

## EVALUATION OF CERTAIN PARASITOIDS AND PREDATORS AGAINST APHIDS, WHITEFLY AND LEAFMINER INFESTING CUCUMBER AND PEPPER IN GREENHOUSES

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### ABSTRACT

The experiments were conducted on certain insect pests infesting cucumber and pepper in green houses bio-control agents were found to be the braconid parasitoid, *Aphidius colemani* Viereck, the cecidomyiid predator, *Aphidoletes aphidimyza* Rond. and the anthocorid predator, *Orius laevigatus* Fieber against aphids (mainly *Aphis gossypii* Glover) ; the aphelinid parasitoids, *Eretmocerus eremicus* Rose and Zoln. and *Eretmocerus mundus* Mercet and the mirid predator, *Macrolophus caliginosus* Wagner against the whitefly *Bemisia tabaci* Genn.; the braconid parasitoid, *Dacnusa sibirica* and the eulophid parasitoid, *Dygliphus isaea* De Koppert against the leafminer *Liriomyza trifolii* Burgess; Results were compared with the chemical control percentages of infestation by *A.gossypii* was higher and its occurrence was most dominant in the bio-control greenhouse (BCG) than in the chemical control greenhouse (CCG). Percentages of parasitism were much higher in the BCG and reached 96 % on cucumber and 100 % on pepper. Infestation by *B.tabaci* was not dominant in both greenhouses and both crops especially on pepper. The numbers of nymphs / leaf on cucumber were much higher in the BCG than in the CCG. Parasitism was noticed only once, on cucumber, in the BCG but before releasing the parasitoids. Infestation by *L.trifolii* on cucumber was found to be more frequent with a higher peak in the CCG than in the BCG. Parasitism in the BCG was 50 % one week after releasing the leafminer parasitoids and no parasitism was noticed in the CCG. The bio-control agents seemed to have a role in suppressing the populations of *A.gossypii* and *L.trifolii* but had no or little effect against *B.tabaci*. The probable reasons for this failure is given. However, the yield of the crop, cucumber or pepper, in the BCG did not differ significantly from that in the CCG .

### INTRODUCTION

The technique of protected culture started in the fifties and the cultivated area increased greatly in the last 30 years to reach 50 – 60 folds in many countries such as France, Italy, the Netherlands and USA. (Tawfik, 1997). The main goal of this technique is to produce crops (mainly vegetables and ornamentals) with high quality, good shape and in a specific timing to obtain high price.

Such crops have been subjected to severe infestation by different pests mainly aphids, whitefly, leafminers and mites as well as plant diseases. The high infestation and the variety of pests have forced the growers to utilize large amounts of chemical pesticides in order to protect the crop and produce high yield. The excessive application of chemicals, in addition to their hazards to human and the environment resulted in developing genetic resistance to such chemicals by many target pests (Gillespie, 1989). Therefore, the researchers had to look for alternative methods of control and in this respect,

the bio-control agents (parasitoids, predators and entomopathogens) have received great attention (Lyon, 1979; Hussey & Scopes, 1985; Lipa, 1985; Kinawi, 1998; Yoldas *et al.*, 1999).

The present investigation deals with utilizing bio-control agents (parasitoids and predators) for controlling aphids, whitefly and leafminer compared to conventional chemical control on cucumber and pepper in greenhouses.

## MATERIALS AND METHODS

Experiments were carried out in the Greenhouse Division, Agriculture Research Centre, at Dokki, Giza, where greenhouses are planted with cucumber and pepper. Chemical pest control is applied against insects, mites and plant diseases.

Four greenhouses, each measured 40 x 9 x 2.75 m, were chosen for the present study and were apart from each other; two were planted with cucumber and the others were planted with pepper in November 2004. All agricultural practices were done in the four greenhouses. Chemical insecticides were applied in one cucumber and one pepper while the other two received bio-control agents.

Three insect pests were found to attack both cucumber and pepper plants; aphids, mainly *Aphis gossypii* Glover, the whitefly, *Bemisia tabaci* Genn. and the leafminer, *Liriomyza trifolii* (Burgess).

The following bio-control agents used were obtained from Koppert Biological Control Systems Inc.:

### Predators :

1. *Orius laevigatus* Fieber ( Hemiptera: Anthocoridae) against aphids at a rate of 500 adults / greenhouse
2. *Macrolophus calliginosus* (Wagner) ( Heteroptera: Miridae) against the whitefly at a rate of 500 pupae / greenhouse
3. *Aphidoletes aphidimyza* (Rondani) (Diptera: Cecidomyiidae) 2005 against aphids at a rate of 1500 pupae / greenhouse.

The first and second predators were released once on Dec. 26,2004 while the third was released twice on Jan. 9,2005 and Feb. 5,2005

### Parasitoids

1. *Dacnusa sibirica* (Hymenoptera: Braconidae) against leafminer at a rate of 125 wasps / greenhouse
2. *Diglyphus isaea* (De Koppert) (Hymenoptera: Eulophidae) against leafminer at a rate of 125 wasps / greenhouse
3. *Aphidius colemani* Viereck (Hymenoptera: Braconidae) against aphids at a rate of 500 mummies/greenhouse
4. *Eretmocerus eremicus* Rose and Zoln. (Hymenoptera: Aphelinidae) against whitefly at a rate of 10,000 pupae / greenhouse
5. *Eretmocerus mundus* Mercet against whitefly at a rate of 10,000 pupae / greenhouse.

The first and second parasitoids were released once on Dec.26,2004, and the third was released three times on the same previous date and on Jan.9,2005 and Feb. 5, 2005. Mean while , the fourth and fifth parasitoides were released once on Jan.9,2005 and Feb. 5, 2005, respectively.

It should be noted that the chemical insecticide, Aphox was sprayed against aphids, on the infested plants only, 3 times on cucumber (on Jan.3 and 29,2005 as well as on Feb.3,2005) and only once on pepper (on Feb.3,2005).

#### **Procedure of Investigation**

The study started on Dec.26,2004 just before releasing the bio- control agents (pre-count) and continued until the end of the season on April 18,2005 Counts and sampling were carried out biweekly from Jan.3 to Jan.31(to avoid any harm of the seedling and young plants) then weekly till the end of the season as follows:

##### **Aphids**

50 plants of each of cucumber and pepper, chosen at random, were examined carefully for infestation by aphids in each greenhouse. The numbers of infested plants were recorded and percentages of infestation were calculated. The plant was considered infested even aphids were noticed on only one leaf. 10 infested leaves were taken to the laboratory, in paper bags, for estimating percentages of parasitism and rearing the aphids till emergence of any parasitoids. Percentages of parasitism were estimated by dissecting 25 – 100 aphid individuals by the aid of a stereomicroscope. The rest of aphids, on the leaves, were kept in glass jars,( 15 cm high and 10 cm diameter each) covered with pieces of cotton-cloth. The jars were provided daily with fresh leaves until emergence of parasitoids which were then identified.

##### **Whitefly**

25 leaves from cucumber and 50 leaves from pepper plants were taken randomly from each greenhouse, kept in paper bags and transferred to the laboratory. By the aid of a stereomicroscope, the number of immature stages whitefly-infested leaves was recorded. 25 - 50 nymphs, in the 2<sup>nd</sup> and 3<sup>rd</sup> instars, represented the infested leaves were dissected and the percentage of parasitism was estimated. The infested leaves were then kept in glass jars until emergence of parasitoids .

##### **Leafminer**

25 leaves from cucumber and 50 leaves from pepper plants were taken from each greenhouse and transferred to the laboratory. Because the mines are easily seen, it was decided to pick up a leaf , from the upper third of the plant , from every 10<sup>th</sup> plant in every row. By the aid of a stereo-microscope, the number of infested leaves which contained larvae and/or pupae of the leafminer were recorded and the percentage of infestation was estimated. The larvae and/ or pupae were dissected to estimate percentages of parasitism.

## RESULTS

1-Aphids (*A. gossypii*)

As presented in Table (1), percentages of cucumber infestation by aphids were, in general, higher and their occurrence was more dominant in the bio-control greenhouse (BCG) than in the chemical control greenhouse (CCG). The aphids were almost absent in the CCG from February 7 until the end of the season except on April 11 when infestation reached 12%. On the other hand, aphids were found during all the season in the BCG, but with very low number and mostly did not exceed 10 / leaf on the tops of the plants.

The date also show that aphid parasitism did not occur in the BCG until February 21 but reached 20% on March 7 and 14 and peaked to 96% on March 28. The parasitoid secured in the laboratory was the species released in the greenhouse (*A. colemani*). No parasitism was found in the CCG.

Table (1): % Infestation by aphids and % parasitism on cucumber and pepper treated with bio-control agents or chemical insecticides

Dates	Cucumber				Pepper			
	% Infestation		% Parasitism		% Infestation		% Parasitism	
	Chemical Control	Biologica I Control	Chemical Control	Biologica I Control	Chemical Control	Biologica I Control	Chemical Control	Biologica I Control
Dec.26,2004	8 (L)	12 (L)	0.0	0.0	6 (L)	18 (L)	0.0	0.0
Jan. 3, 2005	8 (L)	16 (L)	0.0	0.0	8 (L)	24 (L)	0.0	4.0
Jan.17,2005	4 (L)	8 (L)	0.0	0.0	20 (L)	20 (L)	3.0	0.0
Jan.31,2005	4 (L)	28 (L)	0.0	2.0	40 (L)	8 (L)	1.0	0.0
Feb.7,2005	0.0	20 (L)	0.0	0.0	0.0	20 (L)	0.0	12.0
Feb.21, 2005	0.0	4 (L)	0.0	0.0	16 (L)	28 (L)	22.0	35.0
Mar.7,2005	0.0	24 (L)	0.0	20.0	0.0	28 (L)	0.0	65.0
Mar.14, 2005	0.0	16 (L)	0.0	20.0	0.0	12 (L)	0.0	75.0
Mar.21, 2005	0.0	8 (L)	0.0	50.0	8 (L)	8 (L)	36.0	50.0
Mar.28, 2005	0.0	2 (L)	0.0	96.0	0.0	8 (L)	0.0	98.0
Apr.4, 2005	0.0	16 (L)	0.0	50.0	8 (L)	8 (L)	0.0	100.0
Apr.11, 2005	12	10 (L)	0.0	0.0	12 (L)	0.0	14.0	0.0
Apr.18, 2005	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

L = Infestation on tops of plants only (1 - 10 individuals / leaf)

M = Infestation on tops and leaves (11 - 20 individuals / leaf)

Infestation of pepper by aphids was noticed in both greenhouses; CCG & BCG, almost all over the season (Table 1). As on cucumber, numbers of aphids were very low (1-10 / leaf) and concentrated on the tops of the plants. Percentages of infestation were also similar but with a peak of 40% on January 31 in the CCG and 28% on February 21 and March 7 in the BCG.

The data clearly show that parasitism on aphids was much higher in BCG than in CCG, where 0.0 – 36 % with an average of 9.5 % was recorded in the CCG and 0.0 – 100 % with an average of 40.7 % was obtained in the BCG.

**2-Whitefly (*B. tabaci*)**

Table (2) shows that infestation of cucumber plants by whitefly, in general, was not dominant in both greenhouses (CCG & BCG). It was noticed from December 26 until February 7 and on March 21 & 28 in the BCG. Infestation in the CCG was noticed 4 times; on December 26, January 3 & 31 and March 28. Percentages of infestation ranged from 8 to 36 % with an average of 24 % in the BCG and from 4 to 32 % with an average of 16 % in the CCG. The numbers of *B. tabaci* nymphs in the CCG were very low (1-8 individuals / leaf ) but reached 35 nymphs / leaf on March 28.

**Table (2): % Infestation by whitefly on cucumber and pepper treated with bio-control agents or chemical insecticides**

Date	Cucumber Infestation				Pepper Infestation			
	Chemical Control		Biological Control		Chemical Control		Biological Control	
	No of nymphs/ leaf	%	No of nymphs / leaf	%	No of nymphs / leaf	%	No of nymphs / leaf	%
6 Dec. 2004	2.9 (1 – 8)	24	3.2 (2 – 7)	24	2.5 (1 – 5)	8	5.0 (1 – 9)	10
03 Jan. 2005	32	3.7 (2 – 5)	3.6 (1 – 4)	36	3.0 (1 – 6)	14	8.0 (1 – 14)	18
17 Jan. 2005	0.0	0.0	119 (25 – 435)	36	1.0	6	10.5 (10 – 11)	4
31 Jan. 2005	4	2	108 (9 – 420)	24	0.0	0.0	0.0	0.0
07 Feb. 2005	0.0	0.0	59 (20 – 110)	8	0.0	0.0	0.0	0.0
21 Feb. 2005	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
07 Mar. 2005	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14 Mar. 2005	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21 Mar. 2005	0.0	0.0	55 (18 – 220)	32	0.0	0.0	0.0	0.0
28 Mar. 2005	4	35	70 (40 – 100)	8	0.0	0.0	0.0	0.0
04 Apr. 2005	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11 Apr. 2005	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18 Apr. 2005	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

• Values between brackets represent the range .

On the other hand, such numbers were much higher in the BCG; they were very low (1-4 individuals / leaf ) on the first two dates but reached 119 nymphs / leaf ranging between 25-435 and 108 nymphs / leaf ranging

between 9-420 on January 17 and 31, respectively. It is important to notice that no parasitism on *B. tabaci* was found in either CCG or BCG except only once on January 3 ( 4 % ) in the BCG before releasing the parasitoid, *E. eremicus* which took place on January 9.

Infestation by *B. tabaci* on pepper plants was noticed only from December 26 to January 17 in both greenhouses ( CCG & BCG ) .Percentages of infestation were almost similar and ranged from 6 to 14 % in the CCG and from 4 to 18 % in the BCG . The numbers of nymphs were very low and did not exceed 6 individuals / leaf in the CCG and 14 nymphs / leaf in the BCG.laboratory examination showed no parasitism in both CCG and BCG.

### 3-Leafminer (*L. trifolii*)

Pepper plants seemed to be unpreferable host plant for the leafminer as infestation was noticed only once with the same infestation (2%) on January 3 in both CCG and BCG .On the other hand ,infestation of cucumber plants by the leafminer, *L. trifolii* was noticed to be more frequent in the CCG than in the BCG, Fig.(1). Peaks of infestation in the former were found to be on March 14 (24 %) and March 21 (40 %) when no infestation was detected in the BCG. However, Peak of infestation in the BCG (18 %) was found on March 28. Parasitism on the leafminer was found only once in the BCG (50 %) on January 3 just after releasing the parasitoids, *D. sibirica* and *D. isaes* on December 26.

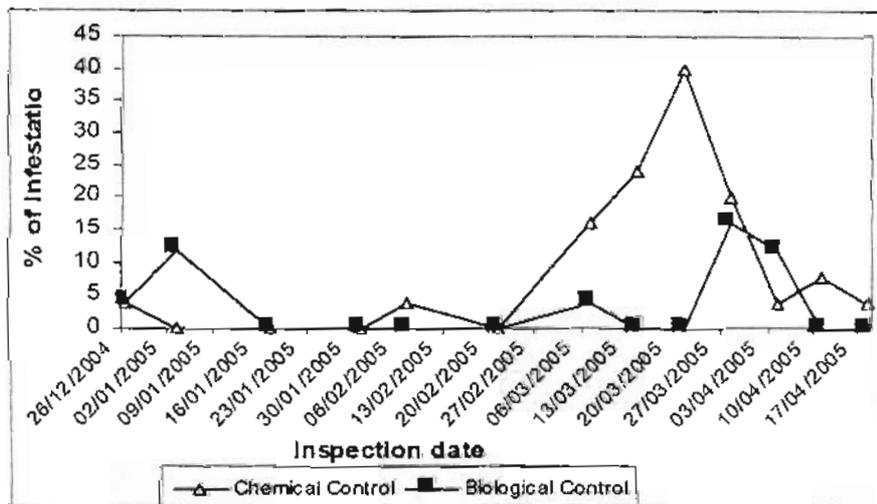


Fig. (1): % Infestation by leafminer on cucumber treated with bio-control agents or chemical insecticides.

## DISCUSSION

The braconid parasitoid, *A. colemani* ( released 3 times) and the cecidomyiid predator, *A. aphidimyza* ( released twice ) might have a role in suppressing the populations of aphids ( mainly *A. gossypii*) on cucumber and

pepper plants in BCG. Although the infestation was almost dominant, the numbers of aphids were very low and concentrated only on the tops of the plants. Percentages of parasitism were much higher in BCG than in CCG, especially after the 3<sup>rd</sup> release of *A. colemani* (on February 5). It is noteworthy that the effect of such natural enemies on aphid populations was supported by applying the chemical insecticide, Aphox, on the infested plants three times in cucumber ( on Jan.3 and 29, and Feb.3) and only once in pepper (on Feb.3) . Percentages of parasitism on such a period, however, were almost nil in both crops whereas they reached high values from 21.2 % in pepper and from 7.3 % in cucumber .The crop yield at the end of the season of cucumber or pepper in the BCG did not differ significantly from that in the CCG. Conte *et al.* (1999) reported that release of *A. colemani* on cucumber in greenhouses several times kept the populations of *A. gossypii* under control without apparent crop damage. Similarly, in a greenhouse study in Germany, Bungler *et al.* (1999) found that *A. colemani* , *A. ervi* and , *A. aphidimyza* were effective in controlling *A. gossypii* on cucumber and the yield was not significantly affected . In contrast, Burgio *et al.* (1997) claimed that *A. colemani* was found to be partially effective against *A. gossypii* on cucumber. Also, Sato *et al.* (1998) mentioned that *A. colemani* and *A. aphidimyza* were released 4 times starting on May 2 at one week intervals in a cucumber greenhouse against *A. gossypii*. The populations of the aphid increased to a high density by mid June and the crop yield decreased by one third compared to a crop using traditional chemical insecticides.

Populations of the whitefly, *B. tabaci* on cucumber were much higher and the infestation was more frequent in the BCG than in the CCG. The role of released natural enemies; the mirid predator, *M. caliginosus* ( released on December, 26) , the aphelinid parasitoids, *E. eremicus* ( released on January 9) and *E. mundus* (released on February 5) was insufficient . Percentages of parasitism were nil all the season except on January 3 (4 %) which was before releasing the parasitoids . In pepper, the role of such natural enemies was unclear as infestation by *B. tabaci* was noticed only from December 26<sup>th</sup> to January 17<sup>th</sup> in both greenhouses .The failure of the bio-control agents released against *B. tabaci* could be attributed to one or more of the following reasons: 1. The numbers of releases were insufficient ; each of them was released only once and with a long period (almost one month) between the two releases . 2. The species utilized could be not suitable for *B. tabaci* as the population of the pest increased on cucumber after releasing *M. caliginosus* or *E. eremicus*. 3.The quality of such bio-control agents was poor and consequently their performance in the greenhouse was not effective. However, the crop yield of cucumber or pepper was not significantly affected as mentioned above.

Biological control of the whitefly on cucumber, tomato and ornamentals was reported to be successful by releasing *Encarsia formosa* 2 – 4 times at rates of 1 parasitoid / m<sup>2</sup> of the greenhouse ( Lipa,1985), 8 individuals / plant ( Hussey & Scopes,1985), 10 individuals / m<sup>2</sup> of the greenhouse ( Lyon, 1979). Granges & Leger (1998) evaluated the biological control of tomato and cucumber pests in greenhouses over 10 years and

came to a conclusion that the whitefly, *Trialeurodes vaporariorum* was successfully controlled by releasing *E. formosa* 3-5 times in the season.

Infestation by leafminer, *L. trifolii* on pepper was noticed only once in both greenhouses (CCG & BCG) while on cucumber it was more frequent in the CCG than in the BCG. Parasitism was found to be 50 % on January 3<sup>rd</sup> just after releasing the parasitoids *D. sibirica* and *D. isaea* (on December 26<sup>th</sup>). Thus, such parasitoids seemed to have a role in controlling the leafminer on cucumber.

Woets & Van der Linden (1985) stated that *D. isaea* can eradicate the populations of *Liriomyza bryoniae* possibly due to its host-feeding behaviour. In addition, Van der Linden (1993) reported that biological control of leafminers on vegetable crops can be achieved relatively easily due to availability of a range of different parasitoid species suited for different pest species and environment.

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تقييم لبعض الطفيليات الداخليه و المفترسات ضد حشرات المن و الذباب الابيض و صانعات الاتفاق التى تصيب محصولى الخيار و الفلفل فى البيوت المحمية .  
منى عبد الحميد شعيب ، سلوى سيد محمد عبد الصمد و محمد سمير توفيق عباس  
قسم بحوث المكافحة الحيوية - معهد بحوث وقاية النباتات - مركز البحوث الزراعية .

قيمت برامج المكافحة الحيويه مقارنة بالمكافحة بالمبيدات التقليدية ضد حشرات المن *Aphis gossypii* و الذباب الابيض *Bemisia tabaci* و صانعات الاتفاق *Liriomyza trifolii* التى تصيب نباتات الخيار و الفلفل فى الصوب . كانت عناصر المكافحة الحيوية المستخدمة ضد حشرات المن والمستوردة من احدى الشركات المتخصصة فى هولندا هى :

*Orius* ( طفيليات داخلية ) و *Aphidoletes aphidimyza* , *Aphidius colemani* .  
*laevigatus* (مفترس ) و ضد الذباب الابيض *Eretmocerus eremicus* , *E. mundus* .  
*Macrolophus caliginosus* (مفترس ) و ضد صانعات الاتفاق *Dacnusa sibirica* , *Dygliphus isaea* ( طفيليات داخلية ) .  
و قد اظهرت الدراسة ان :

نسبة الاصابة بحشرات المن كانت سائدة فى الصوب المعاملة بعناصر المكافحة الحيوية عن المعاملة بالمبيدات التقليدية . ومن جهة اخرى فان نسبة تواجد الطفيليات الداخلية كانت اعلى فى صوب المكافحة الحيوية حيث انها وصلت الى نسبة 96% على الخيار و 100% على الفلفل . ولم تكن نسبة الاصابة بالذباب الابيض سائدة فى كلتا الحالتين بالرغم من ان اعداد الحوريات على ورقة النبات بالنسبة للخيار كانت اعلى فى حالة الصوب المعاملة بعناصر المكافحة الحيوية عنها بالمعاملة بالمبيدات التقليدية . اما بالنسبة لصانعات الاتفاق فقد كانت نسبة الاصابة اعلى فى حالة المعاملة بالمبيدات عن المعاملة بعناصر المكافحة الحيوية ، حيث وصلت نسبة تواجد الطفيليات الداخلية 50% بعد اسبوع من اطلاق الطفيل ، ولم يلاحظ اى طفيليات فى حالة المعاملة بالمبيدات. لذلك فان لعناصر المكافحة الحيوية دور مؤثر فى حالة المن و صانعات الاتفاق بينما قل دورها بالنسبة للذباب الابيض ، مع الاخذفى الاعتبار عدم اختلاف انتاجية كلا المحصولين بنظامى المكافحة .