Influence of Some Novel Insecticides on Physiological and Biological Aspects of *Spodoptera littoralis* (Boisduval)

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ABSTRACT

Chloranitraniliprole, pyridalyl, indoxacarb, emamectin-benzoate and spinetoram are promising insecticides in the Lepidopteran insects control. The effect of the sublethal concentrations (LC_{25}) of these compounds on some physiological and biological aspects of the 4th larval instar of *Spodoptera littoralis* (Boisd.) laboratory strain using feeding technique was investigated. Based on the LC_{50} values, emamectin-benzoat was the most effective insecticide followed by indoxacarb while spinetoram was the least toxic one. Chloranitraniliprole and pyridalyl exhibited a moderate toxic effect. The tested insecticides at LC_{25} significantly decreased the consumption index, relative growth rate and efficiency of converting ingested and digested food into body tissue, while did not significantly affect the approximate digestibility. All the tested insecticides significantly prolonged the larval duration and decreased the pupal duration of *S.littorallis* without significant differences among them. As latent effects on survived larvae, these insecticides significantly decreased the percentages of normal pupae, adult emergence, fecundity and fertility of the pest as compared with control. Spinetoram was the least effective on the biological aspects. Pyridalyl, chloranitraniliprole, emamectin-benzoate and indoxacarb could be used as important tools in integrated management programs of *S. littoralis.*

Key words: Novel insecticides, physiological aspects, biological aspects, *Spodoptera littoralis*

INTRODUCTION

The noctuid *Spodoptera littoralis* (Boisduval) is a major polyphagous pest, widely distributed throughout Africa, Mediterranean area, Europe and several parts of Asia (Azab *et al*., 2001). Over the past 25 years, the extensive use of broad-spectrum insecticides against *S. littoralis* has led to the development of its resistance to many registered insecticides and caused serious problems in environment components and their natural balance between pests and the natural enemies (Abo Elghar *et al*., 2005; Adyin and Gurkan, 2006). Therefore, scientists and workers in the field of insect control are seeking alternatives that are effective against this pest, safe to humans, environmental friendly and compatible with integrated pest management (IPM). Among the most promising alternative to the conventional insecticides are Avermectins, Spinosyns, Oxadiazines, Pyridalyl and Anthronilic diamides with selective properties that are designed to act on specific biochemical sites of physiological processes of the target pests. Also, they have the potential for crop protection against economics pests with low hazard to environment component and natural enemies (Foster *et al*., 2003; Michaud and Grant, 2003; Sakamoto *et al*., 2005 and Dinter *et al*., 2008). Pyridalyl is a novel insecticide exerts excellent control against Lepidopteran and Thysanopteran pests on cotton, vegetables and fruits (Sakamato and Umedo, 2003). Chlorantranilifrole (Rynaxypyr) is a novel compound belonging to anthronilic diamides, featuring a novel mode of action by activating the insect ryanodine receptors, it stimulates the release and depletion of intracellular calcium stores from the sarcoplasmic reticulum of muscle cells, causing impaired muscle regulation, paralysis and ultimately death of sensitive species (Cordova *et al*., 2006), chlorantraniliprole has an excellent profile of safety to beneficial arthropods (Dinter *et al*., 2008). Indoxacarb represents a new class of insecticides (Oxidiazines, with its stomach and contact action (Wise *et al*., 2006. It blocks the movement of sodium ions into the nervous system, resulting in paralysis and death of the pest. Emamectin-benzoate is a novel semi-synthetic avermectin acts by interfering with the action of gamma aminobutyric acid (GABA), It blocks post-synaptic potentials of neuromuscular production and inhibit feeding (Pienkowski and Mehring, 1983 and Wright, 1984). Spinetoram is a new generation of spinosyn group. It causes excitation of the insect nervous system by altering the function of nicotinic and GABA gated ion channels. (Crouse and Sparks, 1998). Feeding and reproduction of any insect are very closely related to nutritional status, where the amount and quality of food consumed by a larvae influence its performance, growth rate, development time, finally its body weight and survival (Slansky and Scriber, 1985). Thus, this study aimed to evaluate the sublethal effects of pyridalyl, chloranitraniliprole, indoxacarb, emamectin-benzoate and spinetoram on some physiological aspects and biological aspects of the 4th larval instar of *S.littoralis* .

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MATERIALS AND METHODS

Insecticides

Commercial pyridalyl (Pleo 50% EC, Sumitomo Chemical Co.), anthranilic diamide insecticide, chloranitraniliprole, (Coragen, 20% SC, Du Pont Co.), indoxacarb (Avaunt, 15% EC, Du Pont Co.), emamectin-benzoate (Proclaim, 5% SG, Syngenta Co.) and spinetoram (Radiant, 12% SC, Daw Agro Sciences Co.) were used in this study.

Insect rearing

The laboratory strain of *Spodoptera littoralis* (Boisduval) was reared in the laboratory of Sakha Agricultural Research Station on Caster bean leaves under constant laboratory conditions of 25 $\pm$ 2^{o}C and 65 $\pm$ 5 R.H. according to (El-Defrawi *et al*., 1964).

Toxicological studies

To study the toxicity of emamectin benzoate, spinetoram, pyridalyl, chlorantaniliprole and indoxacarb against the newly moulted 4th larval instar of laboratory strain, a serial of aqueous concentrations of each compound was prepared. The leaf- dipping technique was adopted according to Abo Elghar *et al*. (1994), where fresh castor bean leaves were dipped for 10 seconds in one of the prepared concentrations. The treated leaves had dried under laboratory conditions before being offer to *S. littoralis* larvae. Hundred larvae distributed in ten replicates (10 larvae/replicate), were used for each concentration. Larvae were fed on leaves immersed in only water as a control. Newly moulted 4th larval instar were fed on the treated leaves in a glass jar covered with muslin for 24 h for the tested compound. The treated leaves were replaced by another untreated ones. Mortality percentages were recorded after 24, 48 and 72 h of treatment. The mortality was corrected using Abbott's formula (Abbott, 1925). The LC_{25}, LC_{50} and slope values of the tested compounds were calculated using the equation of Finney(1971), by software Program.

Physiological studies:

Caster bean leaves were soaked in LC_{25} of each insecticide (which calculated after 72h of exposure for 10 seconds. The newly moulted 4th larval instar of *S. littoralis* were starved for three hours before used in the tests to make insure on empty intestine (El-Malla and Radwan, 2008) and weighted. Five replicates of 10 larvae/each were allowed to fed on the treated leaves for 24 h, then provided daily with untreated leaves for three successive days (experimental period 4 days). Dead larvae were excluded, while the fresh weights of survivors, faeces and uneaten treated leaves in each replicate were daily recorded. Fresh leaves were kept in a similar rearing jar under the same conditions to estimate the natural loss of moisture, which was used for calculating the corrected weight of consumed fresh leaves. Food consumption and utilization were calculated according to the equation given by Waldbauer (1968) and Slansky and Scriber (1982) as follows:

1. Consumption index (CI) = C/TA
2. Relative growth rate (RGR) = (G/TA) x 100.
3. Approximate digestibility (AD) = [C-F)/C] x 100
4. Efficiency of conversion of ingested food to body tissue (ECI)= (G/C) x 100

Where:

C =Fresh weight of leaves consumed

T =Duration of feeding period

A =Mean fresh weight of the larva during the feeding period.

G =Fresh weight gain of the larvae.

F =Faeces weight during the feeding period.

During the experiment, the calculated mean weight (fresh) of the consumed treated leaves corrected as follows:

The corrected weight of leaves consumed [1-a/2][W-(L+bL)]

where:

a =The ratio of loss of water to the initial weight of leaf

b =The ratio of loss of water to final weight of leaf

w =Weight of food introduced

L =Weight of uneaten food.

T =Feeding period.

Antifeedant index were recorded according to Pavela *et al*. (2008)

The feeding deterrent index (FDI) = [(C-T)/(C+T)] x 100

Where: C and T are the control and treated leaves consumed by insect.

Biological studies

Caster bean leaves were soaked in LC_{25} of each insecticide, which was calculated after 72 h. Two hundred larvae were used for each insecticide.The larvae were placed in a glass jar and provided with the treated leaves for 24 h and then the survived larvae were transferred to jars containing fresh untreated leaves and checked daily to determine larval duration, pupal duration, percentages of normal pupae, deformed pupae and adult emergence. One female and one male of emerged adults were placed together, in wood box to maximize successful mating and provided with a piece of cotton soaked in 10% sugar solution as a source of food for each treatment. To determine the fertility (egg hatchability%), three or four patches having not less than 100 eggs were collected during the first three successive days of oviposition and incubated under the laboratory conditions until hatching and the neonates number was recorded, also fecundity (no. of eggs/female) and fecundity percentage was calculated according to Crystal and Lachance (1963) as follows:

$$\%Fecundity = \frac{No.eggs / treated\ female}{No.eggs / untreatedfemale} \times 100$$

Statistical analysis:

All data were subjected to analysis of variance (ANOVA) through SPSS computer program (2004) and the means values were compared using Duncan's multiple range test (1955).

RERSULTS AND DISCUSSION

1.**Susceptibility of *Spodoptera littoralis* to the tested insecticides:**

The results presented in Table (1) revealed that emamectin benzoate exerts excellent control of 4th larval instar of *S. littoralis* followed by indoxacarb. Spinetoram was the least effective after different exposure times. The descending order of larvicidal activity of the tested compounds. Emamectin-benzoate, indoxacarb, Pyridalyl, Chloranitraniliprole and spinetoram, where the LC_{50} values were 0.46, 4.17, 13.01, 15.0, and 48.52 mg a.i./l. after 48h. Their toxicity increased dramatically after 72h to be 0.364, 1.58, 10.16, 10.03, and 13.75 mg a.i./l.,respectively. The present results are in parallel with that of Abdel Rahim *et al.,2009;*El-dewy 2013; El-Naggar 2013 and EL-Sheikh, 2015), where they reported that emamectin-benzoate was the most effective compound against 4th larval instars' of *S. littoralis*, also El-Geddawy *et al.,*2014 stated that emamectin-benzoat is the most potent compound followed by indoxacarb and spinetoram of *S. littorallis*.

2- Effect of the tested insecticides on the food utilization and nutrition indicates of *Spodoptera littoralis* (Boisd.):

Three criteria have been used in judging the utilization of the food by *S.littoralis* larvae the digestibility of the food, the conversion of ingested or digested food into body tissue and the rate of consumption. The nutrition indices and food utilization were recorded and the data are presented in Table (2). It is clear that the larvae fed on treated leaves with LC_{25} of chloranitaniliprole, pyridalyl, indoxacarb, emamectin-benzoate and spinetoram showed significant decrease in their weight compared to control. Moreover, the antifeedant index indicated that emamectin-benzoate and chloranitraniliprole were the highest inhibitiors of feeding recording 36.72 and 32.05%, respectively. With respect to the consumption index (CI) and relative growth rate (RGR), both of emamectin-benzoate and chloranitraniliprole recorded high significant reduction in (CI) and (RGR) compared with control followed by pyridalyl, indoxacarb and spinetoram, without significant differences between them. Antifeedant and growth activity inhibitor reduce pest damage by products but it could be without killing the pest. Woodering *et al*. 1978 and Sundaramurthy, 1977 revealed that the amount of growth reduction was proportional in general to reduce food consumption. Concerning approximate digestibility and converting ingested or digested food % to body tissue, the results presented in Table (2) showed that the digestion of food ingested by larvae was not significantly affected by the tested insecticides.

Table 1. Toxicity of some novel insecticides against 4th larval instar of *Spodoptera littoralis* (Boisd.) by dipping technique at different exposure times

Insecticides	Time (hrs)	LC_{25} (ppm)	LC_{50} (ppm)	Confidence limits Upper	Confidence limits Lower	Slope values$\pm$SE
Chloranitraniliprole	48	15.0	27.72	45.34	22.99	3.22 $\pm$0.88
	72	1.42	10.03	12.44	6.57	1.97$\pm$0.234
Pyridalyl	24	24.83	37.88	42.18	33.59	3.68$\pm$0.45
	48	8.24	13.01	15.2	10.41	3.41$\pm$0.59
	72	5.17	10.16	12.38	7.10	3.12$\pm$.62
Indoxacarb	24	9.74	16.46	18.75	14.66	2.96$\pm$0.313
	48	1.21	4.17	5.34	3.04	1.25$\pm$0.17
	72	0.677	1.58	2.06	1.00	1.83$\pm$0.32
Emamectin-benzoate	48	0.46	1.35	1.67	1.12	1.45$\pm$0.22
	72	0.116	0.364	0.519	0.15	1.36$\pm$0.33
Spinetoram	48	16.0	48.52	61.11	38.45	1.98$\pm$0.93
	72	1.8	13.75	20.42	7.62	1.95$\pm$0.28

Both efficiency of converting ingested (ECI) and digested food (ECD) decreased for to all the tested insecticides compared with control, where ECI is an overall measure of an insect's ability to utilization the ingested food for growth. A drop in ECI indicated that most food is being converted into energy and less is being converting to body tissue (growth). ECD also decreased as the proportion of digested food converted into energy increased and associated with the loss of fitness because of starvation. Decreasing ECI and ECD values indicate that tested insecticides could be elicit some chronic toxicity. From the previous data, all treatment significantly reduced the digestibility. This may be due to the high percent of excretion of food consumption by larvae as compared to control. Generally, emamectin benzoate and chloranitraniliprole were the most effective with decreasing the consumption index, relative growth rate, efficiency of converting ingested and digested food into body tissue, whereas chloranitraniliprole rapidly inhibited the insect feeding and death normally occurs within 24-72 hours. Also, emamectin-benzoate stopped feeding within hours of ingestion and caused death within 48-96 hours. Spinetoram exhibited the least effective in all nutrition indicates and utilization food. Sublethal concentration of pesticides can provide useful information concerning the basic physiological and behavioral responses of the target insect pest and this could be of high important value when new compounds are evaluated for potential application in pest management program (Von Keyserlink, 1988) . The degree of utilization food depends upon the digestibility of the food and the efficiency with which digested food is converted into body material (Sooho and Frankel, 1966). Also, El-Shazly (1993) revealed that varied with the digestibility of food and amount of the digestible portion of food which is converted to body substance and metabolized for energy to maintain life. Our results are in conformity with those obtained by Abo El-Ghar 1993 and El-Malla and Radwan, 2008). They reported that growth rate, consumption index, approximate digestibility, efficiency of conversions of either ingested or digested food to body tissue of *S. littoralis* larvae fed on Abamectin and Sumialfa decreased compared to untreated larvae.

On the other hand, Hassan, 2009; El-Naggar 2013; El-Sheikh 2015 and Rashwann, 2013) found that chloranitraniliprole, emamectin-benzoate and indoxacarb significantly decreased the nutrition indicates and utilization of food. In addition Chunmei Xu et al. (2016) showed that cyantraniliprole had markedly antifeedant effects against 4^{th} instar larvae of *Agrotis ipsilon*, which relatively decreased the same parameters of nutrition indices and utilization food.

3- Effects of the tested insecticides on some biological aspects of *Spodoptera littoralis*:

To determine biological aspects of *S. littoralis*, the newly moulted of 4^{th} instar larvae were fed on caster bean leaves treated with LC_{25} of chloranitraniliprole, pyridalyl, indoxacarb, emamectin-benzoate and spinetoram 24 h and untreated leaves until pupation. The main biological aspects were recorded and the results were presented in Tables (3 and 4).

The results presented in Table (3) showed that all the tested insecticides significantly increased the larval duration which recorded as indoxacarb (23.5 days), chloranitraniliprole (19.0 days) ,pyridalyl (16.5 days) and spinetoram (15.0 days) compared to the control (13.0 days)

In contrary, the tested insecticides decreased the pupal duration without significantly differences among them, while spinetoram significantly prolonged the pupal duration (12 days).

With respect to the latent effects, the data in Table (3) indicated that indoxacarb was the most effective recording (35.0, 9.86 and 71.93%) compared to control (98.0, 1.45 and 97.44%) to percentages of normal pupae, deformed pupae and adult emergence, respectively, followed by pyridalyl (78.88, 12.68, 67.28%), and spinetoram (95.81, 0.67, 82.76). These results are in agreement with the findings of Amer *et al*. (2012). Abdel-Hafez and Osman (2013) found that emamectin-benzoate and pyridalyl decreased pupal weight, pupation and adult emergence percentages of *S. littoralis*. Also, Chunmei Xu *et al*. (2016) stated that sublethal doses of cyantraniliprole at LC_5, $LC_{20,}$ and LC_{40} levels prolonged larval and pupal duration and extended mean generation time and total preovipositional period of *Agrotis ipsilon*.

With regard to fecundity and percentages of fecundity and eggs hatchability, the results presented in Table (4) indicated that indoxacarb and pyridalyl had noticeably decreased the mean numbers of eggs laid by adult female (fecundity), also eggs hatchability (fertility) was significantly decreased in the offspring generation after the parent fourth instar larvae treated with indoxacarb recording 443.43 eggs/female, 20.67%fecundity and 66.11% fertility followed by pyridalyl (816.67 eggs/female, 38.07% fecundity and 67.28% fertility as compared to control (2145.0 eggs/female, 100% fecundity and 97.44% fertility.

Table 2. Effect of novel insecticides at their LC_{25} values on the food utilization and nutritional indices of *Spodoptera littoralis* of 4th larval instar (mean ± SE)

Insecticides	LC_{25} (mg a.i./L)	Mean of larval weight (g) ± SE	Antifeedant index % ± SE	Consumption index (CI)% ± SE	Relative growth rate ± SE	Approximate digestibility ± SE	Converting ingested food (ECI) ± SE	Converting digested food % (ECD) ± SE
Chloranitraniliprole	1.42	0.047±0.001 c	32.05±1.761 b	1.27±0.035 c	-12.44±2.42 e	99.49±0.309 a	-2.81±0.408 c	-2.82±0.399 c
Pyridalyl	5.17	0.055±0.003 bc	28.5±0.99 b	1.99±0.124 a	10.27±0.655 c	98.93±0.615 a	6.113±0.860 b	6.133±0.86 b
Indoxacarb	0.677	0.052±0.001 c	19.03±0.641 c	1.69±0.150 ab	9.94±0.681 c	99.05±0.082 a	5.05±1.229 b	5.1±1.248 b
Emamectin-benzoate	0.116	0.048±0.002 c	36.72±1.703 a	1.19±0.068 c	-1.741±0.191 d	98.33±0.615 a	-1.51±0.391 c	-1.53±0.395 c
Spinetoram	1.8	0.0062±0.003 b	11.61±0.825 d	1.73±0.186 ab	14.02±0.964 b	92.66±3.019 a	6.49±0.617 b	6.54±0.630 b
Control		0.126±0.003a		1.49±0.12 bc	25.41±0.572 a	95.78±2.023 a	18.03±1.428 a	18.87±1.726 a

Means in the same column followed by the same letter are not significantly different according to Duncan Multiple Range Test .

(-):mean the tested compound exhibited negative effects on the growth of the pest

Table 3. Some biological aspects for survived 4th larval instar of *Spodoptera littoralis* laboratory strain when fed on treated castor bean leaves with LC_{25} value of some novel insecticides

Insecticides	LC_{25} (mg a.i./L)	Larval duration (days $\pm$ SE)	Pupal duration days $\pm$ SE	Normal pupae % $\pm$ SE	Deformed pupae % $\pm$ SE	Adult emergence % $\pm$ SE
Chloranitraniliprole	1.42	19$\pm$1.732 b	8.5$\pm$0.866 b	92.5$\pm$1.299 b	1.0$\pm$0.289 b	80.73$\pm$0.289 b
Pyridalyl	5.17	16.5$\pm$0.866 c	8.0$\pm$1.155 b	78.88$\pm$1.663 d	12.68$\pm$1.732 a	67.28$\pm$4.04 c
Indoxacarb	0.677	23.5$\pm$1.443 a	9.5$\pm$0.86 ab	35.0$\pm$1.155 d	9.68$\pm$1.547 a	71.93$\pm$1.732 c
Emamectin-benzoate	0.116	13.0$\pm$0.577 d	8.0$\pm$1.368 b	86.1$\pm$1.212 c	3.22$\pm$1.155 b	79.19$\pm$2.309 b
Spinetoram	1.8	15.0$\pm$0.86 cd	12.0$\pm$0.57 a	95.81$\pm$1.732 ab	0.67$\pm$0.21 b	82.76$\pm$1.732 b
Control		13.0$\pm$1.52 d	2.5$\pm$0.866 a	98.0$\pm$0.57 a	1.45$\pm$0.259 b	97.44$\pm$0.57 a

Means in the same column followed by the same letter are not significantly different according to Duncan Multiple Range Test .

Table 4. Effect of the tested insecticides on number of egg per femal, Fecundity% and egg hatchability of *Spodoptera littoralis*

Insecticides	LC_{25} (mg a.i./L)	No. of eggs/female $\pm$ SE	Fecundity % $\pm$ SE	Egg hatchability + SE
Chloranitraniliprole	1.42	1705.36+11.547 c	93.43+1.73 b	76.8+3.64 b
Pyridalyl	5.17	816.67+9.238 e	38.07+4.62 d	67.28+1.443 c
Indoxacarb	0.677	443.43+23.09 f	20.67+2.88 e	66.11+4.04 c
Emamectin-benzoate	0.116	1307.94+9.82 d	60.98+8.66 c	77.85+4.04 c
Spinetoram	1.8	2004.17+8.08 b	79.5+5.19 b	82.43+1.732 b
Control		2145.00+25.98 a	100 a	97.44+0.866 a

Means in the same column followed by the same letter are not significantly different according to Duncan Multiple Range Test (1955).

Spinetoram was the lowest effective one giving (2004.17 eggs/female, 79.5% fecundity and 82.43% fertility. The reduction in fecundity may be due to disfunction of maturation of an insect egg which depend on the materials that are synthesized by the ovary in suit which includes protein, lipids and carbohydrates, all of which required for embryonic structure (Shaurub *et al*., 1998). On the other hand, reduction in feeding activity of the insect may reduce normal development, weight gain, fecundity and increase mortality (Van Duyn, 1971).

.These results are in agreement with that obtained by many investigators. Abdel-Rahim et al., 2009) who found that emamectin benzoate and pyridalyl at LC_{50} increased the larval and pupal duration of *S. littoralis* and decreased fecundity and fertility. Meanwhile, El-Naggar, 2013 and El-Zahi , 2013 repoted that pyridalyl was more effective against 4th larval instar of *S. littoralis* than emamectin benzoate on the most biological aspects compared to control.

CONCLUSION

From the obtained results, it could be concluded that the novel insecticides, pyridalyl, chloranitaniliprole, emamectin-benzoate and indoxacarb had high effect on *S. littoralis*, where their sublethal concentration (LC_{25}) significantly decreased the utilization food, nutritional indicates and some biological aspects. Thus these compounds could be considered as important tools in integrated management programs of *Spodoptera littoralis*

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الملخص العربي

تأثير بعض المبيدات الحديثة على الصفات الفسيولوجية والبيولوجية لدودة ورق القطن

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مركبات كلورنترانيليبرو، بيريداليل، إندوكساكارب، إيمامكتين بنزوات وسبنتورام مبيدات جديدة موصى باستخدامها في مكافحة يرقات رتبة حرشفية الأجنحة، لذا تهدف الدراسة إلى معرفة تأثير التركيز التحت مميت (LC_{25}) لهذه المركبات على بعض المؤشرات الفسيولوجية ومنها التأثير على معدلات التغذية ودرجة الاستفادة من الغذاء وكذلك دراسة تأثيراتها المتأخرة على بعض الصفات البيولوجية على العمر اليرقى الرابع للسلالة المعملية لدودة ورق القطن وذلك بطريقة التغذية. أوضحت النتائج على أساس التركيز القاتل ل٥٠% من الأفراد المعاملة أن مبيد الأيمامكتين بنزوات أقوى المركبات سمية يليه مبيد الأندوكساكارب بينما أقلها سمية مبيد سبنتورام، أحدث مركبي كلورنترانيليبرو وبيريداليل تأثيرا متوسط السمية. وبناءاً على التركيز القاتل لـ٢٥% من الأفراد المعاملة أن جميع المركبات سالفة الذكر أحدثت خفض معنوي في معامل الاستهلاك ومعدل النمو ومعدل تحول الغذاء المستهلك والمهضوم داخل جسم الآفة، وعلى العكس من ذلك لم تؤثر معنويا على معدل هضم الغذاء مقارنة بالكنترول.كما أظهرت المركبات المختبرة تأثير معنوي في زيادة فترة العمر اليرقى ولكنها أدت إلى خفض معنوي في فترة التعذير وبدون فروق معنوية بين هذه المركبات، وقد أظهرت التأثيرات المتأخرة لهذه المركبات بناءاً على (LC_{25}) حدوث خفض معنوي في النسبة المئوية للتعذير وخروج الفراشات الكاملة وخصوبة البيض الناتج وكذلك خصوبة الأنثى المعاملة مقارنة بالكنترول. مبيد سبنتورام أظهر فاعلية أقل في التأثير على الصفات البيولوجية المدروسة. عامة فإن مركبات بيريداليل، كلورنترانيليبرو، إيمامكتين – بنزوات وإندوكسا كارب يمكن أن تلعب دورا هاما في مكافحة دودة ورق القطن ضمن برامج المكافحة المتكاملة.