117.49	140.99	97.91	1.46

Generally discussing, the overall obtained results indicated that: hexaflumuron and lufenuron were more effective against the three tested stages of *P.operculella* than chlorfluazuron and flufenoxuron. In such regard, Clarke and Jewess (1990) postulated that the lower effect of certain acylureas may be attributed to their less reaching the site of action or to their higher rates of metabolism and excretion. Also, the tested acylurea compounds were more toxic to larvae than eggs and pupae. Such effect may be attributed to the tested compounds may be more active by ingestion than by contact. (Al-Sayed, Ferial *et al.* (1984); Mostafa, Omyma and El-Attal, (1986); Herbert and Harper, 1985 and Biddinger and Hull, 1999).

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دراسات تقييم حيوى لبعض مشتقات الاسيل يوريا ضد فراشه درنات البطاطس

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أجريت دراسات معمليه لتقييم سميه بعض منظمات النمو الحشريه من مجموعة الاسيل يوريا hexaflumuron, lufenuron, chlorfluazuron and flufenoxuron ضد بيض ويرقات وعذارى فراشه درنات البطاطس وأظهرت النتائج المتحصل عليها لمشتقات الاسيل يوريا الاربعه المختبره بالاضافه لمركب profenofos كمركب قياسى نشاطا أباديا ضد فراشه درنات البطاطس.

كما بينت النتائج أن مركبى hexaflumuron, lufenuron كانا اشد سميه من مركبى chlorfluazuron , flufenoxuron ضد الاطوار الثلاثه المختبره وان الطور اليرقى كان اكثر حساسيه من طورى العذراء والبيض بقيم موت نصفية (LC_{50}) تراوحت بين ١٦,٩٨ الى ٣٣١,١٣ ، ١٠٢,٣٣ الى ٥٦٢,٣٤ ، ٤٧٨,٦٣ ، ١٢٠٢,٢٦ جزء فى المليون على التوالى .