INTEGRATED PEST MANAGEMENT ON MAJOR COTTON INSECT PESTS AT KAFR EL-SHEIKH REGION

AHMED HASSEN MESBAH

Plant Protection Research Institute, Department of Biological Control, A.R.C., Giza

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Abstract

Integrated pest management (IPM) trial was carried out at Kafr El-Sheikh region on a cotton field during three seasons (2003, 2004 and 2005) compared with traditional insecticides treated field. In IPM field, any control decision was taken on basis of the weekly surveying of the cotton pests and associated predators as well as the pheromone bait trap moths of both *Pectinophora gossypiella* (Sound) and *Spodoptera littoralis* (Boisd) every three nights. In IPM field, four releases of egg parasitoid, *Trichogramma evanescens* (Westwood.) alternative with two sprays of chemical insecticides were applied in 2003. In season 2004, five *Trichogramma* releases, two insecticide applications and one treatment with Agerin (*Bacillus thuringiensis* (*B. t.* toxin) were carried out. Five releases and three insecticide treatments were applied in 2005 season. In traditional field six, insecticide applications were applied every season.

Eleven insect predator species were surveyed in both two fields, but there were increases in total predator numbers in IPM field ranged between 77.3-90.4% higher than in insecticide treated field. *Scymnus interruptus* was the most dominating predator species in both fields followed with *Metasyrphus corollae* and *Coccinella undecimpunctata* in IPM field and *C. undecimpunctata* and *Orius albidipennis* in traditional field. The overall means of the predators were 5.2, 5.8 and 20.7 individuls/20 cotton plants in IPM field during 2003, 2004 and 2005, respectively. Meanwhile these rates were 2.9, 1.7 and 2.2 indiv./20 plants in the traditional field during the same seasons, respectively.

The active infestation period of the *S. littoralis* larvae was recorded during June-July, especially in the first two seasons. The overall mean numbers of *S. littoralis* larvae was 15.1, 7.1 and 0.6 larvae/20 cotton plants in IPM field during 2003, 2004 and 2005, respectively, compared to, 8.3, 10.3 and 1.7 larvae/20 plants in the traditional field.

As for bollworms, *Pectenophora gossypiella* and *Earius insulana* (Biosd.), generally the highest infestation period was recorded during August-September through the three seasons. The overall means of infestation for were 1.7, 0.8 and 3.7%, *E. insulana* and 6.0, 0.0 & 7.2% for *P. gossypiella* in IPM field during 2003, 204 and 2005 seasons, respectively. In traditional field, these rates were 0.9, 1.2, 4, 4.7, 1.2 and 6.6% for *E. insulana* and *P. gossypiella* in the three seasons, respectively. The overall mean of both bollworms infestations through the three study seasons was 6.5% in IPM field and 5.8% in traditional field.

There were 33.6% reduction of the total number of piercing and sucking pests in IPM field compared with insecticides treated field. The yield in IPM field was 54.1%, 25.7% and 34.3% higher than insecticides treated field during 2003, 2004 and 2005 seasons, respectively with overall mean of 38% during the three study seasons.

On the other hand, there was 227.2, 227.2 and 143.9 % reduction in control costs of IPM field than the traditional field during 2003, 2004 and 2005 seasons respectively.

Key words: Integrated Pest Management (IPM), *Spodoptera littoralis*, (*P. gossypiella*, *E. insulana*), *Trichogamma*, Piercing Sucking Pests.

INTRODUCTION

Cotton (Gossypium barbadense L.) is the main cash money crop in Egypt. Cotton plants undergo infestation by different insect pests during the growing season, subsequently, a serious damage is caused to the yield quality and quantity in case of the unsuccessful controlling procedures. The intensive use of insecticides to control the cotton pests especially the leafworm and bollworms have eliminated the role of natural enemies on such pests in addition to the harm effects on human, animals, environment ect. (El-Arnaouty, 1995, El-Heneidy *et al.*, 1996 and Mesbah *et al.*, 2003).

During the last 20 years, IPM (integrated pest management) concept gained much support among entomologists. It is highly flexible and requires selection among a variety of techniques of the combination of control options that are best suited to a particular circumstance. It requires a multi disciplinary approach (Dent, 1991). Nevertheless, implementation of this concept has not yet given a lot satisfactory results for numerous reasons among which are:

1. Lack of a comprehensive approach to pest farming problems and
2. Lack of coordination between research projects. Such reasons lead to difficulties in decision-making in IPM programs (El-Arnaouty, 1995).

Through available literature or from the observatory works, every investigator or a group of authors tried to control the cotton pests through program against one or more of pests in the course of their specialization or to serve specific program without a comprehensive approach to pest farming problems and the different cotton growth stages as well as the natural enemies associated with the pests in every growth stage. For the above-mentioned reasons, this work aimed to produce a small paradigm of IPM cotton plants in order to minimize the use of insecticides and stress on the role of biological agents especially the parasitoid, Trichogramma evanescens against the bollworms which are considered as most destructive pests of cotton in Egypt, in addition to the natural predators found in the field.

MATERIALS AND METHODS

Field experiment was carried out at Desuq district, Kafr El-Sheikh Governorate (North Egypt) during the successive seasons, 2003, 2004 and 2005. The experimental field was divided into area "A" of half feddan (IPM Field), area "B" (comparator field) of half feddan too, treated with recommended insecticides against cotton insect pests during the three experimental season. The traditional and IPM fields were far from each other by about 300 m. Cotton variety Giza 88 (recommended by Ministry of Agricultural) was cultivated in the 1st week of April in the first season and Giza 86 (also recommended by Ministry of Agriculture) was cultivated on March 21st in 2004 and 2005 seasons. Direct counts of insect pests and their associated predators were taken weekly by the end of May until late September of both fields. The sample was 20 plants (10 hills) weekly except for *Bemisia tabaci* and bollworms. In case of *B. tabaci*, immature stages (eggs, larvae and pupae) were calculated in 40 in2 of the cotton leaves (20 leaves x 2 in2). As for bollworms (*Pectinophora gossypiella* and *Earius insulana*), infestation was determined at weekly intervals starting from July 1 until the last week of September. A sample of 20 green bolls/fed. in the first season and 50 bolls/fed. in the second and third seasons were picked at random for each field. In the laboratory, the bolls were examined and considered infested when containing a larva or more of any of the two bollworms species.

Pheromone traps

For monitoring *Pectinophora* and *Spodoptera* male moths, baited water pheromone traps were used (one of each) in IPM field. The number of moths were recorded every three days, while the pheromone was replaced every 10 days.

The parasitoid, *Trichogramma evanescens* was released and the insecticides applied followed the arrangement showed in Table (1).

At the end of every season, in A & B fields the yield was estimated separately. Daily minimum and maximum temperature and R.H% were obtained from Sakha Meteorological Station. Data of experiments were subjected to appropriate statistical analysis.

The traditional field received the regular chemical control program adopted by Ministry of Agriculture at Kafr El-Sheikh Governorate.

Table 1. Parasitoid releases, dates and rates in IPM field and insecticide applications in both IPM and traditional fields during the three seasons, 2003, 2004 and 2005.

IPM field (A)	Traditional field (B)
I. Season 2003 1-Four releases of *Trichogramma evanescens* were done on June 24th, June 30th, July 14th and August 26th with rates of, 30, 60, 60and100 thous./fed., respectively. 2- Two insecticide treatments were applied on July 26th and August 11th with hexaflumuron (consult 10% EC) + esfenvalerate (sumi-gold KZ 20% EC) and chlorpyrifos (Bestban48%EC) + chlorfluazuran (Atabron 5% EC), respectively	I. Seasons 2003 Six insecticide applications were carried out on June 1st, June 16th, 1st, and 18th of July, 2nd and 20th of August with malathion (Malathion 57% EC) + dicofol (Kalthane 18.5% EC), chlorfluazuron (Atabron 5% EC), chlorpyrifos (Bestban 48% EC) + hexaflumuron (Consult 10% EC), esfenvalerate (Sumi-gold KZ 20% EC) + chlorfluazuron (Atabron 5% EC), chlorpyrifos (Bestban 48% EC) + hexaflumuron (Consult 10% EC) and carbaryl (Sevin 85% WP), respectively.
II. Season 2004 1- Five releases of *Trichogramma* were carried out on 10th ,20th and 30th of June, August 5th and September 8th with rates of 60 thous./fed. for the first three releases and 100 thous/fed. for the last two releases.. 2.- *B. t.* (toxin), *Bacillus thuringensis* Agerin 6.5 W.P on July 6th 3- Two insecticide applications were done, chloropyrifos (Bestban 48% EC) + chlorfluazuron and esfenvalerate + chlorfluazuron on 15/7 and 18/8, respectively.	II. Season 2004 Six chemical treatments were applied on May 10th, June 1st, July 9th and 19th, August 1st and 15th with Malathion, Malathion + chlorofluazuron + Chlorfuazuron, chlorpyrifos, chlorfluazuron + dicofol, esfenvalerate + chlorfluazuron and chlorpyrifos, respectively.
III. Season 2005. 1- Five releases of the parasitoid on June 10th and 17th, and July 4th, 11th and 21st with rates of 60 thous./fed. for the first three releases and 100 thous./fed. for the last two ones. 2- Three chemical treatments on August 1st, 15th and 23rd with chlorpyrifos + chlorfluazuron, chlorpyrifos and chlorpyrifos, respectively.	III. Season 2005. Six insecticide treatments were applied on May 1st and 8th, June 10th, July 15th and 31st and August 22nd with Malathion (Malathion 57% EC), dicofol, chlorpyrifos (Dursban) + chlorfluazuron, chlorpyrifos + chlorfluazuron, chlorpyrifos and chlorpyrifos, respectively. It is noteworthy that the farmer was used the duplex doses in every treatment during 2004 and 2005

RESULTS AND DISCUSSION

In the traditional field (B), weekly survey of the insect pests and associated predators was carried out as well as the bollworms infestation percentages, except that, the farmer was free of all agricultural practices and any control decision making as the general region.

In the integrated pest management (IPM) experimental field, any control decision was carried out on basis of the weekly surveying of the cotton pests and associated predators as well as the catch of the pheromone traps of both P. gossypiella and S. littoralis moths.

1. 2003 season

Three control stages were occurred in this seasons:

1. Early biological control stage (sowing date-July 26).

Through the field observations and the survey of the cotton pests and associated predators which began from the last week of May, many pests were recorded (May 29th-July 3rd), *Agrotis ipsilon*, *Gryllotalpa gryllotalpa* (with few numbers), *Thrips tabaci* (only in the first two inspections), Jassid, red spider, while *S. littoralis* larvae commenced with 20 larvae/20 cotton plants (1-3 instars) and increased gradually to reach 75 larvae/20 plants by the first week of July. During the same period, the *S. littoralis* moths recorded the highest peak (67 moths/3 nights) on June 19 (Fig. 1). In spite of presence of the previous pests with that rates, no chemical treatments were applied due to presence the suitable numbers of insect predators and to postpone the use of chemical insecticide applications as much as possible and give the natural enemies the chance to play their role in IPM program.

As for *P. gossypiella*, although the catch of moths in pheromone trap started from the first week of June (6 moths/3 nights on June 4th) and peaked on June 10th (22 moths/3 nights), no chemical and/or parasitoid release were done since flower buds (infestation receiver) formation was not formed at this at this time.

By the third week of June the cotton buds began to constitute and the high catch of *Pectinophora* moths was recorded in the trap (16 moths/3 nights on June 22nd) accordingly the first parasitoid release was done on June 26th and followed by two other releases on June 30th and July 14 to support the first one (Table 1 and Fig. 1).

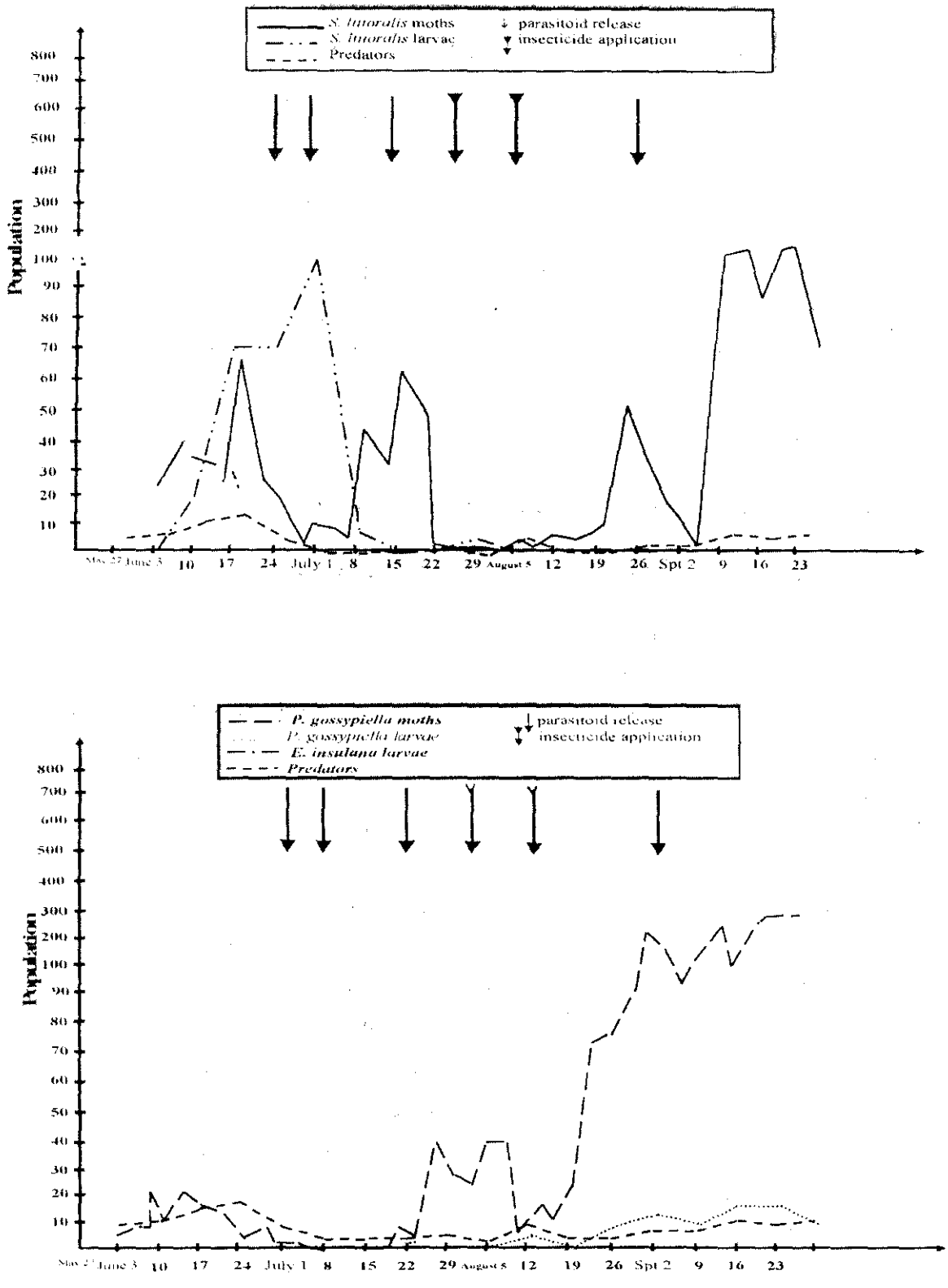

Fig. 1. Number of insect predators , larvae of *Pectinophora* gossypiella , *Spodoptera littoralis* , *Earius insulana* and pheromone traps caches of both *P. gossypiella* and *S. littoralis moths* in IPM field during 2003 season .

2. Chemical control stage

During July no infestation with *P. gossypiella* larvae was recorded, while *E. insulana* larvae were recorded in only two inspections, on July 3rd and July 30 (10 and 5% infestation, respectively).

As for *S. littoralis* larvae, although decreased their numbers during July than June, the recorded larvae were in last stages and caused infestation in cotton buds estimated by 0.5% on July 24th. At the same time, lower number of insect predators was recoded (3 predator/20 cotton plants). So the first insecticide application was applied on July 26th and repeated on August 11th against the leafworm and bollworms conjointly (Table 1 and Fig. 1). It is noteworthy that the *Trichogramma* parasitoid release was stopping during the chemical stage (July 26th-August 26th).

3. The second biological control stage (the late one)

During August, no infestation was recorded by *S. littoralis* larvae, while *S. littoralis* moths were in a law rate until the third week of August. At this time about 80% of immature bolls became safety of the infestation by both, leafworm and bollworms. Infestation by *P. gossypiella* larvae peaked to 10% (on August 21) and the number of moths in trap reached 74 moths/3 nights on August 24th, then *Trichogramma* parasitoid was released with the highest rate (100 thous./fed.) on August 26th. The first picking of the crop started on September 16th.

II. Season 2004

The same bases and control steps in the previous seasons were imitated, but the parasitoid release occurred early, where three releases were carried out on June 10th, 20th and 30th (Table 1 and Fig. 2) to constitute population of the parasitoid in IPM field and to avoid any infestation with *P. gossypiella* larvae that may occurr in the biological control stage.

In spite of no *S. littoralis* larvae were recorded until the last week of June, S. littoralis moths were recorded with the highest number on June 28th (960 moths/3 nights) (Fig. 2). Three days later (July 1st) *S. littoralis* larvae reached the highest peak during the season (70 larvae/20 cotton plants).

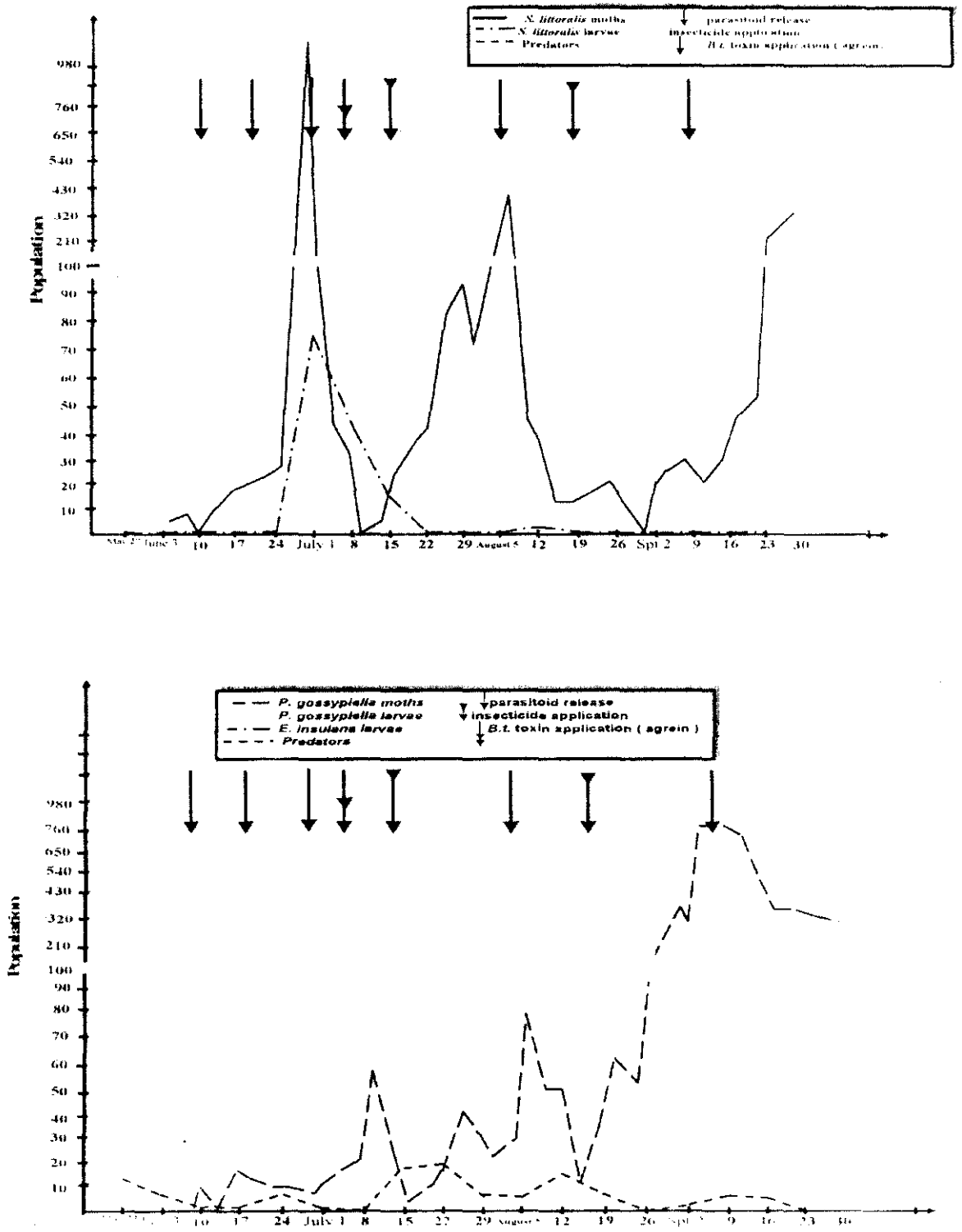

Fig. 2. Number of insect predators, larvae of *Pectinophora gossypiella*, *Spodoptera littoralis* , *Earius insulana* and pheromone traps caches of both *P. gossypiella* and *S. littoralis* moths in IPM field during 2004 season.

- Number of insect predators , *Spodoptera littoralis larvae* per 20 cotton plants *weekly*. *P. gossypiella* and *S. littoralis moths* per 3 nights.
- Number of both *P. gossypiella* and *E.insulana larvae* per 100 bolls weekly.

At this time, no infestation with bollworms was recorded. *B. t* (toxin), *Bacillus thuringiensis* (Agerin) was used (on July 6th) against the young leafworm larvae. In spit of intense reduction of *S. littoralis* larvae (Fig. 2), those larvae were in late stage and caused infestation to the cotton buds, reached to 1.8% on July 15th, then the first chemical treatment was applied this time 15 (Table 1). No infestation of both leafworm or bollworms were recorded until the first week of August, but high number of *Pectinophora* moths was recorded in its trap, so the fourth parasitoid release was carried out on August 5th.

Catch of both *Pectinophora* and *Spodoptera* moths were increased in the traps, 70 and 338 moths/3 nights, respectively by the second week of August so insecticide application was applied again on August 18 to protect the plants from any infestation. By the last week of August and first one of September, *Pectinophora* trap catches raised and peaked on September 8th, (382 moths/3 night), then the fifth parasitoid release was carried out with high rate (100 thous/fed.) on Sept. 8th.

No infestation with *P. gossypiella* was recorded during this season, this may be an evidence of the parasitoid activity while *E. insulana* caused 0.8% and the infestation in cotton buds with *S. littoralis* larvae was 0.1%.

III. Season 2005

Only two controlling stages occurred during season 2005 as follows:

1. Biological control stage

As the last two cotton seasons, beside the presence of the natural biological control agents, especially the predators, five parasitoid releases of *Trichogramma* were applied during this stage starting from the second week of June until the third week of July (Table 1 and Fig. 3). No infestation with *P. gossypiella* was recorded until July 29th,where suddenly 12% of green bolls were infested.

2. Chemical control stage

Release of the parasitoid in case of high rate of *P. gossypiella* larvae infestation would be ineffective, subsequently the first insecticide application was used on August 1st (Table 1 and Fig. 3). This insecticide treatment was not capable to minimize the infestation, so insecticide application was used again on August 15th and repeated on August 23rd, but the infestation with both *P. gosypiella* and *E. insulana* remained

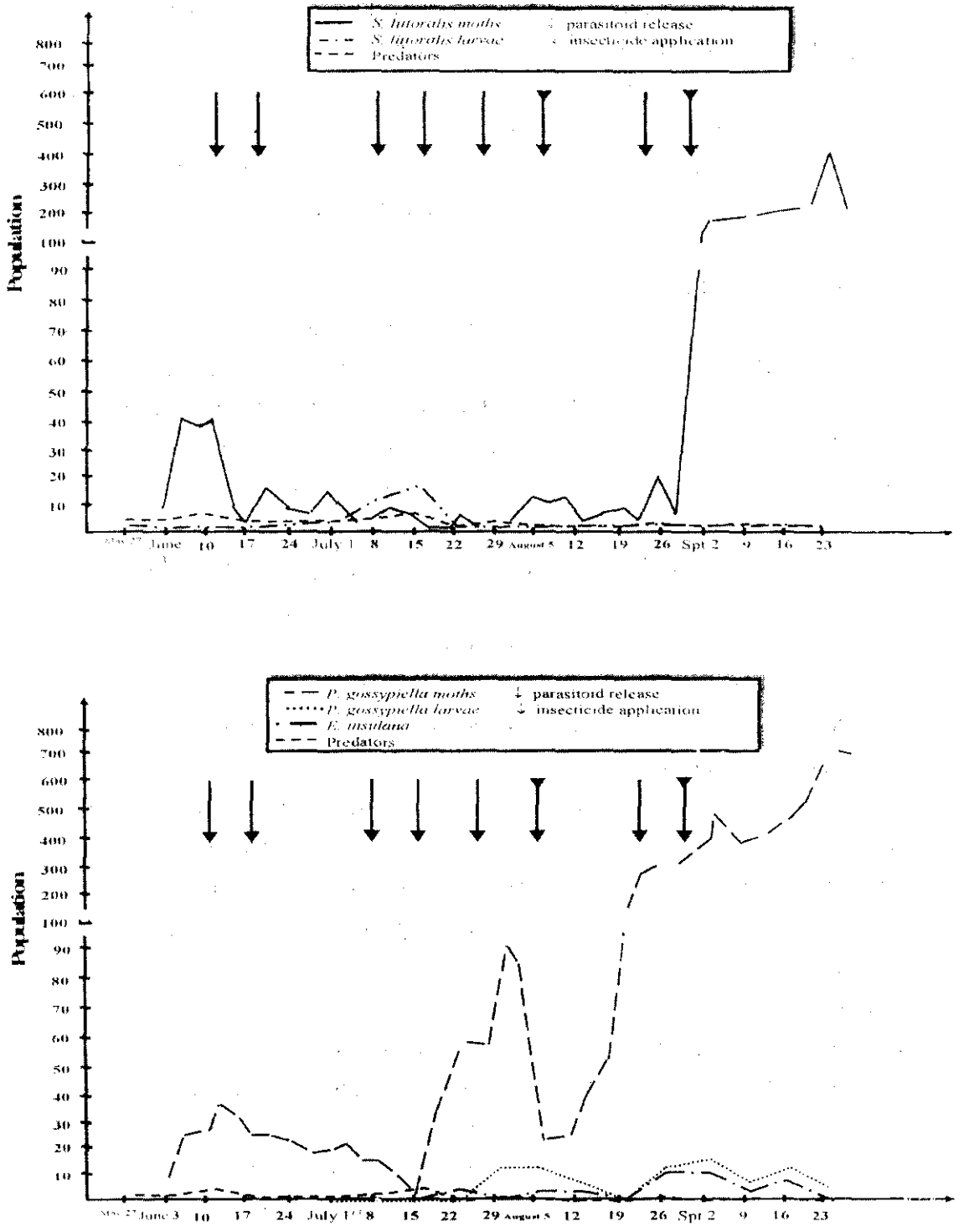

Fig. 3. Number of insect predators , larvae of *Pectinophora gossypiella* , *Spodoptera littoralis, Earius insulana* and pheromone traps caches of both *P. gossypiella* and *S. littoralis moths* in IPM field during 2005 season.

- Number of insect predators , *Spodoptera littoralis* larvae per 20 cotton plants weekly, *P. gossypiella* and *S. littoralis* moths per 3 nights.
- Number of both *P. gossypiella* and *E.insulana* larvae per 100 bolls weekly.

high, where they were 16, 12, 20, 12, 8 and 4% with *P. gossypiella* and *E. insulana* on August 26th, September 2nd and 9th, respectively.

In spite of using the recommended insecticides according to the recommendation of the Ministry of Agricultural, the increase of bollworms infestation rates led to the reduction of the cotton yield in season 2005. This may be due to the use of only one insecticide in most cases (Bestban 48% EC) besides the use of this insecticide in many seasons before 2005 inside other insecticides and the lack of G.R group (Atabron). A situation in which the farmers obtained the insecticides from the private sector which in many cases is unreliable source.

As for *S. littoralis* larvae, they occurred with the least number during this season compared with the last two seasons, where the overall mean was 0.6 larvae/20 cotton plants and their infestation of cotton buds was 0.002%.

Statistical analysis for the data of the three considered seasons, revealed highly significant correlation among both *Scymnus interruptus* and *Syrphus* spp. and *Aphis gossypii* in 2004 and 2005 seasons, while it was highly significant between *Chrysoperla carnea* and *Pectenophora gossypiella* larvae in 2003 and *Aphis gossypii* in 2005 and significant only between *Ch. carnea* and *P. gossypiella* moths and *Spodoptera littoralis* larvae in 2003. Data also revealed highly significant and significant between both *Syrphus* spp. and *S. interruptus* and *S. littoralis* larvae, respectively in 2005 season. Also, there was highly significant correlation between *Metasyrphus corollae* and R.H% in 2003 and in contrast the correlation was highly negative between *Coccinella undecimpunctata* and R.H.% in 2003 and 2004. Meanwhile, the correlation between *Ch. carnea* and temperature was negative in 2003 but it was highly significant in 2005.

Comparison between IPM and traditional field

1. Survey and abundance of insect predators

Eleven insect predators were recorded in the two examined fields (Table 2). The most dominant species were *Scymnus interruptus, Metasyrphus corollae, Coccinella undecimpunctata, Orius albidipennis* and *Chrysoperla carnea*. These predators were represented with 213, 105, 68, 55 and 34 indiv./1080 cotton plants, respectively in IPM field in the three study seasons. In the traditional field, these numbers were 37, 3, 20, 15 and 20 indiv./1080 cotton plants (Table 2).

The present results are in accordance with those of El-Heneidy et al., 1997, El-Saadany et al., 1999, Mesbah et al., 2003, and Khalifa 2004. In contrast of the previous results, El-Mezayyen and Abou-Attia, 1996 recorded that *Chrysoperla carnea* was the most dominant predator in cotton field, while *Scymnus spp.* were the least dominant one.

Table 2.The total numbers of insect predators in IPM and traditional field at Kafr El-Sheikh Governorate during 2003, 2004 and 20005 cotton seasons.

Insect predator species	Stages	2003		2004		2005		Total	
		IPM	Trad.	IPM	Trad.	IPM	Trad.	IPM	Trad.
Coccinella undecimpunctata L.	A.L	33	10	22	6	13	4	68	20
Cydonia vicina isis Cr.	"A	0	0	0	0	18	0	18	0
Cy. vicina nilotica Muls	A	0	0	0	0	14	0	14	0
Rhizobius litura F.	A	0	0	0	0	2	0	2	0
Scymnus interruptus Goeze	A, L	33	24	41	4	145	9	219	37
S. syriacus Mars.	A	0	0	3	0	2	0	5	0
Paederus alfierii Koch.	A	4	0	3	2	8	0	15	2
Metasyrphus corollae	L	2	0	6	0	97	3	105	3
Orius albidipennis Reut.	A,N	7	0	8	5	40	10	55	15
Chrysoperla carnea Steph.	L	8	5	12	15	14	0	34	20
Ischnura senegalensis Ramb.	A	6	0	10	0	20	4	36	4
Total		93	39	105	32	373	30	571	101

A = Adult L = Larvae N = Nymphs
IPM = Integrated pest management field
Trad. = Traditional field (insecticides treated field).

2. The effect of the cotton pests and the role of associated predators

2.1. The role of predators

Data in Table (3) show that the predators appeared with high numbers in IPM field during May, where the monthly mean was 7 indivs./20 cotton plants, coincided with *Empoasca lypica* and *Thrips tabaci*. The highest peak of the predators occurred in June coincided with the previous pests and *S. littoralis* egg-mass in addition of the first appearance of the aphids. These data are in agreement with those of El-Heneidy *et al.* (1979), El-Saadany *et al.* (1999) and El-Hussini *et al.* (1996, 2000) who found that the insect species and predators started to increase during June because of the remarkable migration from clover fields to neighborhood cotton plants suitable for feeding and egg oviposition. However, most predatory arthropods during June-July in untreated cotton fields gave evidence to the occurrence of strong relationship between predatory arthropods and *S. littoralis* egg-masses. The lowest monthly mean that was recorded in July may be due to the use of the insecticide applications. The population of the predator build up again during August and peaked in September, the monthly mean was 6.5 predators/20 plants. In the insecticide treated field, only one peak was recorded in September and the monthly mean was 5 ind./20 plants.

Table 3. Monthly means of insect pests and associated predators in cotton fields at Kafr El-Sheikh region during three seasons 2003, 3004 and 2005 in IPM and traditional field.

Months / Stages	Insects predators		*Bemisia tabaci**		*Aphis gossypii*		*Empoasca lybica*		*Earis insulana **		*Pectinophora gossypiella **		*Spodoptera littoralis*		*Thrips tabaa*	
	IPM	Trad.	IPM	Trad.	IPM	Trad.	IPM	Trad.	IPM	Trad.	IPM	Trad.	IPM	Trad.	IPM	Trad.
	2003															
May	7.0	3.0	0.0	0.0	0.0	0.0	60.0	40.0	0.0	0.0	0.0	0.0	0.0	0.0	196.0	80.0
June	10.0	2.5	0.0	0.0	1.0	2.0	36.3	13.3	0.0	0.0	0.0	0.0	40.0	37.5	15.0	5.0
July	1.6	2.8	4.8	2.0	26.6	216.0	44.8	6.0	3.0	0.0	0.0	0.0	22.4	0.2	0.0	0.0
August	3.0	1.3	9.5	28.0	514.5	1110.0	7.0	10.3	2.5	3.0	3.1	4.5	0.0	0.0	0.0	0.0
September	6.5	5.0	6.8	17.8	20.0	66.0	18.0	7.5	0.0	0.0	12.5	10.58	0.0	0.0	0.0	0.0
Overall mean	5.2	2.9	4.9	10.7	126.4	321.4	26.4	11.7	1.7	0.9	6.0	4.7	15.1	8.3	14.2	5.6
	2004															
May	12.0	4.0	0.0	0.0	0.0	0.0	0.0	11.0	0.0	0.0	0.0	0.0	0.0	0.0	240.0	0.0
June	3.8	0.5	0.0	0.0	1.3	0.0	12.5	1.5	0.0	0.0	0.0	0.0	0.0	0.5	32.5	0.0
July	8.4	0.0	3.4	2.4	15.2	28.0	51.0	43.2	0.0	0.0	0.0	0.0	25.0	37.0	0.0	0.0
August	5.0	5.0	2.0	17.5	39.0	218.0	11.2	23.3	2.0	3.8	0.0	3.8	0.4	0.0	0.0	0.0
September	2.8	1.5	7.3	20.0	25.3	80.0	5.1	8.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Overall mean	5.8	1.7	3.1	9.0	20.9	74.0	21.2	20.1	0.8	1.2	0.0	1.2	7.1	10.3	20.6	
	2005															
May	4.0	2.0	0.0	0.0	0.0	0.0	44.0	45.0	0.0	0.0	0.0	0.0	0.0	0.0	80.0	0.0
June	7.3	3.0	0.0	0.0	3.5	8.0	64.0	38.0	0.0	0.0	0.0	0.0	0.3	0.3	14.0	0.0
July		2.6	1.8	2.0	1753.0	2336.0	39.	14.6	0.8	0.8	2.5	0.0	2.0	3.0	0.0	0.0
August	14.0	0.8	46.3	3.3	0.0	1.5	3.5	6.5	5.0	4.0	8.5	8.5	0.0	0.0	0.0	0.0
September	5.3	0.3	2.5	85.8	0.0	0.0	2.0	3.5	6.0	8.0	121.0	13.0	0.0	0.0	0.0	0.0
Overall mean	20.7	2.2	2.0	7.0	487.9	901.4	26.0	19.6	3.7	4.0	7.2	6.6	0.6	1.2	7.6	

* *B. tabaci* immature stages/40 in^2

** *P. gossypiella* and *E. insulana* larvae/100 green bolls

IPM = Integrated pest management field

Trad = Traditional field (insecticides treated field)

In 2004 season the highest monthly means of the predators in IPM field were recorded during May and July with monthly mean of 12 and 8.4 predators/20 plants, respectively. In the traditional field only one peak of the predators was recorded during August with monthly mean of 5 predators/20 cotton plants.

During 2005 season, the highest numbers of the predators were recorded in IPM field especially in July, where the monthly mean was 53.4 predators/20 plants coincided with the highest population of the aphids which reached 1753 aphids/20 cotton plants as monthly mean in July too. On contrast, in insecticide treated field the highest monthly means were recorded in June and July and represented with 3 and 2.6 predators/20 plants and the overall mean during the season was 2.2 ind./20 cotton plants. The reduction of the predators number in the traditional field due to the insecticide application ranged between 77.3-90.4 during the three study seasons.

The present results are in accordance with those of El-Heneidy *et al.,* 1987 who recorded that the native predators are the most effective biocontrol agents in the Egyptian cotton fields. They added that the predators have active roles continue until scheduled spraying of cotton that starts by early July and at this time, a decline (up to 80%) in the predators population usually occurs. Also, El-Heneidy *et al.,* (1996) found that there are potential relationship between predators and several prey in the Egyptian cotton fields. The present results also are in agreement with those of El-Saadany *et al.* (1999) who found that the predator densities were three times more numerous in the pheromone treated fields than the corresponding cotton treated with recommended insecticides. In this regard also Mesbah *et al.,* 2003 found that the overall mean of the predators was 47% in *Trichogramma* treated field compared with 17.6% in insecticides treated field. Also, Khalifa in (2004) recorded reduction in predatory population in cotton field due to insecticide applications reached 74.7 and 67.8% during the two study seasons. El-Barbary (2006) recorded five predators associated with bollworms, *P. gossypiella* and *E. insulana*, they were the true spider *Thanatus albini* and four insect predators, *Orius* spp., *C. undecimpunctata, Scymnus* sp. and *Chrysoperla carnea*.

2.2. The incidence of the cotton pests

2.2.1. *Spodoptera littoralis*

During 2003 season, the highest monthly mean number of *S. littoralis* in IPM field was recorded in June (40 larvae/20 cotton plants) followed by 22.4 larvae/20 plants in July (Table 3 and Fig. 4). The infestation in flower-buds by *S. littoralis* during June and July reached 0.2% in traditional field, associated with few numbers of *S. littoralis* larvae, where the monthly means in June and July were 37.5 and 0.2 larvae/20 plants, respectively. The infestation in flower buds was more dangerous due

to the size of the larvae causing more damage on flower buds and the infestation rate was 0.3%. The overall means of *S. littoralis* larvae in IPM and traditional fields were 15.1 and 8.3 larvae/20 plants, respectively.

In the second season (2004), the highest infestation with *S. littoralis* larvae was recorded during July in the two fields (IPM and traditional fields) (Table 3 and Fig. 4). The monthly means in July in both fields were 25 and 37 larvae/20 plants, respectively, while the overall means were 7.1 and 10.3 larvae/20 cotton plants, respectively.

In 2005 season, *S. littoralis* infestation recorded the lowest rate, the overall means were 0.6 and 1.2 larvae/20 plants in IPM and insecticide treated field, respectively.

The present results are in line with those of Metwally *et al.* (1979) who recorded the first *S. littoralis* egg-masses on May 12th (1977) and the highest number was attained in June which associated with the highest larval peak. While in 1978 the eggs were appeared at the first of June and the highest number was recorded at the end of June. The present results also are in agreement with those of Mesbah *et al.,* (2003) who found the highest percentages of *S. littoralis* on fallen flower buds and squares during August in both cotton treated with insecticides and other treated with *Trichogramma* parasitoid releases. In this regard, Khalifa (2004) recorded the highest rate of *S. littoralis* larvae in untreated cotton through the first and second week of July, while in insecticides treated cotton field it was in the last week of June and the first one of July.

2.2.2. Bollworms (*E. insulana* and *P. gossypiella*)

2. 2. 2. 1. *E. insulana*:

Data in Table (3) showed that the highest monthly mean of *E. insulana* infestation in IPM field was recorded in July (3%) during 2003 season, while it was in August in traditional field and represented with 3% too. During 2004 season, *E. insulana* appeared in July only on both IPM field and traditional field and represented with 2 and 3.8%, respectively.

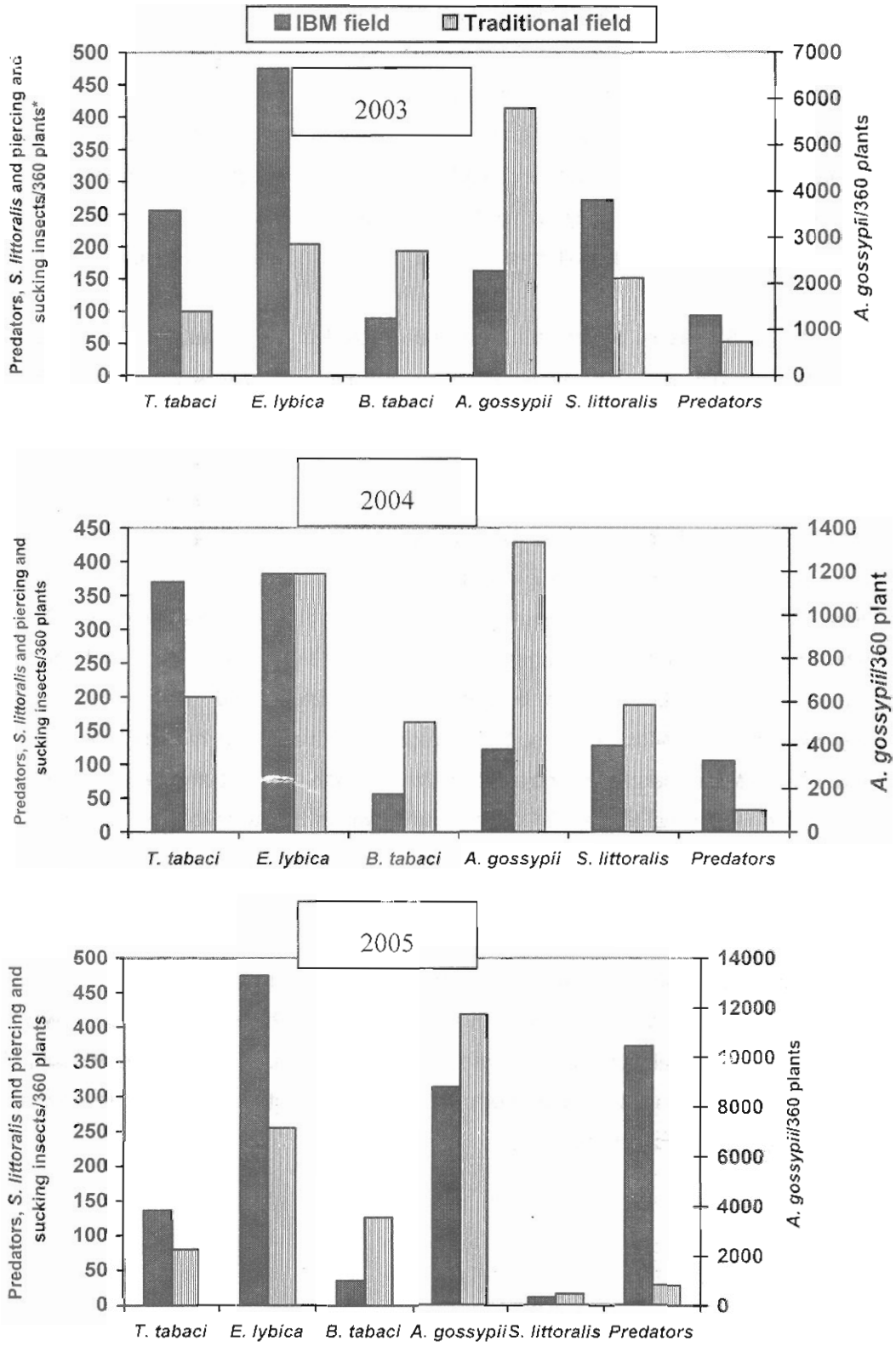

Fig. 4. Comparison between the total numbers of insect predators and major insect pests in IPM and traditional fields during 2003, 2004 and 2005 seasons.

* *B. tabaci* immature stages/72 in^2

The highest infestation rate with *E. insulana* during the three seasons recorded in 2005 season, and started in July-September. In highest monthly mean of infestation was 6 and 8% in September in IPM and traditional field, respectively. The overall means were 1.7, 0.9, 0.8, 1.2, 3.7 and 4% in IPM and traditional field during 2003, 2004 and 2005, respectively.

2.2.2.2. *P. gossypiella*:

P. gossypiella infestation occurred in both IPM and traditional fields during August in 2003 season and represented with 3.1 and 4.5% in IPM in both fields, respectively. Highest rate of infestation was recorded during September (2003) in both two fields. The monthly mean in September was 12.5 and 10.8%, respectively (Table 3). El-Heniedy *et al.* (1996) recorded that *P. gosypiella* and *E. insulana* increased sharply at the end of the season.

During 2004 season, no infestation with *P. gossypiella* was recorded in IPM field, while it occurred during August in traditional one with a mean of 3.8%. Through the present work, the highest rate of *P. gossyipella* infestation was recorded during 2005 season. The infestation appeared early in IPM field in July with monthly mean of 2.5% and increased gradually to reach 12% in September. In traditional field, the *P. gossypiella* infestation was delayed until August and represented with 8.5% (monthly mean) and increased to 13% in September Table (3).

The overall means of *P. gossypiella* infestations were 6.0, 0.0 and 7.2% in IPM field during 2003, 2004 and 2005 seasons respectively, while they were 4.7, 1.2 and 6.6% in the traditional one, respectively. The present results showed that 4-5 releases of, *Trichogramma* alternative with two insecticide applications led to 6.5% infestation of the bollworms in IPM field as overall mean through the three study seasons (2003, 2004 and 2005) compared with 5.85% in traditional one (six insecticide applications).

The present results are in accordance with those of Mesbah *et al.*, (2003) who recorded 10.9 and 13.7% as overall mean of *P. gossypiella* and *E. insulana* infestations on cotton bolls, respectively during two seasons (1999 & 2000) when depended only on *Trichogramma* releases (four releases) in cotton field, comparison with 14.5 and 6.9% in insecticides treated field (four treatments) during the same seasons. They also found that (during 2001) when used the *Trichogramma* releases alternative with IGR (three times), the infestation with *P. gossypiella* and *E. insulana* was 11.4 and 4.2%, respectively compared with 8.5 and 11.6% in case of *Trichogramma* releases only and 14.5 and 10.2% in only insecticides treated field. In this regard also, Critely *et al.* (1983) recorded that the use of two or three applications of formulated pheromone followed by two or three applications of conventional pesticides gave better control for the cotton pests complex than using of four of five applications of insecticides only.

The present results revealed also reduction of infestation rates with bollworms in IPM field especially in the early seasons. This may be due to the early performances of control steps especially the biological control stage depending on the natural biological control agents as well as *Trichogramma* parasitoid releases. These data are in agreement with those of Kostandy (1992) who stated that the only feeding sites for pink bollworm larvae in early season are the flower buds and flower, and the early control of the this infestation in the flower is supposed to decrease propagation of the pest in the following green bolls. The same author (1997) recorded that the rate of infestation was increased two times during July when the application time was delayed until more than six green bolls had been formed. In this regard, Attique (1998) referred the little infestation with *P. gossypiella* at the early season (July & August) to the adverse effect of high temperature on the pest egg population on commonly cultivated cotton. Also, Attique *et al.* (2004) recorded that the use of broad spectrum insecticides to control *P. gossypiella* at this stage is not justified because they reduce the natural enemies.

2.2.2.3. The piercing and sucking pests

Generally, piercing and sucking pests were highly presented in insecticides treated field than in IPM field with 33.6% during the three study seasons (2003, 2004 and 2005) especially the cotton aphids, *Aphis gossypii*. Highest monthly mean number of aphids recorded in IPM field during August in 2003 and 2004 and represented with 514 and 39 individuals/20 cotton plants, respectively. In 2005 season, *Aphis gossypii* suddenly appeared with highest numbers during July with monthly mean of 1753 indivs./20 plants and disappeared until the end of season. The overall mean of aphid population in IPM field was 126.4, 20.9 and 487.9 individuals/20 plants in 2003, 2004 and 2005 seasons, respectively . In the corresponding traditional field, the highest infestation with aphids was recorded during July in first and third seasons, while in the second season it was in August and represented with 216, 2336 and 218 indivs./20 cotton plants, respectively. The overall mean was 321.4, 74 and 901.4 individuals/20 plant during 2003, 2004 and 2005 season, respectively.

Empoasca lybica numbers in both two fields, IPM and traditional field. The overall mean was 26.4, 21.2 and 26 indivs./20 plants in 2003, 2004 and 2005 seasons, respectively. These rates were 11.7, 20.1 and 19.6 in corresponding comparator field, respectively.

B. tabaci appeared with few numbers in both two fields during the three study seasons. The overall means were 4.9, 10.7, 3.1, 9.0, 2.0 and 7 immatures/40 in^2 in IPM and traditional field during 2003, 2004 and 2005, respectively.

Thrips tabaci was detected in two inspections only at the last week of May and the first one in June and disappeared towards the end of the season in the two fields during the three study seasons. The overall mean in IPM field were 14.2, 20.6 and 7.6 indiv./20 cotton plants during 2003, 2004 and 2005, respectively. In the corresponding insecticides treated field they were 5.6, 11.1 and 6.2 indiv./20 plants, respectively.

The present results also show that presence of *B. tabaci* and *A. gossypii* with higher rates in insecticides treated field than those in IPM field which could be attributed to the adverse effects of insecticides applications on the natural enemies especially the predators and the specific behavior of *B. tabaci* to insecticides. On contrast, the populations of *E. lypica* and *T. tabaci* were higher in IPM field compared with insecticides treated field.

The present results are in accordance with those of Flint (1995) who stated that whiteflies are quit difficult to control with currently available pesticides and in general, the best approach is an integrated pest management strategy that relies first on cultural and biological control methods and uses chemical control only when needed. The current results are in agreement also with those of Khalifa (2004) who recorded that *Empoasca lybica* appeared in cotton plants almost the whole seasons, with particularly high numbers during July and August, while *Aphis gossypii* numbers were low during May and June and sharply increased by third week of July and the highest number was detected in early August. She also added that *Thrips tabaci* was surveyed during May and June and completely disappeared till end of the season, and in generally *A. gossypii* and *B. tabaci* increased in insecticides treated cotton field compared with those in untreated one. In this regard, also El-Mezayyen *et al.* (2007) recorded that the highest numbers of aphids existed on cotton variety Giza 85, while Giza 85 and Giza 70 harboured the least number. On the other hand, Giza 45 and Giza 85 were the least infested varieties with whiteflies and jassids which showed the highest affinity to Giza 89 and Giza 86, respectively.

3. The yield

The yield in IPM field was 10.4, 13.2 and 9.0 quintal/feddan in 2003, 2004 and 2005, respectively. In the traditional field these values were 6.75, 10.5 and 6.7 quintal/feddan, respectively. The increasing of the yield in IPM field was estimated by 54.1, 25.7 and 34.3%, respectively, with overall mean of 38% during the three study seasons than those in comparator field (insecticides treated field). It is noteworthy that in 2003 season the cotton variety Giza 88 was sowing in both two fields, while Giza 86 was used in 2004 and 2005 in both two fields too.

4. Cost of control

The cost of control in IPM field during 2003 season was 158 Egyptian pounds/fed. as well as in 2004 this included 100 pounds for four parasitoid releases/fed. and 58 pounds for two insecticide applications from the periodic treatments as recommended by Ministry of Agricultural. In 2005 season these costs were 212 pounds, five parasitoid releases and three insecticide applications due to the previous causes. In corresponding, in traditional field (insecticide treated field) the cost control was 517 pounds/fed. every season, this included 335 pounds for four insecticide applications and 182 pound/fed. to hand picking of the egg-masses of leafworm, *S. littoralis*. This increasing of cost price control in traditional field represented 227.2% higher than in IPM field during 2003 and 2004 separately, while in 2005 the increasing in cost of pests control in insecticide treated field was estimated by 143.9% higher than in IPM field.

The recommendations

1. The charged personell of the pests control must have a good knowledge of the biology and ecology of the target pests and associated natural enemies as well as the climatic conditions which affected both.
2. Any decision of pests control must be depend on a survey of the pests and associated natural enemies.
3. Avoidance of the insecticide treatments in the early season due to their impact on the natural enemies and eliminating their role and leave the pests unchecked, while the insecticide application should be limited and only when needed.
4. Accuracy in limiting the treatments either with insecticide or bioagent.

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REFERENCES

1. Amany, A. Khalifa. 2004. Ecological and biological studies on certain insect predators to control the pests. M. Sc. Thesis, Fac. of Agric. Tanta Univ., 99 pp.
2. Attique, M. R. 1998. Management of cotton whitefly *Bemisia tabaci* G. and bollworms *Pectinophora gossypiella* (Saund) and *Helicoverpa armigera* (Hub.) in the Punjab, Pakistan Ph.D. Thesis, Quidi-Azam Univ. Islamabad, Pakistan, 271 pp.
3. Attique, M. R., Z. Ahmed. A. I. Mohyuddin and M. M. Ahmed. 2004. Oviposition site preference of *Pectinophora gossypiella* (Lepidoptera: Gelechidae) on cotton and its effects on boll development. Crop Protection. 23, 287-292.
4. Critely, B. R., D. G. Ampion, L. J. Mc Veigh, A. R. Justum, M. M. Hosny and A. Nasr El-Sayed. 1983 Control of pink bollworm *Pectinophra gossypiella* (Sound.) (Lepidoptera: Gelechiidae) in Egypt by mating distruption using an aerially applied microencapsulated pheromone formulation. Bull. Ent. Res. 73, 289 – 299.
5. Dent, D. 1991. Insect pest management, C. A. B. International, Wallingford, UK. 604 pp.
6. El-Arnaouty, S. A. 1995. Factors affecting decision making in pest management. Egypt. J. Biol. Pest. Control, 9 (2): 71-82.
7. El-Barbary, M. M. 2006. The role of some natural enemies in the controlling of pink and spiny bollworms. Ph. D. Thesis, Fac. Agric. Masoura Univ. 136 pp.
8. El-Heneidy, A. H., Amira, A. Ibrahim, D. Gonzalez, N. M. Abdel-Salam, J. Ellington and G. M. Moawad. 1997. Pest-predators interaction in untreated cotton fields at three plant growth stages. 2- Planting date impact. Egypt. J. Agric. Res., 75(1): 137-155.
9. El-Heneidy, A. H., M. S. Abas and M. S. El-Dakrowry. 1979. Seasonal abundance of certain predators in untreated Egyptian clover and cotton field in Fayoum Governorate. Bull. Ent. Soc., Egypt 62: 91 – 96.
10. El-Heneidy, A. H., M. S. Abas and A. A. Khadr. 1987. Comparative population densities of certain predators in cotton field treated with sex pheromones and insecticides in Menoufia Governorate, Egypt. Bull. Ent. Soc. Egypt. 16: 181 – 190.
11. El-Heneidy, A. H., Y. H. Fayad, D. Gonzalez, N. M. Abdel-Salam, J. Ellington and G. M. Moawad. 1996. Pest-predators interaction in untreated cotton fields at three plant growth stages: 1- Location Impact. Egypt. J. Biol. Pest. Control., 6(1): 75-81.
12. El-Husseini, M. M., E. A. Agamy and H. E. Abou Bakr. 1996. Manipulation of insect predators to migrate from clover into cotton fields as contribution to organic cotton production. The VI. International IFOAM Agribio-mediterranean Conference, 21 – 24 Nov., Cairo Egypt.

13. El-Husseini, M. M., E. A. Agamy and S. M. M. Sayed. 2000. Migration of anthocorids from clover to cotton fields and its importance for stripe technique in traditional and organic cotton production. Egypt. J. Biol. Pest Control, 10 (2): 75 – 79.
14. El-Mezayyen, G. A. and F. A. Abou-Attia. 1996. Population fluctuation of certain cotton sucking insect pests and associated predators as influence by some weather factors at Kafr El-Sheikh. J. Agric. Res. Tanta Univ. 22 (4): 518-530.
15. El-Mezayyen, G. A., A. M. Nassef, H. M. Mansour and M. M. Metwally. 2007. Susceptibility of some cotton varieties to infestation with sucking insects and the main associated predators at Kafr El-Sheikh region. Egypt. J. Agric. Res. (Impress).
16. El-Saadany, G. B., R. S. M. El-Fateh, Z. H. A. Hamid and M. A. Romeilah. 1999. The triangle relationship between key pests, related biological agent and specific chemicals as factors governing the cotton IPM program. Egypt. J. Agric. Res., 77(2): 559-574.
17. Flint, M. L. 1995. Whiteflies in California a resource for cooperative extension. Univ. of California, state wide integrated pest management project, Div. of Agric. and Natural Resources UCIPM Publication, 19, 53 pp.
18. Kostandy, S. N. 1992. Effect of deflowering on cotton boll infestation with pink bollworm, *Pectinophra gossypiella* (Saund.). Bull. Ent. Soc., Egypt, 70, 45 – 49.
19. Kostandy, S. N. 1997. Proper timing of insecticidal spray against pink bollworm in relation to infestation and boll formation on cotton plant. Bull. Ent. Soc., Egypt 24, 62 – 68.
20. Mesbah, A. H., Mona, A. Shoeb and A. H. El-Heneidy. 2003. Preliminary approach towards the use of the egg parasitoid, *Trichogrammatoidae bactrae* Nagraja against cotton bollworms in Egyptian cotton fields. Egypt. J. Agric. Res., 81(3): 981-995.
21. Mewtally, S. M. I., A. S. El-Khodary and A. A. El-Zanan .1979. Seasonal fluctuation of the major pests population and their predaceous insets at Kafr El-Sheikh Province. J. Agric. Res. Tanta Univ. 5(1): 300-308.

المكافحة المتكاملة لأهم آفات القطن فى منطقة كفر الشيخ

أحمد حسن مصباح

معهد بحوث وقاية النباتات – قسم بحوث المكافحة الحيوية – مركز البحوث الزراعية – الجيزة

لقد تم إجراء هذه التجربة للمكافحة المتكاملة لأهم آفات القطن فى منطقة كفر الشيخ خلال ثلاث مواسم متتالية ٢٠٠٣ ، ٢٠٠٤ ، ٢٠٠٥م وقورنت النتائج بحقل آخر تتم فيه المكافحة التقليدية من حيث المقاومة اليدوية للطع دودة ورق القطن واستخدام المبيدات حسب توصيات وزارة الزراعة. فى حقل المكافحة المتكاملة تم اتخاذ قرار المكافحة على أساس الحصر الأسبوعى للآفات والمفترسات الحشرية المصاحبة وكذلك قراءات المصائد الفرمونية لفراشات دودة اللوز القرنفلية ودودة ورق القطن كل ثلاث ليالى.

فى موسم ٢٠٠٣ تم إطلاق طفيل التريكوجراما *Trichogramma evanecens* أربع إطلاقات فى حقل المكافحة المتكاملة بالاضافة لاستخدام المبيدات الكيماوية مرتين.

فى موسم ٢٠٠٤ تم إطلاق الطفيل خمسة مرات، واستخدام المبيد الحيوى البكتيرى (الأجرين) مرة واحدة بالإضافة لمعاملتين كيماويتين، بينما فى موسم ٢٠٠٥ تم إطلاق الطفيل خمسة مرات واستخدام المبيدات الكيماوية ثلاث مرات، علماً بأنه لم تستخدم المقاومة اليدوية لنقاوة لطع دودة ورق القطن فى حقل المكافحة المتكاملة خلال الثلاث سنوات.

فى حقل المكافحة التقليدية تم استخدام المبيدات الكيماوية ست مرات فى كل موسم، وكذلك المقاومة اليدوية للطع دودة ورق القطن.

ولقد أوضحت النتائج وجود أحدى عشر مفترساً فى كلا الحقلين، وسجلت زيادة فى تعداد المفترسات فى حقل المكافحة المتكاملة تراوحت بين ٧٧,٣ – ٩٠,٤ % عنها فى حقل المكافحة التقليدية، وكان المتوسط العام لتعداد المفترسات فى حقل المكافحة المتكاملة هو ٥,٢ ، ٥,٨ ، ٢٠,٧ مفترساً / ٢٠ نبات خلال المواسم ٢٠٠٣ ، ٢٠٠٤ ، ٢٠٠٥ على التوالى مقارنة بـــ ٢,٩ ، ١,٧ ، ٢,٢ مفترس / ٢٠ نبات فى حقل المكافحة التقليدية خلال نفس المواسم على التوالى.

سجلت أعلى فترة إصابة بدودة ورق القطن خلال يونيو ويوليو وكان المتوسط العام لتعداد يرقات دودة ورق القطن فى حقل المكافحة المتكاملة هو ١٥,١ ، ٧,١ ، ٠,٦ يرقة / ٢٠ نبات خلال المواسم ٢٠٠٣ ، ٢٠٠٤ ، ٢٠٠٥ على التوالى مقارنة بـــ ٨,٣ ، ١٠,٣ ، ١,٧ يرقة / ٢٠ نبات على التوالى.

على نسب إصابة بديدان اللوز القرنفلية والشوكية سجل خلال أغسطس وسبتمبر فى المواسم الثلاثة. وكان المتوسط العام لنسب الإصابة فى حقل المكافحة المتكاملة ١,٧ ، ٠,٨ ، ٣,٧% بدودة اللوز الشوكية و ٦ ، صفر ، ٧,٢ % بالقرنفلية على التوالى. وكانت هذه النسب فى حقل المكافحة التقليدية هى ٠,٩ ، ١,٢ ، ٤,٠ ، ٤,٧ ، ١,٢ ، ٦,٦ % بدودة اللوز الشوكية والقرنفلية

خلال الثلاث مواسم على التوالى. وقدر المتوسط العام للإصابة بديدان اللوز فى حقل المكافحة المتكاملة خلال الثلاث مواسم بـــ ٦,٥ ، ٥,٨ %.

سجلت الحشرات الثاقبة الماصة نقصاً فى تعدادها فى حقل المكافحة المتكاملة قدر بـــ ٣٣,٦ % مقارنة بحقل المكافحة التقليدية.

وبالنسبة للمحصول فقد سجلت زيادة فى محصول حقل المكافحة المتكاملة مقدارها ٥٤,١ ، ٢٥,٧ ، ٣٤,٣ % خلال الثلاثة مواسم على التوالى بمتوسط عام ٣٨ % عنه فى حقل المكافحة التقليدية ومن جهة آخرى كانت تكاليف المكافحة أقل فى حقل المكافحة المتكاملة بنسبة ٢٢٧,٢ ، ٢٢٧,٢ ، ١٤٣,٩ % خلال الثلاث مواسم على التوالى مقارنة بتكاليف المكافحة فى الحقل التقليدى.