Recent Approaches To Control Bollworms In Cotton Fields

El-Bassiuony M. M
Plant Protection Res., Institute Agric. Res. Center, Alex., Egypt

ABSTRACT

This study was carried out in a private farm at Abo-Homos, El-bihaeira governorate, to evaluate certain new control measures against bollworms in cotton fields through the application of certain insecticides i.e.; the insect growth inhibitor: Atabron® & Match® and /or bio-pesticides: Agerin®, Dipel-2x® and Spintor® with releasing the parasitoid *Trichogramma evanscens* in comparison with the conventional insecticide (a Synthetic pyrethroide"Sumi-Alpha®"). Also the effect of these compounds was determined on the yield. The results indicated the positive effective role of each of used insect growth inhibitors: Atabron® & Match® and /or bio-pesticides: Agerin®, Dipel-2x® & Spintor® with releasing the parasitoid *Trichogramma evanscens*, which to more or less extent decreased the rate of the infestation of cotton bolls with the pink and spiny bollworms (*Pectinophora gossypiella* & *Earis insulana*). Yield production was increased compared with the conventional insecticide and untreated check. In addition, the results indicated that the efficiency of the evaluated unconventional insecticides could be arranged descendingly as follows: Spintor® followed by Atabron®, Dipel-2x®, Match® and the least tested compound was Agerin®. In conclusion, both of Atabron® and Spintor® with releasing the parasitoid *Trichogramma evanscens* can be used instead of the Synthetic pyrethroide"Sumi-Alpha®" for controlling cotton bollworms to attain a decreased hazardous effect on the environment and human.

INTRODUCTION

Cotton, the world's most important fiber crop is grown on more than 74 million acres in some 80 countries (EPA, 1980). Eight of the top producers are, The United States, India, China, The Soviet Union, Egypt, Brazil, Mexico and Argentina which produce more than nine-tenths of the world crop.

Amongst common prevailing destructive pests in cotton plantation, the lepidopterous bollworms which are considered to be the most destructive late season insect pests on cotton plants in Egypt. Particularly cotton plants are considered to be the most favorable host to them. All parts of cotton plant are subjected to the infestation of each of the above mentioned pests. The most damage parts of the cotton plants are the foliage, squers, and green bolls.

Pesticides can provide economical protection from pests that otherwise would cause significant loss. Careless or excessive use of pesticides, however, can result in poor control, crop damage, higher expenses and hazards to health and the environment. Crop injury (phytotoxicity) due to pesticides can result from an improper application

method, poor timing or/and excessive rates of application; drift and residues in soil or water. Moreover, the extensive use of pesticides in cotton fields has seriously affected the population densities of natural enemies. Also, the widespread application of pesticides might accelerate the density occurrence of some cotton pests, mostly insects and mites, which developed resistance to certain pesticides.

The biological control of phytophagous insects by mass release of egg parasitoids has become more practical in recent years. Practical uses of trichogrammatid egg parasitoids are new being used against many lepidopterous pests on several key crop i.e.; corn, sugar-cane, cotton, fruit trees and vegetables (Hassan, 1993; Smith, 1994; Andow et al., 1995; Zandigiacome & Greatti, 1997and Abd El-Hafez & Nada, 2000; Khidr *et al.*,2003).

Therefore, the present study was adopted to evaluate the efficiency of application of some new insecticides, bio-insecticides and a natural compound with the consequent release of the parasitoid *Trichogramma evanscens* in reducing the infestation incidence by the cotton bollworms.

MATERIAL AND METHODES

1. Experimental design:

Field experiments were carried out in a private farm at Abo-Homos, El-Bihaeira Governorate, Egypt, during two successive growing cotton seasons of 2003 and 2004.

Whereas, in both seasons of 2003 and 2004, an area of one feddan and half was cultivated with cotton variety (Geiza 70) on April the10th and the 20th, respectively. The normal agricultural practices were followed during both seasons. The experimental area was divided in to plots each of 0.25 feddan (1050m^2). The completely randomized block design was utilized in the initiated experimental traits with three replicates for each treatment as well as untreated check. Each plot was separated from the adjacent one by half-meter belt to minimize the interference of spray drift from one treatment to another.

2. Treatments:

The pesticides and their common name, chemical name, chemical structure and applied rate per feddan are shown as follows:

2.1. IGIs group:

a. Lufenuron (Match®) 5% EC; (*RS*)-1-[2,5 - dichoro-4-(1,1,2,3,3,3-hexa fluro propoxy) phenyl]-3-(2,6-difluoro benzyl) urea. It was supplied by Sengenta Co. and sprayed at a rate of 400 ml/fed.

b. Chlorfluazron (Atabron®) 5% EC; 1-[3, 5-dichloro-4-(3chloro-5-trifluoro methyl-2-pyriloxy) phenyl]-3-(2, 6-difluro benzoyl) urea. Applied at a rate of 200 ml/fed.

2.2. The Synthetic pyrethroides:

Es-Fenvalerate (Sumi-Alpha®) 5% EC (S)-α-cyano-3-phenoxy benzyl. (S) -2-(4-chlorophenyl)-3-methyl butyrate. It was applied at a rate of 600 cm^3 / fed.

3.2. Bio-insecticides:

a. Agerin® (6.5%WP) is a commercial product of *Bacillus thuringiensis* sup.sp. *kurstaki* (*B.t*) (32000 IU/mg).It is produced by the International Company for Bio-Gro- Egypt under license from: Agricultural Genetic Engineering Research Institute-AGERI ARC-Geiza. And applied at a rate of 500 g/Fed.

b. Dipel-2x® (WP) is also a commercial product of *Bacillus thuringiensis* sup.sp. kurstaki (B.t) 32000 IU/mg. and applied at a rate of 200 g/Fed.

4.2. Natural compound:

Spinosad (Spintor®) 24 SC; it is a novel preparation and has unique mode of action which provides a new tool for insect control that can be used to slow the development of resistance for most of insect of stored products. It is a new class (Naturalyte); and was applied at a rate of 50 ml/Fed.

5.2. The parasitoid used:

The parasitoid *Trichogramma evanscens* was used as ready-use package under name of TRICO® which kindly obtained from International Company for Bio-Agriculture, Cairo, Egypt.

3. Releasing of the parasitoid *Trichogramma evanscens*.

The parasitoid was released as pupae within the parasitized *Sitotroga cerealella* eggs at a rate of 23100-26400 parasites/ feddan. Releases were applied into the field using a device that protects the parasitoid pupae from predators and unfavorable weather conditions. To decrease the labor cost, the device which consists of thick paper card (8 x 12 cm.) was modified, as it was folded to make a closed container (8 x 6 cm.). Three cards of Angoumois grain moth *Sitotroga cerealella* eggs (1x1cm.) (containing parasitoid pupae about 350-400 pupae per card; each card contained three different stages of pupae development 1, 2 & 3 days pre emergence) were glued in this container with a pupae total of 1050-1200 parasitoids / card. Cards were hanged manually before the sunset on the plant at about 50 cm above the ground. Each feddan required about 22 cards; though the rate of releasing comprised 22 paper cards / feddan / release. Also, the distance between the release points was 14m, and started 7m apart from the edges of the field (Agamy, 2003). In the first

season, the parasitoid release was conducted after boll formation on July, the 25th, while, in the 2nd season of 2004, parasitoid release was performed on July, the 5th, after the formation of 1st fruiting branch of cotton plant.

4. Sampling technique of cotton bollworms for insects inspection:

The tested pesticides against the pink bollworm (*Pectinophora gosspiella*) (Saund) (Lepidoptera: Gelechiidae) and the spiny bollworm (*Earias insulana*) (Boisd) (Lepidoptera: Noctuidae) during cotton seasons of 2003 &2004 were applied when the number of detected insect-pest was equal or exceeded the economic threshold of infestation (3 %), under the release of *Trichgramma evanescens* program.

Prior to the application of treatments (release of the parasitoid or/and pesticides spray), an initial estimation of the level of infestation was carried out immediately to determine the primary infestation level of bollworms. Later weekly samples of 100 green bolls / treatment were taken randomly. The level of bollworm infestation was weekly estimated along ten weeks during the growing season of 2003 & 2004. In each taken sample, the bolls were examined externally before dissection and internal inspection. Infestation records were based on the existence of injury symptoms regardless the presence of the larvae. Statistical analysis using "F" and "L.S.D." testes was performed for the comparison.

5. Determination of cotton yield:

In each treatment, ripened open bolls from twenty-five cotton plants were collected to determine the rate of cotton yield / plant, from which, the total yield /feddan was relatively calculated as follows:

$$\text{Yield} = \frac{\text{Plant yield (g) x No. of plants /F (45000)}}{1000 \times 157.5}$$

RESULTS AND DISCUSSION

1. Effect of field application of the tested chemical & bio-insecticides with release of the parasitoid *Trichogramma evanescens* on bollworms infestation:

The pink and the spiny bollworms are the most destructive insect-pests of cotton. If they left uncontrolled, they could cause a great reduction of cotton yield. Controlling bollworms by chemical means alone is rather costly, in addition to the hazards they luring to man and the environment. The used parasitoids *Trichogramma sp.* is an alternative biological control tool that has been found to be effective against the cotton bollworms in

Egypt. *Trichogramma* species are small parasitoids that attack a variety of lepidopterous pests. They have the advantage of attacking bollworms by ovipositing on and parasitizing their eggs.

In this study, the integration of *T. evanescens* with other control measures was investigated. The release of the parasitoid as pupae must be performed in the pre-emergence time or as merely emerging adult. So, the release of pupae was lately done at a time of 4-5 pm for enhancing the incidence of high rate of active parasitization. In case of light infestation (<3%) the release of the parasitoid was only done and later parasitoids release was repeated at fortnight intervals. While, incase of recording high infestation (>3%) that release was performed at 7 days intervals before the application of the tested compounds to avoid the possible drastic effect of them on the parasitoids adults.

The data represented in Table 1 show the effect of the application of the different tested insecticides with the synchronous release of the parasitoid *T. evanescens* on the number of the inspected pink and spiny bollworm larvae/100bolls during the cotton growing season of 2003. In comparison to the rate of inspected and counted larvae for the untreated check and those of the different treatments, it is evident that all the applied treatments except Agerin®, reduced the number of both the pink and spiny bollworm larvae to be less than the Economic Injury Level (EIL). The least efficiency of Agerin® (B.t based formulation) was clearly observed all over the inspection intervals post application time.On the other hand, the chemical insecticide Es-Fenvalerate was the most efficient compound allover and up to the end of the inspection periods.

Generally, it was noticed that the number of the pink bollworm *Pectinophora gossypiella* larvae was more than that of the spiny bollworm *Earias insulana* in the choosen cultivated area during the growing season of 2003. The inspected number of the spiny bollworm larvae was reduced from 6 larvae / 100 bolls to 2 larvae / 100 bolls after the first treatmental application till the third one and they reduced to zero larvae after the 4th and 5th applications of chemical treatments, while that of the pink bollworm was more reduced or/and coincided after the 4^{th} and 5^{th} applications of performed treatments.

From the Table 1, it could be also seen that Chlorfluazuron was as effective as Es-fenvalerate giving a lower trend of reduced infestation that gained by the application of Es-Fenvalerate. Therefore, Es-Fenvalerate as a chemical insecticide can be altered or replaced by chlorfluazuron to get best results through the treatment of releasing the parasitoid *T. evanescens* and to avoid its drastic effect on the beneficial insects (parasitoids and predators) and on the environment.

Because Agerin® was proved to be the least efficient compound among the tested insecticides; it was replaced by the Spintor® (a spinosad compound) which had been tested with the other insecticides during the cotton growing season of 2004.

The included results in Table 2 show the effect of the tested insecticides with the release of the parasitoid *T. evanescens* on the pink and spiny bollworms infestation. It could be seen that the infestation during the cotton growing season of 2004 was low compared with that of 2003. Therefore, the effect of the different treatments with the parasitoid release will not be clearly pronounced. Nevertheless, it could be said that all the run treatments kept the level of the infestation low.

During the growing season of 2004, the number of applications (two applications) was less than that of 2003 (five applications) due to the greatly reduced number of inspected bollworm larvae [less than the EIL (3 %)]. The release of the parasitoid was done during the period of the low infestation and the pesticide applications were started by the end of August 2004. Again, the number of the pink bollworm larvae was relatively higher than that of the spiny bollworm. Along the period of pesticides application, the number of both inspected bollworms was greatly reduced or completely coincided, particularly in case of the use of the chemical insecticides Es-Fenvalerate, the most effective insecticides which has been followed by Spintor®. These results are in agreement with those obtained by Nalting *et al.*(1997) who reported that spinosad (used as Tracer®) at low rates (0.04-0.11 lb ai/acre) provided levels of activity on cotton pests similar to those pyrethroids applied at recommended use rates. The two tested IGIs, Lufenuron and Chlorfluazuron were equal in their effect on reduced the number of bollworms larvae. Dipel® was more effective on the spiny bollworm and less effective on the pink bollworm because the newely hatched larvae of pink bollworm penetrate the locules of a green bolls within few hours post hatching to hide and feed on the internal content of boll, while the spiny bollworm larvae still exposed to the residues of the applied pesticides due to their feeding habits and that might give the chance of ingesting the bacteria *B. thuringiensis* to the limit that its mode of action can be pronounced and completed.

2. Effect of the tested chemical & bio-insecticides with release of the parasitoid *Trichogramma evanescens* on cotton yield (seasons of 2003 and 2004).

Injury of cotton plants by pests can best be understood in terms of their effect on cotton yield. The first affected plant stage after seeds germination is the vegetative growth which is attacked by mites and other

sucking pests. The most damaging insect pests are those attacking bolls: the pink and spiny bollworms which reduce the yield vigorously .

Cotton yield can be used as an indicator to show the positive effectiveness of the tested insecticides in reducing the insect-pest; mainly those affecting and attacking cotton bolls, the fibers and seeds within them .

Data concerning the effect of the evaluated conventional and unconventional insecticides with release of *Trichogramma evanescens* on cotton yield in the growing cotton seasons of 2003 and2004 are shown in Table 3. In the general, unconventional insecticides with the release of *Trichogramma evanescens* [Lufenuron = "Match®", Chlorfluazuron = "Atabron®", Agerin® and Diepl-2x®] and/or the conventional [Es-Fenvalerate = "SumiAlpha®"] produced higher yield giving 7.7, 7.9, 3.7, 7.8 and 8.5 ken. /F, respectively. In this concern, the tested insecticides can be arranged in the following descending order: SumiAlpha® › Atabron® › Dipl-2x® › Match® › Agerin®, as compared with the untreated check (3.5 ken. /F). However, the application of Agerin® gave a lower cotton yield of 3.7 ken. /F in comparison to the other treatments. The results also elucidate that the unconventional insecticides with release of *Trichogramma evanescens* [Lufenuron = "Match®", Chlorfluazuron = "Atabron®", Spintor® and Dipel-2x®] and conventional [Es-Fenvalerate = "SumiAlpha®"] tested during the cotton season of 2004 produced higher yields amounted to 7.9, 8, 8.2, 8.1and 8.2 ken. /F, respectively. In this concern, Spintor® & SumiAlpha® gave the higher yield that amounted to 8.2 ken. /F in comparison to the untreated check (4.4 ken./F). These results would assure that the application of Spinosad provided levels of activity on cotton pests similar to that synthetic pyrethroid that has been used to control these pests.

Table (1): Effect of the application of different insecticides on the number of the pink and spiny bollworms larvae/100 bolls with *Trichogramma evanescens* release during the season of 2003.

Compound	Before treatment (25/7)		No. and date of pesticides sprays									
			1st*** (15/8)		2nd (30/8)		3rd (13/9)		4th (28/9)		5th (13/10)	
	P**	S**	P	S	P	S	P	S	P	S	P	S
Lufenuron	19.03	8.67	10.00c*	4.00c	10.00c	2.00c	8.00c	2.67c	8.00b	1.00cd	4.00c	1.33c
Chlorfluazuron	18.00	6.00	10.00c	2.67cd	10.00c	2.00c	5.33d	2.00c	2.00e	0.67d	2.00d	0.67c
Agerin®	20.67	8.00	15.00b	8.00b	24.00b	13.33a	22.00b	8.00b	21.00b	8.00b	22.00b	8.00 b
Dipel-2x®	19.00	6.00	10.00c	8.00b	8.67d	4.76b	6.00d	2.00c	2.67c	2.00c	2.00d	1.33c
Es-Fenvalerate	20.00	6.00	10.00c	2.00d	4.00e	2.00c	2.00e	2.00c	2.00f	0.00d	0.67e	0.00c
Untreated cheek	24.00	6.33	23.33a	15.33a	30.00a	14.00a	34.00a	10.00a	34.00a	10.00a	36.00a	10.0 0a
Calculated F			88.01	74.08	309.13	255.30	465.45	38.75	1076.00	140.71	82.93	82.9 3
L.S.D.$_{0.05}$			1.78	1.78	1.78	1.19	1.78	1.78	1.19	1.11	1.45	1.45

*** *Trichogramma evanescens* was released in 25/7, 9/8, 24/8, 9/9, 22/9, 7/10.
**P = the pink bollworm *Pectinophora gosspiella* larvae and S =the spiny bollworm *Earias insulana* larvae.
*Means followed by the same letter(s) are not significantly different.

Table (2): Effect of the application of different insecticides on the number of pink and spiny bollworm larvae/100bolls with *Trichogramma evanescens* release during the season of 2004.

Compound	No. and date before sprays								No. and date after pesticides sprays			
	12/7***		27/7		12/8		1st 27/8		2nd 12/9		27/9	
	P**	S**	P	S	P	S	P	S	P	S	P	S
Lufenuron	0.00	0.00	0.00	0.00	1.00	0.00	4.00	2.00	3.33b*	0.67b	1.33bc	0.00b
Chlorfluazuron	0.00	0.00	0.00	0.00	0.00	1.00	4.00	2.00	3.33b	0.00b	1.33bc	0.00b
Spintor®	0.00	0.00	0.00	0.00	2.00	0.00	4.00	1.00	3.33b	0.00b	0.67bc	0.00b
Dipel-2x®	0.00	0.00	0.00	0.00	0.00	2.00	3.33	4.00	2.67b	0.00b	2.00b	0.00b
Es-Fenvalerate	0.00	0.00	0.00	0.00	0.00	0.00	4.00	2.00	3.33b	0.00b	0.00c	0.00b
Untreated ccccccheek	2.00	2.00	4.00	2.00	6.00	4.00	8.00	4.00	6.67a	4.00a	7.33a	2..00a
Calculated F	-	-	-	-	-	-	-	-	5.47	34.60	23.63	0.84
L.S.D.$_{0.05}$	-	-	-	-	-	-	-	-	2.05	-	1.68	-

*** *Trichogramma evanescens* was released in 5/7, 20/7, 5/8, 20/8, 4/9, 19/9.
**P = the pink bollworm *Pectinophora gosspiella* larvae and S =the spiny bollworm *Earias insulana* larvae.
*Means followed by the same letter(s) with the same column are not significantly different.

Table (3): Effect of different tested insecticides with the release of *Trichogramma evanescens* on cotton yield (season of 2004).

Treatments	Seed cotton yield			
	Season 2003		Season 2004	
	(g)/plant	(Ken.)/Fed.	(g)/plant	(Ken.)/Fed.
Es-Fenvalerate	29.8	8.5	28.6	8.2
Lufenuron	27	7.7	27.8	7.9
Chlorfluazuron	27.8	7.9	28	8
Agerin®	12.8	3.7	-	-
Spintor®	-	-	28.6	8.2
Dipel-2x®	27.2	7.8	28.4	8.1
Untreated	12.4	3.5	15.5	4.4

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الملخص العربى

بعض الأتجاهات الحديثة فى مكافحة ديدان اللوز فى حقول القطن

محمد محمد البسيونى

مركز البحوث الزراعية- معهد بحوث وقاية النبات – الأسكندرية – مصر

تم إجراء التجربة الحقلية فى هذة الدراسة فى مزراعة بمركز أبوحمص – محافظة البحيرة وذلك أثناء مواسم النمو 2003 و 2004. وتهدف إلى تقيم دور الأعداء الطبيعية فى ظل إستخدام بعض بدائل المركبات الكماوية مثل (مثبطات النمو الحشرى والمبيدات الحيوية) وأثراها فى خفض لإصابة القطن ببعض أفات حرشفية الأجنحة (ديدان اللوز) وتأثيرها على خصائص المحصول وإنتاجيتة. وأظهرت النتائج المتحصل عليها مايالى: 1- عند أطلاق طفيل التريكوجراما فى موسم 2003 و قبل تطبيق معاملات رش المركبات المختبرة بسبعة أيام على فترات مختلفة خوالى 14 يوماً بين الأطلاقة والأخرى. أوضحت النتائج أن كل المعاملات التى أجريت فى ظل أطلاق طفيل التريكوجراما أدت إلى خفض عدد يرقات كلاً من ديدان اللوز القرنفلية والشوكية ماعدا الأجرين® الذى كان أقل المركبات المستعملة تأثيراً. بعكس سومى ألفا® مركب بيرثرويد الذى كان أكثرها تاثيراً. كما اثبتت النتائج أن الكلورفليزرون (الأتبرون®) مع أطلاق طفيل التريكوجراما أعطى نتائج قريبة أو مماثلة للسومى ألفا® و كان أكثر تأثيراً من ليفينيرون (مانتش®), لذا فإنة من الممكن إستبدال سومى ألفا® بالكلورفليزرون (الأتابرون®) فى برنامج مكافحة ديدان اللوز كمركب أمن بيئياً. بينما فى موسم 2004 كانت الإصابة منخفضة بالمقارنة بموسم 2003 نظراً لأن أطلاق الطفيل فى هذا الموسم قد تمت مبكراً مع ظهور أول

فرع ثمرى فى النصف الأول من شهر يوليو مما تسبب فى هذا الإنخفاض وعندما وصلت الإصابة إلى الحد الأقتصادى الحرج فى نهاية شهر أغسطس تم تطبيق رش المبيدات المستعملة التى حافظت على هذا المستوى المنخفض للإصابة حتى نهاية الموسم. وأكدت نتائجهذا الموسم أيضاً أن مركب السومى ألفا® كان أكثر هذه المركبات فعالية يلية فى ذلك مركب السبينوساد (سبينتور®).ثم مركبين IGIs [الكلورفليزرون (الأتابرون®) و الليفينيرون (مانتش®)] اللذان تساوى فى التأثير. كما وجدا أن تأثير مركب الدايبل® (*Bt*) على ديدان اللوز الشوكية كان أكثر منه على ديدان اللوز القرنفلية.2 - أدى إستخدام مثبطات النمو الحشرى, المبيدات الحيوية و المركب الكيماوي سومى ألفا® فى ظل إطلاق طفيل التريكوجراما إلى الحصول على محصول عالى فى ظل إصابة منخفضة بديدان اللوز حيث قدرت الأنتاجية بـ 8.5 , 7.7 , 7.9 , 7.8 قنطار قطن زهر / فدان لكلاً من سومى ألفا® , الليفينيرون (مانتش®) , الكلورفليزرون (الأتابرون®) و الدايبل® على التوالى ماعدا الأجرين® الذى لم تزيد إنتاجيتة عن 3.7 قنطار / فدان مقارنةً بالكنترول (3.5 قنطار / فدان) وذلك خلال موسم 2003 ولذا لم يتم إستخدامة فى الموسم التالى. بينما أدى إستخدام مثبطات النمو الحشرى, المبيدات الحيوية و المركب الكيماوي في ظل إطلاق طفيل التريكوجراما فى موسم 2004 إلى الحصول على محصول عالى وإصابةمنخفضة بديدان اللوز حيث قدرت الأنتاجية بـ 8.2 , 7.9 , 8 , 8.1 , 8.2 قنطار قطن زهر / فدان لكلاً من سومى ألفا® , الليفينيرون (مانتش®) , الكلورفليزرون (الأتابرون®) , الدايبل® والأسبينتور® على التوالى مقارنة بالكنترول الذى وصلت إنتاجيتة إلى 4.4 قنطار / فدان، مما أوضح أن تأثير المركب الكيماوي سومى ألفا® تعادل مع تأثير مركب الأسبنتور® فى تحقيق الأنتاجية العالية وذلك لتساوى تأثير كلاً منهما على معدل الأصابة المنخفضة بديدان اللوز ممايشجع تأكيد إمكانية إستخدام الأسبينتور® كبديل للمركبات البرثرويد فى برامج مكافحة ديدان لخفض معدلات التلوث وتحقيق الأمان البيئى.