

**EFFICIENCY OF NATURAL PRODUCT EMAMECTIN BENZOATE  
AGAINST COTTON LEAFWORM, *SPODOPTERA LITTORALIS*  
(BOISD) AND PINK BOLLWORM, *PECTINOPHORA*  
*GOSSYPIELLA* (SAUND.)**

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**Abstract**

Field and laboratory trials were conducted in Zagazig – Sharkia Governorate during 2007 and 2008 cotton seasons to evaluate the efficacy of emamectin benzoate (against cotton leafworm *Spodoptera littoralis* and pink bollworm *Pectinophora gossypiella*). Emamectin benzoate resulted in initial kill of 93.73 and 92.39 % reductions in the numbers of cotton leafworm *Spodoptera littoralis*, larvae, comparing with 98.22 and 95.93 % for the recommended IGR hexaflumuron (Consult) (while as the residual effect emamectin benzoate revealed to 83.69 and 82.35% reductions comparing with 95.07 and 93.93 % for the hexaflumuron, in 2007 and 2008 cotton seasons, respectively). The efficiency of emamectin benzoate in comparison with the recommended insecticide chlorpyrifos (Dursban) against cotton bollworm, pink bollworm, *Pectinophora gossypiella*, they resulted in 59.40 and 54.68% for emamectin benzoate, and 81.81 and 83.21% for chlorpyrifos as average seasonal reductions, during the two cotton seasons, respectively. Laboratory trials revealed that LC<sub>50</sub> and LC<sub>90</sub> of emamectin benzoate were higher with cotton leafworm than pink bollworm, which were 2.783 and 1.656 ppm at LC<sub>50</sub>, while they were 29.096 and 11.193 ppm at LC<sub>90</sub>, respectively. The slope value of emamectin benzoate with cotton leafworm was 1.257 less than with pink bollworm which recorded 1.544.

**INTRODUCTION**

Cotton leafworm, *Spodoptera littoralis*, and pink bollworm, *Pectinophora gossypiella*, are the major pest's destructive cotton fields in Egypt. The organophosphate, carbamate, and pyrethroid classes of insecticides represented the major elements for controlling these pests for many years. The environment, animals and human strongly affected by these hazard insecticides, as well as the insects became resistance in different degrees to their actions. So, it is necessary to use safe control agents including chemicals of new made of action in control programs of both insect pests.

Emamectin benzoate a new bioinsecticide was isolated from fermentation of *Streptomyces avermitilis* a naturally occurring soil. Biochemistry acts by stimulating the release of  $\gamma$ -aminobutyric acid, an inhibitory neurotransmitter thus causing paralysis, Tomlin (2003).

Among the bioinsecticides, emamectin benzoate was found to be the best with the highest relative toxicity (1093.2, 986.5, 870.6, 254.3 & 160.3 times) than triazophos, cypermethrin, deltamethrin, chlorpyrifos and quinalphos, respectively, to resistant strain of *Spodoptera litura* (Fab.) to which the pest was developed high levels resistance Prasad *et al.* (2007). In field trial, abamectin 1.8% EC significantly effective in suppressing bollworm incidence of complex (*Earias vittella*, *Helicoverpa armigera* and *Pectinophora gossypiella*) and increased the seed cotton over control. They stated that the potentiality of abamectin would fit in very well towards the development of specific strategies and tactics for the management of bollworms complex with the novel molecules as an alternative to synthetic insecticides. Birah *et al.* (2008) and Raghuraman *et al.* (2008) suggested that the EC formulation of emamectin benzoate could be recommended as a component of sustainable management of bollworms in cotton.

This work aimed to evaluate the efficacy of emamectin benzoate against cotton leafworm, *S. littoralis* and pink bollworm, *P. gossypiella*, under field and laboratory conditions.

## MATERIALS AND METHODS

Field and laboratory trials were carried to evaluate the efficacy of emamectin benzoate against major cotton insect pests on Egypt, cotton leafworm, *S. littoralis* and pink bollworm, *P. gossypiella*.

### FIELD TRIALS

Field trials were carried out in Inshas Elbasal - Zagazig - Sharkia Governorate, during 2007 and 2008 cotton seasons.

#### Cotton leafworm trials

The emamectin benzoate (Emamectin EC 1.9%) at the rate of 300 ml/feddans, was evaluated against cotton leafworm, *S. littoralis* in cotton field in comparing with the recommended IGR hexaflumuron (Atabron EC 10%) at the rate of 200 ml/feddans. Egg masses in three feddans of cotton field were not collected and left to hatching. When the hatched larvae reached to about the end of their 3<sup>rd</sup> instar larvae, the area was divided into three equal areas of one feddan for each, representing the three treatments, emamectin benzoate, hexaflumuron and control. The numbers of cotton leafworm per 100 cotton plants (except the newly hatched larvae collected around the egg masses) were counted for every treatment before spray directly, then 400 liters of the insecticidal solutions were performed using earth motor. The numbers of cotton leafworm per 100 cotton plants were counted 5, 10 and 15 days after spray. Henderson and Telton (1955) equation was used to calculate the reduction

percentages of cotton leafworm larvae. The reduction in numbers of larvae after 5 days was represented initial kill, and the average reduction after 10 and 15 days was represented residual effect.

### **Pink bollworm trials**

The emamectin benzoate (EC 1.9%) at the rate of 300 ml/feddan, was evaluated against pink bollworm, *Pectinophora gossypiella*, in cotton field in comparing with the recommended insecticide chlorpyrifos (Dursban EC 48%) at the rate of 1000 ml/feddan.

Area of one feddan of cotton field for every insecticide and control, was used to conduct the evaluation. Hundred green bolls were collected randomly from each treatment area and examined in laboratory. The numbers of pink bollworm larvae were recorded, and when the infestations reached to 5%, the program of spray began. Three spray applications with 15 days interval of the two insecticides were done using 600 liters insecticidal solutions by earth motor. Hundred green bolls were collected randomly from each treatment before spraying and weekly after application, and reductions were calculated according to Henderson and Telton (1955) equation.

## **LABORATORY TRIALS**

### **1- Cotton leafworm**

A susceptible strain (laboratory strain) of *S. littoralis* was used in this experiment. Using a dipping technique, disks of castor bean leaves were dipped in graduated concentrations solutions of emamectin benzoate for 10 second, and left to dryness, and then offered to the 2<sup>nd</sup> instar larvae in glass containers of ½ kg capacity, every glass container contain 10 larvae, and three replicates were used for every concentration and the same technique which used with control treatment using castor bean leaves dipped in water only and dried before offered to the larvae. After treatment the larvae were held in electric incubator at 26±1 °C and 75±5 % RH. After 24 hours the experiment was investigated and the dead larvae were recorded and removed. The alive larvae were transferred to another glass container contain untreated castor bean leaves. The experiment was investigated daily till the 5<sup>th</sup> day. The percent mortalities of larvae after 5 days were calculated and corrected when needed using abbott's formula (1925). The LC<sub>50</sub> and LC<sub>90</sub> were calculated according to Finny (1971)

### **2- Pink bollworm**

The proper conditions and diet for maintaining laboratory colony of the pink bollworm, *P. gossypiella* were followed according to the method described by Abd El-Hafez *et al.* (1982).

Serial aqueous dilutions were prepared for emamectin benzoate. 1 ml. of each dilution was mixed with 5 g of artificial diet in Petri dishes and left to dryness. The newly hatched larvae of pink bollworm were offered to the Petri dishes. Four replicates of ten larvae were used for every dilution and another 4 replicates were left without treatment as check. After treatment, the larvae were held in electric incubator at  $26 \pm 1$  °C and  $75 \pm 5$  % RH. After 24 hours, the alive larvae were recorded and transferred to another clean Petri dishes contains untreated artificial diet. After 5 days, the percent mortalities were calculated and corrected according to Abbott's formula (1925). The LC<sub>50</sub> and LC<sub>90</sub> were calculated according to Finny (1971)

Results were analyzed by using a microcomputer based probit analysis. The concentration – mortality line for emamectin benzoate with every tested insect, and the LC<sub>50</sub> and LC<sub>90</sub> were determined.

## RESULTS AND DISCUSSION

### FIELD TRIALS

#### **Efficacy of emamectin benzoate against cotton leafworm *Spodoptera littoralis***

The efficiency of emamectin benzoate comparing with the recommended insect growth regulator (IGR) hexaflumuron against cotton leafworm *S. littoralis*, during 2007 and 2008 cotton seasons was evaluated and the obtained data presented in Table (1).

For the initial kill which represent the percent reduction in the numbers of the cotton leafworm larvae after 5 days of insecticides application, emamectin benzoate resulted in 93.73 and 92.39 % reductions comparing with 98.22 and 95.93 % for the recommended IGR hexaflumuron, in 2007 and 2008 cotton seasons, respectively.

According to the residual effect as shown in Table (1), emamectin benzoate revealed 83.69 and 82.35% reductions comparing with 95.07 and 93.93 % for the IGR, hexaflumuron, in 2007 and 2008 cotton seasons, respectively. Cook *et al.* (2007) found that emamectin benzoate controlled *Spodoptera exigua* infestation in cotton plant up to 10 days after treatment compared to the untreated. Argentine *et al.* (2002) reported that emamectin benzoate was effective in controlling *Spodoptera exigua* on sugar beet at projected field rate. Prasad *et al.* (2007) reported that emamectin was the most toxic against *Spodoptera litura* followed by novaluron and indoxacarb. Kumar *et al.* (2008) found that the LC<sub>50</sub> value of emamectin benzoate was 0.00266 and 0.02 ug larva<sup>-1</sup> for susceptible and field population of *Earias vittella*, respectively.

The previous data appeared highly efficiency of emamectin benzoate in controlling the larvae of cotton leafworm, and strongly showed a promise in using this

compound in the integrated management of cotton leafworm, especially because it has a new mode of action than that of the recommended insecticides for this pest, and also for its low toxicity against beneficial insects.

#### **Efficacy of emamectin benzoate against pink bollworm, *Pectinophora gossypiella***

The efficiency of emamectin benzoate comparing with the recommended insecticide chlorpyrifos against cotton bollworm and pink bollworm, *P. gossypiella*, during 2007 and 2008 cotton seasons are presented in Table (2).

The two insecticides were applied three times with 15 days intervals on cotton plants to determine their efficiency in reducing the infestation of cotton green bolls with pink bollworm. The results revealed that chlorpyrifos was more active than emamectin benzoate. The average seasonal reductions rates were 59.40 and 54.68% for emamectin benzoate, and were recorded 81.81 and 83.21% for chlorpyrifos during 2007 and 2008 cotton seasons, respectively.

#### **LABORATORY TRIALS**

Data collected in Table (3) showed that at LC<sub>50</sub> and LC<sub>90</sub> values of emamectin benzoate were higher with cotton leafworm than pink bollworm, as they were 2.783 and 1.656 ppm at LC<sub>50</sub>, while were 29.096 and 11.193 ppm at LC<sub>90</sub>, respectively. The slope value of emamectin benzoate with cotton leafworm was 1.257 less than with pink bollworm which recorded 1.544.

The obtained results shown in Table (3) clearly showed that emamectin benzoate was more toxic on pink bollworm, *P. gossypiella*, than cotton leafworm *S. littoralis*. Also, values of slope revealed that pink bollworm more susceptible for emamectin benzoate than cotton leafworm. Dhawan *et al.* (2007) found that the LC<sub>50</sub> of emamectin benzoate against the third instar larvae of *S. littoralis* was 0.0001 ppm, and the emamectin benzoate was the most toxic insecticide comparing to other tested insecticides.

Concerning the toxic effects of emamectin benzoate against cotton leafworm and pink bollworm, data obtained from field and laboratory trials exhibited opposite effects against both insect pests. There for, so we must not depend on the results of laboratory as values can recorded in the field, because there is many factors in the field can change these values, such as photo stability Trans laminar uptake, leaf nutritional status, Verkerk and Wright (1996). Behavior feeding of the insect in the field, amount of toxicant uptake by the insect or the age of the insect, and many other factors.

Data obtained showed a promising to use emamectin benzoate in the integrated control programs of cotton leafworm, *S. littoralis*, and pink bollworm, *P. gossypiella*,

Table 1. The efficiency of emamectin benzoate comparing with the recommended insect growth regulator (IGR) hexaflumuron against cotton leafworm *Spodoptera littoralis*, during 2007 and 2008 cotton seasons

Seasons	Insecticides	Dose /feddan	Numbers of cotton leafworm larvae before application	Numbers of larvae and reductions	Numbers and reductions of cotton leafworm larvae			Initial kill	Residual effect
					5 days	10 days	15 days		
2007	Emamectin benzoate	300 ml	750	Numbers	55	69	16	93.73	83.69
				Reduction	93.73	88.73	78.66		
	Hexaflumuron	200 ml	1350	Numbers	28	35	9	98.22	95.07
				Reduction	98.22	96.82	93.33		
	Control	-----	1120	Numbers	1310	915	112		
	2008	Emamectin benzoate	300 ml	1150	Numbers	105	80	67	92.39
Reduction					92.39	86.08	78.63		
Hexaflumuron		200 ml	1270	Numbers	62	33	24	95.93	93.93
				Reduction	95.93	94.80	93.07		
Control		-----	1100	Numbers	1320	550	300		

Table 2. The efficiency of emamectin benzoate compared with the recommended insecticide chlorpyrifos against cotton bollworm, pink bollworm, *Pectinophora gossypiella*, during 2007 and 2008 cotton seasons

Seasons	Insecticides	Dose /feddan	Numbers of pink bollworm larvae before application	Numbers of larvae and reductions	Numbers and reductions of pink bollworm larvae /100 green bolls after application									% average seasonal reductions
					1 <sup>st</sup> spray			2 <sup>nd</sup> spray			3 <sup>rd</sup> spray			
					1week	2 weeks	Mean reduction	1week	2 weeks	Mean reduction	1week	2 weeks	Mean reduction	
2007	Emamectin benzoate	300 ml	3	Numbers	3	5	-----	7	8	-----	12	17	-----	59.40
				Reduction	60.00	58.33	59.16	61.11	64.44	62.77	57.89	54.66	56.27	
	Chlorpyrifos	1000 ml	4	Numbers	3	3	-----	3	5	-----	5	9	-----	81.81
				Reduction	70.00	81.25	75.62	87.50	83.33	85.41	86.84	82.00	84.42	
	Control	-----	2	Numbers	5	8	-----	12	15	-----	19	25	-----	-----
2008	Emamectin benzoate	300 ml	4	Numbers	5	9	-----	10	13	-----	18	22	-----	54.68
				Reduction	53.12	51.78	52.45	58.33	55.68	57.01	55.00	54.16	54.58	
	Chlorpyrifos	1000 ml	4	Numbers	3	4	-----	3	4	-----	5	6	-----	83.21
				Reduction	71.87	78.57	75.22	87.50	86.36	86.93	87.50	87.50	87.50	
	Control	-----	3	Numbers	8	14	-----	18	22	-----	30	36	-----	-----

Table 3. The LC<sub>50</sub>, LC<sub>90</sub> and slope of emamectin benzoate on cotton leafworm *Spodoptera littoralis*, and pink bollworm *Pectinophora gossypiella*

Insect	LC <sub>50</sub>	LC <sub>90</sub>	Slope
Cotton leafworm	2.783	29.096	1.257
Pink bollworm	1.656	11.193	1.544



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## تقييم فعالية المركب الطبيعي ايمامكتين بنزوات علي كل من دودة ورق القطن ودودة اللوز القرنفلية

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أجريت تجارب حقلية و معملية بمحافظة الشرقية مركز الزقازيق خلال عامي ٢٠٠٧ و ٢٠٠٨ لتقييم تأثير مركب الأيمامكتين بنزوات علي دودة ورق القطن ودودة اللوز القرنفليه وقد أوضحت النتائج أن مركب الأيمامكتين بنزوات سبب خفض أولي قدرة ٩٣,٧٣ و ٩٢,٣٩ % في تعداد دودة ورق القطن مقارنة بنسب خفض ٩٨,٢٢ و ٩٥,٩٣ % لمركب الهكسافلومورون بينما الأثر الباقي لمركب الأيمامكتين بنزوات اظهر خفض في تعداد يرقات دودة ورق القطن قدرة ٨٣,٦٩ و ٨٢,٣٥ % مقارنة بنسب خفض ٩٥,٠٧ و ٩٣,٩٣ % لمركب الهكسافلومورون في موسمي ٢٠٠٧ و ٢٠٠٨ علي التوالي. علي الجانب الأخر سبب مركب الأيمامكتين بنزوات متوسط خفض سنوي قدرة ٥٩,٤٠ و ٥٤,٦٨ % في تعداد يرقات دودة اللوز القرنفليه مقارنة بـ ٨١,٨١ و ٨٣,٢١ % لمركب الكلوروبريفوس خلال موسمي الدراسة ٢٠٠٧ و ٢٠٠٨ علي التوالي. في حين أوضحت التجارب المعملية إن قيمة  $LC_{50}$  و  $LC_{90}$  لمركب الأيمامكتين بنزوات كانت ٢,٧٨٣ و ٢٩,٠٩٦ جزء في المليون لدودة ورق القطن و ١,٦٥٦ و ١١,١٩٣ جزء في المليون بالنسبة لدودة اللوز القرنفليه.