Comparative Assessment of Toxicity, Persistence, and Latent Bio-Effects Post Semi-Field Treatment of Some Conventional and Non-Conventional Insecticides upon the Cotton Leafworm, *Spodoptera littoralis* (Boisd.) (Lepidoptera: Noctuidae).

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ABSTRACT: In the cotton fields, *Spodoptera littoralis*, a polyphagous lepidopteran insect, is known as a major pest since it destroys the entire cotton crop cycle and results in considerable economic losses. Perfect tactics for integrated pest management programs based on choosing which insecticides would be effective under the field conditions. The current study targeted to compare the initial, persistence and residual effect of non-conventional insecticides with various modes of action (Pyridalyl, Emamectin benzoate, Indoxacarb, and Triflumuron) and the conventional insecticide (Prophenofos) against the fourth instar larvae of *S. littoralis* field strain. Pyridalyl was the most effective with a high initial kill (93.25%) followed by Emamectin benzoate (90.31%) with longer residual effects. Pyridalyl showed the maximum persistence periods with LT_{50} (5.87 days) followed by Emamectin benzoate and Profenofos, which came in the second order with 1.62 and 1.37 days, respectively. All the tested insecticides caused latent effects after treatment. Pyridalyl and Triflumuron significantly prolonged the larval duration, followed by Emamectin benzoate and Profenofos. Pyridalyl and Emamectin benzoate treatments caused significantly high percentages of malformed pupae. All the insecticides reduced the adult emergence percentages. Profenofos, Emamectin benzoate and Pyridalyl reduced the fecundity percentage. Pyridalyl and Emamectin benzoate significantly prolonged the egg incubation period. Pyridalyl, Emamectin benzoate and Profenofos reduced egg fertility. Pyridalyl is thought to be an effective insecticide in Egyptian cotton fields infested with *S. littoralis* larvae followed by Emamectin benzoate with great safety for mammals and beneficial arthropods as part of an integrated pest management program.

Keywords: Semi field, *Spodoptera littoralis*, persistence, biology

INTRODUCTION

The Egyptian cotton leafworm, *Spodoptera littoralis* (Boisd.) (Lepidoptera: Noctuidae), is one of the most severe widespread pests destroying the national cotton industry. It is one of the pests under quarantine in the EPPO zone and continuously infests cotton as well as more than 87 host species of cultivated crops (**El-Sheikh, 2015, Hamama and Fergani, 2019**). The control programs against *S. littoralis* primarily rely on the intensive application of conventional pesticides, which cause undesirable effects on the environment, non-target organisms, beneficial insects, and also the progressive development of resistance and multiple resistance problems (**Aydin and Gürkan, 2006, Fergani *et al.*, 2022**). Therefore, the application of less toxic, environmentally safe, and biodegradable insecticides was important.

The mechanisms of conventional insecticides and organophosphates such as Prophenofos mainly affect acetylcholinesterase activity (AChE) followed by accumulation in peripheral and central nervous systems (**Smallman and Mansingh, 1969**). Pyridalyl has strong insecticidal properties against lepidopterous insects with a specific form of toxicity on the epidermal cell preventing the growth of the insects (**Sakamoto *et al.*, 2004**). Emamectin benzoate, a bio-insecticide produced by the modified soil bacterium, *Streptomyces avermitilis* affects the insect's neurological systems by an increase in chloride ion flux at the neuromuscular junction, which causes feeding to stop, inhibits muscle contraction and causes irreversible paralysis. Additionally, it acts as an agonist for GABA and glutamate-gated chloride channels. The blockage of voltage-dependent sodium channels is another mode of action induced by Indoxacarb (**Fanigliulo and Sacchetti, 2008; Fergani, 2019**). The bio-rational insecticides, insect growth regulators such as triflumuron interfere with the physiology of the pest through the stimulation of specific deterrent receptors or disrupt the chitin synthesis and development of the target pest (**El-Sabrout and Zahran 2016**).

The current semi-field study aims to evaluate the extent of initial and residual toxicity of the non-conventional insecticides (Pyridalyl, Emamectin benzoate, Indoxacarb, and Triflumuron) compared to the conventional one (Profenofos) on the fourth instar larvae of a field strain of S. *littoralis*. In addition, the persistence of these insecticides was examined in terms of the determination of the median lethal time (LT_{50}) and their latent effects on some biological parameters during the insect life cycle.

MATERIALS AND METHODS

Tested Insecticides:

Five technical-grade pesticides were evaluated:

1- Pyridalyl (Pleo® 50% EC) (2, 6-dichloro-4-4 (3, 3- dichloroallyloxy) phenyl-3-[5-(trifluoromethyl) - 2- pyridyloxy] propyl ether), supplied by Sumitomo Chemical Co. Ltd, applied at the rate of 100ml/Feddan.

2- Emamectin-benzoate (Amazon® 5.7% SG), (Avermectin) (4"-epi-methylamino-4"-deoxyavermectin Blb benzoate), supplied by Syngenta Co., was applied at the rate of 80 g /Feddan.

3- Indoxacarb (Eso plus® 30% WG), (Carbamate: oxadiazine), (S-Methyl-7-chloro-2[methoxycarbonyl-[4-(trifluoromethoxy)phenyl]carbamoyl]-3,5-dihydroindeno[1,2-e][1,3,4]oxadiazine-4a-carboxylate)(supplied by Du Pont Co., applied at 60 g /Feddan.

4- Prophenofos (Celian® 72% EC) (Organophosphate) supplied by Adwia Co., was applied at the rate of 750 ml/Feddan.

5- Triflumuron insecticides (Elsystin® 48% SC) (CSI), supplied by Syngenta Co., was applied at the rate of 100 ml/Feddan.

Rearing technique:

To establish a culture of the *S. littoralis* field strain, egg patches were collected from untreated cotton plants at Sakha Agricultural Research Farm, Kafr El-Sheikh Governorate; and transported to the lab at 27°C and 70°RH. On caster bean leaves (*Ricinus communis*), neonate larvae were reared until they reached the fourth larval instar, at which point they were treated according to **El-Defarwi *et al.* (1964).**

Semi-field applications:

On the farm of the Sakha Agricultural Research Station, the experiments were conducted by the end of May in the 2022 growing season. The local cotton plant variety (Giza 94) was planted in an experimental area of around 2000 m^2 in a randomized complete block design that was untreated with pesticides, and the recommended agricultural practices were implemented. The experimental area was divided into six equal plots. Four plots (each about $95m^2$) were assigned to each treatment in both the treated and untreated areas. Between plots, two rows of plants were left unsprayed. The spraying was carried out once on July 18 on cotton plants during the 2022 season with 100 liters of water for Feddan. Treatments were performed at sunset using a knapsack motor sprayer (CP3) of 20-liter capacity with one nozzle. The recommended field rate of each tested insecticide was used in conjunction with standard agricultural practices. The tested insecticides were diluted using irrigation water. Sprays completely cover the plants. Meanwhile, control plots were sprayed with water only.

Laboratory trials:

Toxicity studies:

To evaluate the toxicity of conventional (Profenofos) and non-conventional (Pyridalyl, Emamectin benzoate, Indoxacarb, and Triflumuron) insecticides against the field strain of *S. littoralis*, some egg masses were brought into the lab for hatching and reared in the laboratory at Sakha Agricultural Research Station, Plant Protection Research Institute Branch, Cotton Pesticides Evaluation Department under constant conditions of 27 ± 2°C, 70 ± 5 RH. Ten newly moulted 4^{th} instar larvae of *S. littoralis* were transferred to plastic pots (500 ml) covered with a clean piece of muslin cloth. The treated cotton leaves (0, 1, 3, 7, and 10 days) were randomly selected from each plot in the field and offered daily for feeding. Seven replicates were performed for each treatment and the control. Mortality percentages were recorded 48 hrs post-treatment. Mortality percentages were corrected according to Abbott's equation (Abbott, 1925). The LT_{50} and slope values of the tested insecticides were calculated using probit analysis at a 95% ($p \leq 0.05$) confidence level (Finney's equation, 1971).

Biological studies:

To evaluate the effect of the insecticides under investigation on some biological parameters, seventy newly moulted fourth instar larvae distributed in seven replicates (10 larvae\replicate) for each treatment were starved for six hrs. Treated cotton leaves were introduced to larvae and allowed to feed for 24 hrs on the treated cotton leaves. Alive larvae were transferred to jars containing fresh untreated cotton leaves and observed daily. The same technique was used for control treatment except those larvae were allowed to feed on untreated cotton leaves. Daily inspections were implemented until adult emergence. Larval mortality, larval and pupal duration, deformed pupa percentage, and adult emergence percentages were recorded compared to untreated control. Adult fecundity was determined by placing one female and one male in a glass jar (500 ml) provided with a piece of cotton soaked in 10% sugar solution as a source of food and covered with a clean piece of muslin cloth. Four jars were prepared with one male and one female for each treatment and the control. Clean sheets of twisted paper were put in each jar for oviposition. The jars were checked up daily for counting the number of laid eggs. Egg hatchability was determined by transferring four egg patches (more than 100eggs/patch) into clean plastic jars during the first three days of oviposition and incubating under laboratory conditions until hatching. The number of eggs /female, eggs' incubation period and hatchability percentages were recorded. Statistically significant differences were determined by one-way analysis of variance (ANOVA) (SPSS, 2004). Fecundity percentages were calculated according to **Crystal and Lachance (1963)** as follows:

$$\text{Fecundity \%} = \left\{ \frac{\text{No.eggs/treated female}}{\text{No.eggs/untreated female}} \right\} \times 100.$$

RESULTS

Toxicity of the tested insecticides against the fourth instar larvae of *S. littoralis*:

The toxicity of conventional (Profenofos) and non-conventional (Pyridalyl, Emamectin benzoate, Indoxacarb, and Triflumuron) insecticides with different insecticidal groups against fourth instar larvae of *S. littoralis* under laboratory conditions during the 2022 cotton growing season is shown in (Table 1). The obtained data showed that all the tested insecticides showed high initial toxicity (initial kill) on the fourth-instar larvae of *S. littoralis.* In terms of larval mortality, in a-descending order Pyridalyl, Emamectin benzoate, profenofos, Trprofenofosand Indoxacar,b caused mortality of 93.25, 90.31, 86.52, 75.91, and 65.24%, respectively.

Among the five tested insecticides, Pyridalyl was significantly the most toxic one after the tenth day against the 4th instar larvae of field strain causing (78.21%) followed by Emamectin benzoate causing (72.11%). Meanwhile, Indoxacarb was the least potent of other tested insecticides causing (45.62%). The obtained results showed that the residual effects decrease with increasing the exposure time in all treatments.

Insecticide Field Persistence:

To evaluate the persistence (the residual effect) of the tested insecticides through this investigation, the median lethal time (LT_{50}), the time needed to kill 50% of fourth-instar larvae of *S. littoralis* was determined (Table 2). Data showed the maximum persistence period (LT_{50}) value at the recommended rate of Pyridalyl was 5.87 days. Emamectin benzoate and Profenofos came in the second order with LT_{50} values of 4.62 and 2.37 days, respectively. On the other hand, Indoxacarb and Triflumuron showed minimal persistence periods with LT_{50} values of 1.62 and 1.37 days, respectively.

Table1. Initial and residual mortality of *S. littoralis* fourth-instar larvae upon treatment with conventional and non-conventional insecticides under semi-field conditions

Treatments	% Corrected larval mortality (Mean ±S.D.)				
	Days after spraying				
	Initial kill	Residual effect			
	Zero time	1st	3rd	7th	10th
Indoxacarb	65.24±1.49^{d}	60.55±1.51^{d}	50.45±1.21^{d}	50.00±2.61^{d}	45.62±1.12^{d}
Triflumuron	75.91±1.11^{c}	73.21±2.41^{c}	68.35±2.0^{c}	60.11±0.38^{c}	58.91±2.01^{c}
Profenofos	86.52±2.01^{b}	82.19±1.21^{b}	80.14±2.41^{b}	75.12±1.11^{b}	70.97±3.61^{b}
Emamectin benzoate	90.31±1.82^{a}	89.54±3.41^{a}	81.01±1.31^{a}	77.84±1.24^{b}	72.11±1.45^{b}
Pyridalyl	93.25±1.24^{a}	90.81±2.11^{a}	87.11±1.21^{a}	80.62±2.91^{a}	78.21±0.97^{a}
Control	0.00	0.00	0.00	0.00	0.00

-In a column, means followed by the same letters are non-significantly different, P≥0.05.

Table 2. Median lethal time (LT50) of the tested insecticides against the fourth instar larvae of S. littoralis under semi-field conditions

Treatments	LT_{50} Time(days) (95% Confidence limits)	Slope ± SE	X^2
Indoxacarb	1.62 (1.89-1.51)	1.08±0.11	0.89
Triflumuron	1.37 (1.41-1.01)	0.77±0.21	1.10
Profenofos	2.37 (2.98-2.42)	1.31±0.14	1.23
Emamectin benzoate	4.62 (6.45-4.01)	1.52±0.33	5.21
Pyridalyl	5.87 (7.11-4.21)	0.89±1.11	2.84

Latent effects of the tested insecticides on some biological aspects of *S. littoralis*:

The extended effects of the tested insecticides after semi-field treatments on larval mortality and some biological parameters of *S. littoralis* were assessed compared to the control (Tables 3 and 4). Pyridalyl and Triflumuron significantly prolonged the larval duration (19.51±1.52 and 18.81±1.21 days), respectively, followed by Emamectin benzoate and Profenofos (17.61±1.11 and 16.51±0.89 days). No significant effect on the larval duration was recorded in the case of Indoxacarb treatment compared to the control (14.50±1.60 days). However, Triflumuron, Profenofos, and Pyridalyl significantly prolonged the pupal duration by 11.78±1.23, 10.45±1.15, and 9.67±1.21 days, respectively, whereas Emamectin benzoate and Indoxacarb were less effective, 8.11±0.89 and 7.89±0.45 days, respectively compared to the normal untreated pupal duration (4.24 days).

Regarding the latent effects of the tested insecticides on the percentage of pupation and deformation in pupae, The data in Table 3 showed that the treatments with Pyridalyl and Emamectin benzoate significantly increased pupal deformation (14.76±1.62 and 13.23±1.98 %) respectively, followed by Indoxacarb treatment (8.81±1.33 %), Profenofos and Triflumuron treatment (5.41±1.21 and 3.11±1.24 %), compared to the control (2.21%). Concerning their latent effects on the adult emergence percentage, Pyridalyl, Profenofos and, Emamectin benzoate significantly decreased the adult emergence percentages (73.11, 70.1 and, 70.1%), followed by Triflumuron and Indoxacarb treatments (85.12 and 81.11%) compared to the untreated, which recorded 98.11%.

The data in Table (4) clearly showed the latent effect of the tested insecticides on the treated *S. littoralis* fourth instar larvae with regard to calculated fecundity percentages, egg incubation periods and egg hatchability percentages. The obtained results showed that Profenofos reduced the mean number of eggs laid by adult females 7.58% (349.13 eggs) followed by Emamectin benzoate at 25.39% (504.13 eggs) and Pyridalyl at 48.31 %(959.11eggs). while Triflumuron and Indoxacarb were slightly reduced the mean numbers of eggs laid by adult female that were 90.68 % (1800.14 eggs) and 83.12 %(1650.11 eggs) respectively, compared to the control's 100% (1985 eggs). On the other hand, The treatment with Pyridalyl and Emamectin benzoate significantly prolonged the incubation period of egg (4.32 days) followed by Profenofos (4.0 days), while Indoxacarb and Triflumuron slightly decreased the incubation period of eggs (3.21 and 3.11 days) compared to the untreated (4.32days). In connection with the extended effects of the tested insecticides on adult fertility termed by the percentage of egg hatchability recorded, Triflumuron and Indoxacarb slightly reduced the percentage of egg hatchability (84.11 and 80.23%) in the offspring generation, respectively. While Pyridalyl, Emamectin benzoate and Profenofos significantly reduced the percentage of egg hatchability (75.12, 72.32 and 67.21%), respectively, compared to the untreated (91.32%).

Table 3: The latent effects of the tested insecticides on some biological aspects of the surviving 4th instar larvae of *S. littoralis*

Pesticides	Larval duration (day)(Mean ±S.D.)	Pupal duration (day) (Mean ±S.D.)	Deformed pupae % (Mean ±S.D.)	Adult emergence % (Mean ±S.D.)
Indoxacarb	14.00±1.31 c	7.89±0.45 b	8.81±1.33 b	81.11±1.21 b
Triflumuron	18.81±1.21 a	11.78±1.23 a	3.11±1.24 c	85.12±1.51 b
Profenofos	16.51±0.89 b	10.45±1.15 a	5.41±1.21 c	70.1±1.09 c
Emamectin benzoate	17.61±1.11 b	8.11±0.89 b	13.23±1.98 a	70.1±2.00 c
Pyridalyl	19.51±1.52 a	9.67±1.21 a	14.76±1.62 a	73.11±0.98 c
Control	14.50±1.60 c	4.24±1.21 c	2.21±0.32 c	98.11±1.51 a

-In a column, means followed by the same letters are non-significantly different, P≥0.05.

Table4: The latent effects of the tested insecticides on female fecundity, egg production, incubation period and hatchability of *S. littoralis* eggs

Pesticides	No. eggs/female (Mean ±S.D.)	Fecundity % (Mean ±S.D.)	Incubation period (Mean ±S.D.)	Hatchability % (Mean ±S.D.)
Indoxacarb	1650.116.42 c	83.12±2.89 e	3.21±1.13 b	80.23±3.11 b
Triflumuron	1800.14±5.11 b	90.68±1.89 b	3.11±1.11 b	84.11±2.01 b
Profenofos	349.13±2.11 f	7.58±2.85 c	4.00±2.00 a	67.21±4.01 d
Emamectin benzoate	504.13±5.13 e	25.39±4.57 d	4.32±1.23 a	72.32±3.05 c
Pyridalyl	959.11±7.12 d	48.31±2.56 e	4.32±1.23 a	75.12±1.32 c
Control	1985.00±1.45a	100a	3.25±1.31 b	91.32±1.42 a

- In a column, means followed by the same letters are not significantly different, P≥0.05.

DISCUSSION

Through semi-field investigations, the initial toxicity of non-conventional insecticides (Pyridalyl, Emamectin benzoate, Indoxacarb, and Triflumuron) compared to conventional insecticides (Profenofos) was evaluated against fourth instar larvae of the *S. littoralis* field strain. The tabulated results showed that Pyridalyl induced the highest larval mortality against *S. littoralis* followed by Emamectin benzoate, Profenofos, Triflumuron, and Indoxacarb after different exposure times that decreased with elapsed time. The residual effect of Pyridalyl against fourth instar larvae of *S. littoralis* on cotton, when compared with the other tested insecticides, was in agreement with those of **Sakamoto *et al*., (2004)** and **Abbasi-Mojdehi, *et al*. (2019)**, who mentioned that this innovative insecticide, with a novel mode of action, showed significant toxicity to lepidopterous insects. It is distinct from any other traditional pesticides and has considerable safety for many types of non-target organisms. In addition, the obtained results are in line with the earlier work of **Satio *et al*. (2005)** and **Abdel-Hafez and Osman (2013)**, who concluded that Pyridalyl would be the most promising insecticide for the application against *S. litura*. Emamectin benzoate also showed high initial kill effects and showed residual effects until the tenth day achieving high protection for the cotton plant against the fourth instar larvae of *S. littoralis.* It was also mentioned that Emamectin benzoate had toxic effects against several larval instars of *S. littoralis* under semi-field evaluation that decreased by increasing the exposure time (**Fetoh *et al*., 2015**). In addition, **Ezz El-Din *et al*., (2009)** and **Abdu-Allah (2010)** proved that Emamectin-benzoate was the most effective insecticide against fourth instar larvae of *S. littoralis* than Profenofos and Indoxacarb. On the other hand, some investigations showed that the most effective insecticides of *S. littoralis* are Emamectin benzoate, which is followed by Indoxacarb, Pyridalyl, Profenofos and Triflumuron (**Bird, 2015, Silva *et al*., 2016 and Mushtaq and Sanobar, 2017**). **Korrat *et al*., 2012** proved that Emamectin benzoate (LC_{50} = 0.017 ppm) was more toxic than chlorfluazuron (LC_{50}= 0.42 ppm) and Profenofos (LC_{50}=10.9 ppm). Prophenofos, an organophosphorus insecticide, also demonstrated very high toxicity as a nerve poison that kills insects by inhibiting acetylcholinesterase and preventing nerve transmission. According to the data in Table 1, the tested pesticides caused significant mortality rates in the fourth instar larvae of *S. littoralis* during the semi-field trial, and those rates increased over time with residual effects ranging from 46% to 79%.

As regards the persistence of the tested insecticides in cotton plants under field conditions, our results showed that Pyridalyl has the superior residues with the highest (LT_{50}) value followed by Emamectin-benzoate and Profenofos in the second order. Meanwhile, the minimal persistence values were with Indoxacarb, Triflumuron, and these findings are in agreement with those of **El-Dewy, (2013)**. The persistence of any insecticide is defined as its capability to resist breaking and to be stable and effective with the same physical, chemical, and functional characteristics under environmental conditions **(Helfrich, 2009)**. In the field, many factors affect the persistence of insecticides starting from their characteristics including stability, volatility, solubility, and formulation through the site and method of application and the environmental conditions **(Beggel *et al*., 2010)**. In addition to the characteristics of the soil and water and their resistance to degradation, the characteristics of the crop, such as the kind of plant structure, stage, and growth rate, also might have an impact on the persistence of the insecticides. Even 14 days after treatment, according to **Isayama and Kasamatsu (2004)**, Pyridalyl still exhibited a 100% mortality rate in *S. litura* on potted cabbage plants, even after rainfall.

Based on the probit analysis, the persistence of the tested insecticides was expressed in the form of the median lethal time (LT_{50}), a standard time measurement that was used to study the effectiveness of the tested insecticide residues against the fourth instar of *S. littoralis* after application under field conditions by feeding the fourth instar larvae on the sprayed plants after zero, 1, 3, 7, and 10 days. The obtained results showed that Pyridalyl and Triflumuron could lead to prolongation of the larval duration followed by the effect of treatment with Emamectin benzoate and Profenofos. Meanwhile, the increased larval duration did not change the case of Indoxacarb treatment and these findings disagree with those of **Gamil *et al*., (2011)**, who found that treatment with sub-lethal doses of Indoxacarb caused the extended larval duration of *S. littoralis*. **El-Dewy, 2013** found that, when compared to the control treatment, Indoxacarb, followed by Emamectin-benzoate and Pyridalyl, significantly extended the larval duration of the fourth instar larvae of *S. littoralis*. In the same line, the obtained results clearly showed that Triflumuron, Profenofos and Pyridalyl significantly prolonged the pupal duration while Emamectin benzoate and Indoxacarb were the least effective compared to normal pupal duration and this disagrees with the findings of **Abdel-Hafez and Osman (2013)** that the pupation duration and adult emergence percentages of *S. littoralis* decreased as a result of the usage of Emamectin-benzoate and Pyridalyl. The reduction in the percentage of adult emergence in all treatments was in harmony with those obtained by **(Jian-jun and Tian 2009)**. The sub-lethal effects of Pyridalyl, Emamectin benzoate, Indoxacarb, Profenofos and Triflumuron in this study caused latent effects in terms of prolonged periods of larval and pupal duration, increasing the deformation percentages in pupae and the adult emergence percentage. This negative impact could be explained by a disturbance in hormone duration, which would cause physiological issues and interfere with the growth and development of *S. littoralis* after treatment. Triflumuron, a chitin synthesis inhibitor (CSI), has a lipophilic nature that may destroy the chitin in the exoskeleton of insects and prevent them from growing and moulting. Similar conclusions were obtained by **Bakr *et al*. (2010)**.

In the same line, the extended residual effects of the tested insecticides had a significant effect on the treated *S. littoralis* regarding the reduction in fecundity and fertility (hatchability), which was also recorded in all treatments compared to the control. The obtained results were in agreement with **El-Naggar, (2013)** and **El-Zahi, (2013)** who mentioned that Pyridalyl and Emamectin benzoate were effective in reducing fecundity and egg hatchability of *S. littoralis*. The reduction in fecundity in the case of treatment with Triflumuron was in agreement with those obtained by **Butter *et al*., (2003)** and **Saenz-de-Cabenzon *et al*., (2004)**. The failure of the oogenesis process and incomplete embryonic construction caused by the studied pesticides' sub-lethal effects may be caused by a deficiency in the essential nutrients supplied by the ovaries, such as lipids, carbohydrates, and yolk protein. **Shaurub *et al*., (1998)** clarified that the primary physiological disturbance of the treated females' ovaries during the larval instars may have been caused by a decrease in DNA and RNA synthesis, which caused the ovarian nurse cells and oocytes to vacuolate. **Soltani and Mazouni, (1992)** explained this reduction because of the reduction in longevity, the number of oocytes per ovary, and disturbance in the oviposition period. The reduction in egg hatchability was also in line with **Sallam, (1999)** who explained that it could be due to the disturbance in cuticle formation of the embryo with weakened chitinous mouthparts that were not sufficiently hard to hatch through the surrounding vitelline membrane.

In conclusion, the present semi-field study revealed that the promising non-conventional insecticides Pyridalyl and Emamectin benzoate showed better toxicity against *S. littoralis* after different time intervals, their residual effects were extended for longer periods; and their persistence in the field is extended when compared to the conventional insecticide (Profenofos). Pyridalyl and Emamectin benzoate have demonstrated high levels of selectivity in previous field studies, enabling long-term pest control. For the treatment of *S. littoralis*, extensive study should be conducted on these pesticides, with an emphasis on their application in the field.

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الملخص العربي

تقييم مقارن للسمية والثبات الحقلي والتأثيرات الممتدة على بعض المعايير البيولوجية الناشئة عن المعاملة شبه الحقلية ببعض المبيدات التقليدية والغير تقليدية ضد دودة ورق القطن.

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في حقول القطن تعتبر دودة ورق القطن من حرشفيات الأجنحة التي تدمر جميع أجزاء نبات القطن مسببة خسائر اقتصادية فادحة للمحصول. وتعتمد برامج المكافحة المتكاملة لها على كيفية إختيار المبيدات الملائمة والفعالة تحت الظروف الحقلية. وتهدف هذه الدراسة الشبه حقلية إلى مقارنة مجموعه من المبيدات الغير تقليدية وتشمل (البيريداليل والإيمامكتين بنزوات والإندوكساكارب والترايفلوميرون) بأحد المبيدات التقليدية (البروفينوفوس) في مكافحة العمر الرابع للسلالة الحقلية لدودة ورق القطن من حيث السمية والثبات والأثر المتبقي. وأوضحت النتائج أن مبيد البيرادليل هو أفضل هذه المبيدات من حيث السمية المباشرة يليه مبيد الإيمامكتين بنزوات مع تأثيرهم المتبقي المرتفع إلى اليوم العاشر. وأيضا إحتل مبيد البيرادليل المرتبة الأولى من حيث الثبات في الحقل يليه مبيدي الإيمامكتين بنزوات و البروفينوفوس. وأظهر مبيدي الإندوكساكارب والترايفلوميرون أقل نسبة ثبات في الحقل. كما أشارت النتائج إلى أن جميع المركبات سببت تغيرات بعد المعاملات. وقد سبب مبيدي البيرادليل والإيمامكتين بنزوات ظهور أعلى نسبه في تشوه العذارى يليه مبيد الإندوكساكارب. وقد وجد أن جميع المبيدات سببت حدوث خفض في النسب المئوية لخروج الحشرات. كما أظهرت النتائج تأثير مبيد البروفينوفوس على معدل الخصوبة ومعدل فقس البيض تلاه مبيدي الايمامكتين بنزوات والبيرادليل. بينما وجد أن مبيدات البيرادليل والإيمامكتين بنزوات أحدثت زيادة معنوية في طول فترة حضانة البيض أتبعها تأثير مبيد البروفينوفوس بينما لم يسبب مبيد الإندوكساكارب تأثير ملحوظ. وأيضا أظهرت مبيدات البيرادليل والإيمامكتين بنزوات و البروفينوفوس تأثيراً غير معنوي على معدل الخصوبة مقارنة بالكونترول. ومن خلال الدراسة نصف الحقلية الحالية أثبت مبيدي البيرادليل والإيمامكتين بنزوات فعاليتهما وتأثيرهما على العمر الرابع لدودة ورق القطن وإمكانية إستخدامهما بنجاح في برامج المكافحة في حقول القطن المصرية.