J. Agric. Sci. Mansoura Univ., 30 (1): 655 - 669, 2005

RELEASE OF *Coccinella undecimpunctata* L. AND *Chrysoperla carnea* (STEPH.) AS A BIOLOGICAL CONTROL TOOL OF THE COTTON APHID, *Aphis gossypii* GLOVER ON TOMATO PLANTS UNDER FIELD CAGE CONDITIONS.

Abdel-Salam, A. H.; M. E. Ragab; L. A. El-Batran, and A. R. Ahmed
Economic Entomology Department, Faculty of Agriculture, Mansoura University, Mansoura 35516, EGYPT.

ABSTRACT

This study was outlined to declare the effect of releases of *Coccinella undecimpunctata* (larvae and adults) and *Chrysoperla carnea* (larvae) at different predator: prey ratios (P: p) to control the cotton aphid, *Aphis gossypii*, on tomato plants under field cage conditions during summer season of 2003.

Effective control of *A. gossypii* was gained after one day from introducing the larvae of the coccinellid predator when the P: p ratio was 1:15 or 1:30, meanwhile at higher ratios (1:60 and 1:75), the aphid numbers decreased after seven days from the release.

The cotton aphid numbers decreased by 96.7 and 77.5% at 1:15 and 1:30 P: p ratios, respectively when adults of the coccinellid released. The number of aphids remained zero for a period of 13 days after the release. At the predator: prey ratio of 1:45, the reduction percentage of aphid densities was 47.8 and 86.1% after one and four days. Whereas, at the higher ratios (1:60 and 1:75), the reduction percentage was 37.1 and 33%, 77.1 and 62%, and 92.1 and 88% after one, four, and seven days from the release, respectively.

Chrysoperla carnea larvae at a P: p ratio of 1:15 yielded excellent control of *A. gosspii* with the reduction percentage 88.3% after one day from the release. There was a drastic drop in the aphid populations after chrysopid larvae release at the P: p ratios of 1:30 and 1:45. The reduction percentages were (64.2 and 39.4%), and (96.7 and 81.7 %), respectively after one and four days from the release.

According to regression analysis between P: p ratios of *C. undecimpunctata* (larvae and adults) and larvae of *C. carnea* and reduction percentage of the cotton aphid, there were negatively high relationship of both predators, which means that the reduction rate was increased with lower P:p ratios and vice versa.

Keywords: *Coccinella undecimpunctata*, *Chrysoperla carnea*, predator: prey ratio, *Aphis gossypii*.

INTRODUCTION

In recent years, the cotton aphid, *Aphis gossypii* (Hemiptera: Aphididae) has become a serious pest of several economic vegetable crops including tomato. Reduced plant vigor, stunting and deformed plant parts are common symptoms of aphid infestations. In some cases, it is the production of honeydew or presence of sooty mold that alerts the gardener to an aphid outbreak. In addition, aphids are excellent transmitters of several viral diseases such as the mosaic viruses, that cause leaves to shrivel and that infect a wide range of hosts. In some cases, it is the appearance of virus symptoms that indicate aphid activity (Ebert and Cartwright, 1997).

Rising costs of insecticides, widespread insecticides resistance and increasing restrictions on insecticides use have spurred interest in an insect management by other means, including biological control. Biological control is

the cornerstone in every satisfactory program in an integrated pest management. Control of insect pests by predators is operationally defined as the action of predators that maintains a pest population at a lower level than would occur in the absence of the predators. It involves the manipulation of trophic interactions to achieve a reduction in pest density (Ehler, 1996). Theory and practice of biological control suggest that generalist predators can be effective control agents. Field studies show that generalist predator species can reduce pest numbers by a significant degree and in some cases reduce or prevent crop damage. This evidence is mainly from semi-field conditions (field cage) and providing that predator: prey ratios and the timing of releases are optimized (Symondson *et al*., 2002). Generalist insect predators are frequently abundant in annual crops including vegetable crops and have been identified as important in suppression populations of damaging insects (Rosenheim *et al*. 1995).

Several methods have been used to measure the effect of predators on aphid populations (Hodek *et al.,* 1972). One common technique is to use field cage conditions to enclose known numbers of predatory species with artificially known numbers of aphid species. Shands *et al.* (1972) used this technique and found that releases of *Chrysopa* spp., *Coccinella septempuntata* L., and *Coccinella transversoguttata* Brown larvae reduced *Myzus persicae* (Sulz.) populations.

The coccinellid*, Coccinella undecimpunctata* (Coleoptera: Coccinellidae) and the green lacewing, *Chrysoperla carnea* (Neuroptera: Chrysopidae) are considered as generalist predators. *C. undecimpunctata* is one of the most important predators encountered in Egyptian fields. It is being considered as a potential agent for biological control of aphids, cotton leafworm, whiteflies and other soft bodied insects. Detailed studies on their role against several insect pests have been studied extensively (Ghanim and El-Adl, 1987; Eraky and Nasser, 1993; Abdel-Salam, 1995; Zaki *et al*., 1999; Al-Eryan *et al*., 2001).

The green lacewing has relatively short generation times, larvae have a relatively broad range of acceptable preys (Hydron and Whitcomb 1979), and they are amenable to mass-rearing, release, and manipulation in the field (Hasegawa *et al.* 1989, Tauber and Tauber 1993). The role of *C. carnea* in controlling different aphid species on various crops has been studied by several investigators (Hassan *et al*., 1985; Hagley 1989; Al-Arnaouty and Sewify, 1998). Ebert and Cartwright (1997) reported that *C. carnea* was able to cause an overall reduction in aphid abundance when caged on field grown cotton. The relative occurrence and population densities of both *C. undecimpunctata* and *C. carnea* as main predators of *A. gossypii* were also investigated on some tomato varieties at Mansoura region (Ragab *et al*., 2002)

Therefore, the aims of the current study were: 1) to compare the effect of released larvae versus adults of *C. undecimpunctata*, 2) to evaluate the optimal predator: prey ratio for the release of larvae or adults, and 3) to compare the effectiveness of *C. undecimpunctata* versus *C. carnea* for controlling the cotton aphid, *A. gossypii* on tomato plants under field cage conditions.

MATERIAL AND METHODS

The experimental traits were conducted at the farm of Economic Entomology Department, Faculty of Agriculture, Mansoura University during the summer of 2003. The tomato variety was Castle Rock. The tomato plants were transplanted on the 15th of June, 2003. The plants received the normal agricultural practices.

Adults of *C. undecimpunctata* and *C. carnea* were collected from the experimental farm of the Economic Entomology Department. The eggs laid by each female of both predators were removed daily and monitored until hatching. The hatched larvae were reared individually to avoid cannibalism on the cotton aphid, *A. gossypii* in petri-dishes (12 cm. in diameter) until the second instar or adult emergence.

Twenty four cages (100x180x70 cm) were covered with muslin and prepared with one meter long zipper to facilitate counting of the pest and predator stages. Tomato plants under cages were sprayed with Malathion 57%. E.C. to kill any insects on the plants before releasing the predators. Three weeks after spraying, artificial infestation from the cotton aphid nymphs was made at the following numbers: 15, 30, 45, 60, and 75/plant. The introduction of aphid nymphs was done by fine camel brush.

The coccinellid predator was released into the cages as early second instar larvae or as newly emerged adults; meanwhile, the chrysopid was introduced as early second instar larvae from laboratory rearing. The following predator: prey ratios: 1:15, 1:30, 1:45, 1:60, and 1:75 were used for each stage. Four replicates were used at each predator: prey ratio and four replicates for check (without releasing). The number of aphids and the predator stages were carefully counted every three days to measure the success of the release rate.

Data analysis:

Aphid numbers at predator: prey ratios were subjected to one way analysis of variance (ANOVA), and the means separated using Duncan's Multiple Range Test (Costat, 1990). In addition, simple linear regression between predator: prey ratio and reduction percentage was run.

RESULTS

1. Release of *C. undecimpunctata* larvae

An effective control of the cotton aphid populations was achieved after one day from release of the coccinellid larvae with the predator: prey ratio of 1:15 and 1:30 (Table 1). The reduction percentage of these ratios was 93.3 and 71.7%, respectively. It was observed that the number of aphids at these ratios remained zero for a period of 13 days after release of the predator larvae.

When the predator: prey ratios was 1:45, the reduction percentage was 52.8 and 82.8% after one and four days from introducing the predator larvae, then the aphid numbers remained zero after seven days from release. Whereas, at 1:60 and 1:75, the aphids reduced by 34.6 and 32% after one day, 73.6 and 61% after four days, and 90.8 and 86% after seven days from release of the predator larvae (Table 1).

From the above results, effective control of *A. gossypii* was gained after one day from introducing the larvae of the coccinellid predator when the P:p ratio was 1:15 or 1:30, while at higher ratios (1:60 and 1:75) of *C. undecimpunctata* larvae, the aphid numbers decreased after seven days from release.

The statistical analysis showed that there was a significant decrease of the cotton aphid numbers at the different predator: prey ratios and days after release of *C. undecimpunctata* larvae.

The regression equations between predator: prey ratios of the coccinellid larvae (as independent variable X) and reduction percentages of aphid numbers (as dependent variable Y) were derived: Reduction rate (Y)=103.08-1.0117 predator: prey ratio (X), Y=114.8-0.696X, and Y=106.52-0.248X, respectively (Fig. 1). These equations indicated that there was a highly negative relationship between P: p ratios and reduction rates which mean that the reduction rate was increased with lower P: p ratios and vice versa.

Table 1: Reduction percentages of *A. gossypii* after release of *C. undecimpunctata* larvae at different predator: prey ratios under field cage conditions on tomato plants.

Days after release	P: p ratio				
	1:15	**1:30**	**1:45**	**1:60**	**1: 75**
1	93.30	71.70	52.80	34.90	32.00
4	100.00	100.00	82.80	73.60	61.00
7	100.00	100.00	100.00	90.80	86.00
10	-	-	-	100.00	100.00
13	-	-	-	-	-

2. Release of *C. undecimpunctata* adults

The results of released adults with the predator: prey ratios of 1:15 and 1:30 showed that the coccinellid adults were successful in decreasing the cotton aphids after one day from the release (Table 2). The number of cotton aphids decreased by 96.7 and 77.5% at 1:15 and 1:30 P: p ratios, respectively. It was noticed that the number of aphids remained zero for a period of 13 days after the release. At the predator: prey ratio of 1:45, the reduction percentage of aphid densities was 47.8 and 86.1% after one and four days. Whereas, at the higher ratios (1:60 and 1:75), the reduction percentage was 37.1 and 33.0%, 77.1 and 62.0%, and 92.1 and 88.0% after one, four and seven days from the release, respectively (Table 2). The best control of aphid populations was achieved using the lower predator: prey ratios (1:15 and 1:30) after one day from adults release. According to data analysis, there were significant variations among the different predator: prey ratios and days after the release of *C. undecimpunctata* adults.

Based on simple linear regression between P: p ratios of *C. undecimpunctata* adults and reduction percentage of the cotton aphid, there were negatively strong relationship after one, four and seven days from the release of the coccinellid adults. The regression equations were: Y=108.76-1.1187X, Y=114.71-0.6593X, and Y=105.59-0.2127X, respectively. The values of R^2 were 0.9253, 0.9381, and 0.80 in succession (Fig. 2).

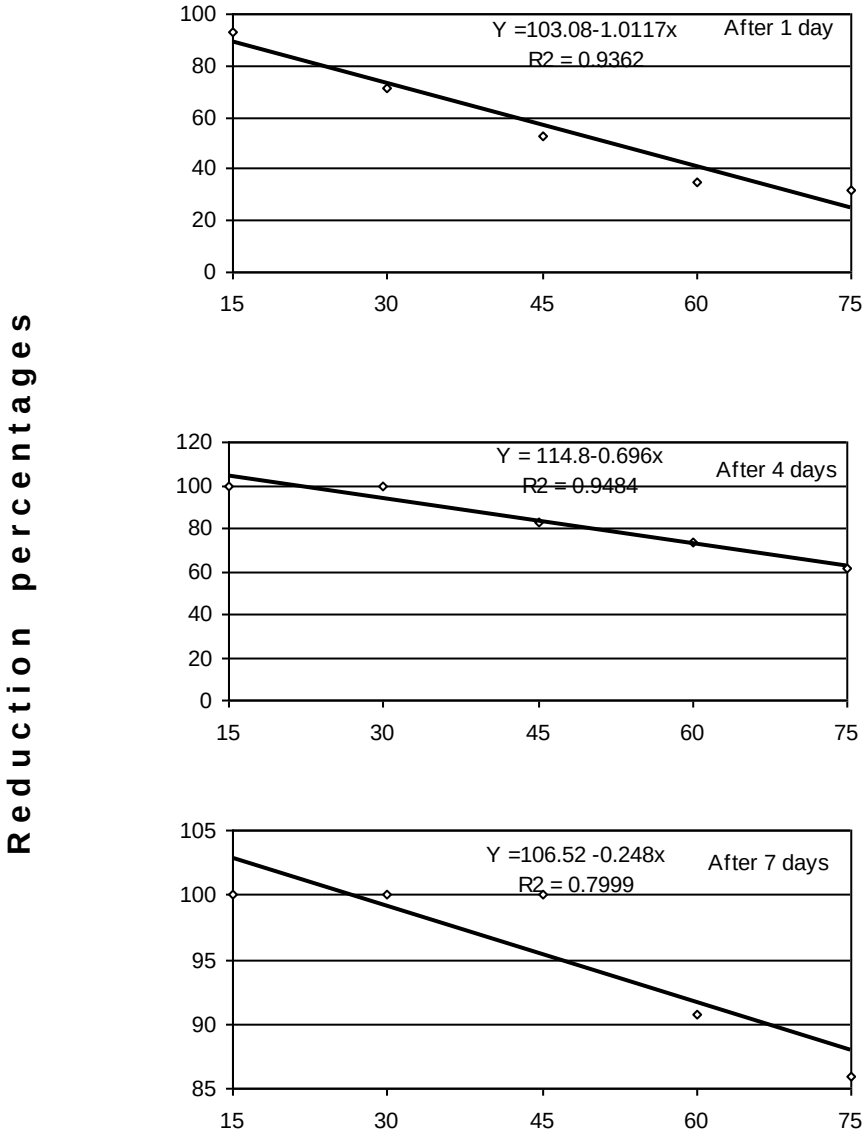

Fig. 1: Simple linear regression between predator: prey ratios (X) and the reduction percentages (Y) of *C. undecimpunctata* larvae under field cage conditions.

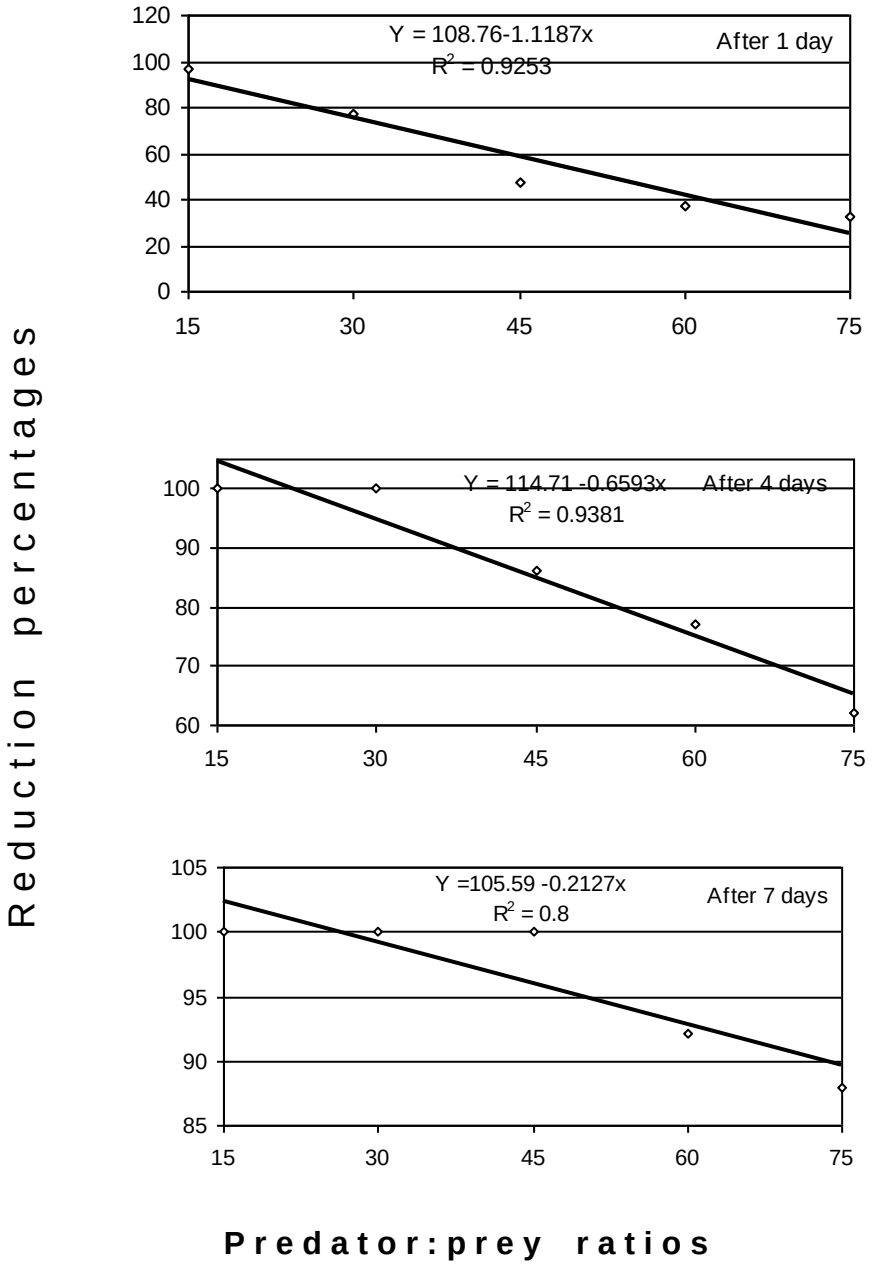

Fig. 2: Simple linear regression between predator: prey ratios (X) and the reduction percentages (Y) of *C. undecimpunctata* adults under field cage conditions.

Table 2: Reduction percentages of *A. gossypii* after release of *C. undecimpunctata* adults at different predator: prey ratios under field cage conditions on tomato plants.

Days after release	P: p ratio				
	1:15	**1:30**	**1:45**	**1:60**	**1: 75**
1	96.70	77.50	47.80	37.10	33.00
4	100.00	100.00	86.10	77.10	62.00
7	-	-	100.00	92.10	88.00
10	-	-	-	100.00	100.00
13	-	-	-	-	-

3. Release of *C. carnea* larvae.

Larvae of the chrysopid predator at a P: p ratio of 1:15 yielded good aphids control with the reduction percentage 88.3% after one day from the release (Table 3). From the data in Table (3), there was a drastic drop in the aphid populations after released larvae at the P:p ratios of 1:30 and 1:45. The reduction percentage was (64.2 and 39.4%), and (96.7, and 81.7 %) for the above ratios, respectively, after one and four days from the release.

After one, four, and seven days from the release, the reduction percentage of aphid numbers was 32.5 and 29.0, 70.4 and 60.0 and 87.9 and 82.0%, respectively for the P: p ratios of 1:60 and 1:75. Based on ANOVA analysis, there were significant differences among the P: p ratios and days after release of chrysopid larvae.

There was highly negative relationship between P: p ratios of *C. carnea* larvae and reduction percentage *A. gossypii* (Fig. 3). The values of R^2 were 0.8944, 0.9754, and 0.80 for one, four and seven days after the release, respectively.

The results in Table (4), clearly indicate that at the low predator: prey ratios (1:15, 1:30, and 1:45), there was a non-significant difference between the coccinellid larvae and adults, or chrysopid larvae, whereas, at the higher ratios (1:60 and 1:75), there was a significant variation between the predatory stages (adults versus larvae).

Table 3: Reduction percentages of *A. gossypii* after release of *C. carnea* larvae at different predator: prey ratios under field cage conditions on tomato plants.

Days after release	P: p ratio				
	1:15	**1:30**	**1:45**	**1:60**	**1: 75**
1	88.30	64.20	39.40	32.50	29.00
4	100.00	96.70	81.70	70.40	60.00
7	-	100.00	100.00	87.90	82.00
10	-	-	-	100.00	100.00
13	-	-	-	-	-

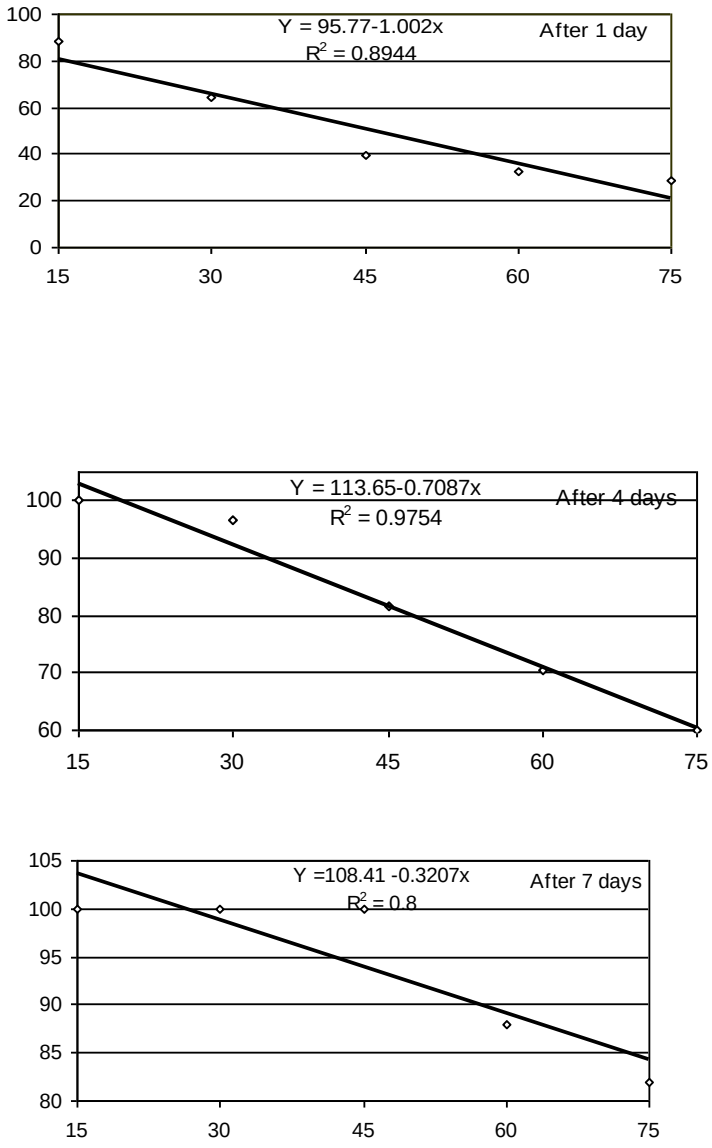

Fig. 3: Simple linear regression between predator: prey ratios (X) and the reduction percentages (Y) of *C. carnea* larvae under field cage conditions.

Table 4: Average number of *A. gossypii* per plant after release of *C. undecimpunctata* and *C. carnea* at different predator: prey ratios under field cage conditions on tomato plants.

P: p ratio	*C. undecimpunctata* larvae	*C. undecimpunctata* adults	*C. carnea* Larvae
1:15	0.33 a^{E}	0.17 a^{E}	0.58 a^{E}
1:30	2.83 a^{D}	2.25 a^{D}	3.92 a^{D}
1:45	9.67 a^{C}	9.92 a^{C}	11.83 a^{C}
1:60	20.17 b^{B}	18.75 c^{B}	21.83 a^{B}
1:75	30.25 b^{A}	29.25 b^{A}	32.25 a^{A}

[a]**Means followed by the same small letter in a row or capital letter in a column are not significantly different at the 1% level of probability (Duncan's Multiple Range Test).**

In the check cages (without predator release), the number of cotton aphids increased 100% after one day from initial artificial infestation at 15, 30, 45, 60, and 75 aphids/plant. After four days, the aphid increased rapidly to 140, 150.8, 155, 167, 158 aphids/plant. Up to 1000%, increasing rate of cotton aphids occurred after 13 days from initial artificial infestation (Fig. 4). The number of aphids increased sharply and heavily damaged the tomato plants. These results confirmed the effect of the two predators in suppressing the number of cotton aphids. Based on the regression analysis, there was a highly negative relationship between initial artificial infestation of *A. gossypii* and average final of increasing number of the cotton aphid. The value of R^2 was 0.8488 (Fig. 5).

DISCUSSION

Biological control has a great potential for use against the cotton aphid, *A. gossypii* based on successes of biological control against other aphid species and the abundance of biological control agents (Ebert and Cartwright, 1997; Zaki *et al*., 1999; Al-Eryan *et al*., 2001). Many potential predators have been identified against *A. gossypii* including *C. undecimpunctata* and *C. carnea*. Both predators are active aphidophagous in Egyptian fields due to their highly prey consumption rates, highly fecund, and highly searching rates (Ghanim and El-Adl, 1987; Eraky and Nasser, 1993; Abdel-Salam, 1995; Al-Arnaouty and Sewify, 1998; Zaki *et al*., 1999; Al-Eryan *et al*., 2001).

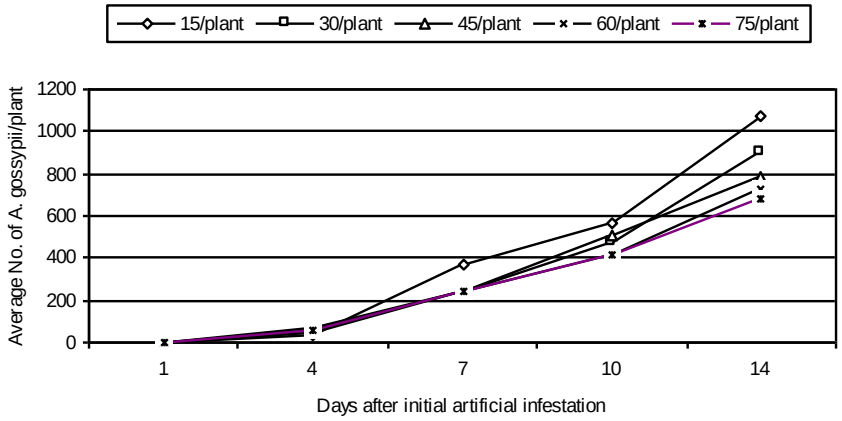

Fig. 4: Average of increasing numbers of *A. gossypii* under field cage conditions on tomato plants. Plants were initially inoculated with 15, 30, 45, and 75 aphids/plant.

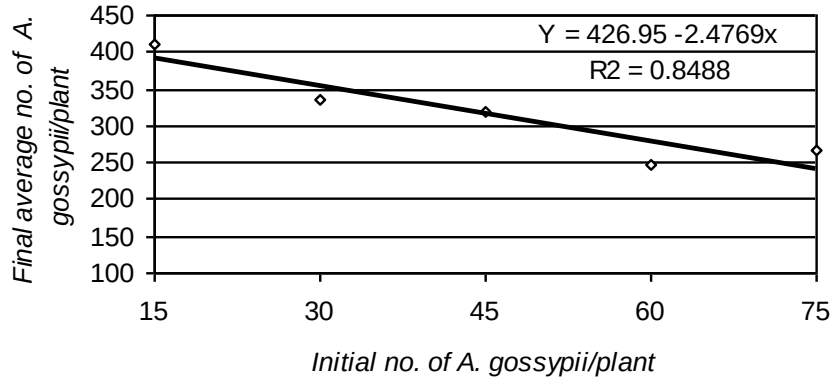

Fig. 5: Simple linear regression between the initial number (X) and final average numbers (Y) of *A. gossypii* under field cage conditions.

Naturally, occurring predators are usually not sufficient to control aphid populations and so augmentation release of predators into the agro-ecosystem would be necessary to gain successful biological control (Hagley 1989; Abdel-Salam, 1995; Ebert and Cartwright, 1997; Al-Arnaouty and Sewify, 1998; Acheampong and Stark, 2004). However, their food resources affect the performance of bio-control agents. Therefore, a proper predator: prey ratio should be determined. The results of the current study clearly demonstrated that the effective P: p ratios were 1:15 and 1:30 for the coccinellid predator, *C. undecimpunctata* larvae or adults after one day of release under field cage conditions. Moreover, the release of the predator at the rate of 1:75 could not possibly keep the population of aphids down to a satisfactory level after seven days. Whereas, after ten days, the reduction percentage was 100%. On the other hand, the predator: prey ratio at 1:15 could suppress the aphid populations down to a satisfactory level, but there was not enough prey left for the predators to build up its populations. These results are in completely agreement with the following reports. Gurney and Hussey (1970) gained good control of *M. persicae* by releasing second instar larvae of the coccinellid, *Cycloneda sanguinea* L. at a P: p ratio of 1:20. In contrary, Adashkevich (1975) reported that best control of aphids gained in 10 days when first instar larvae of *Coccinella septempunctata* L. were released against *A. gossypii* at P: p ratio of 1:50 and 1:100. Meanwhile, a similar trend with our results was obtained by Hamalaninen (1977) who found that larvae of *Adalia bipunctata* L. at ratio of 1:5 yielded a good control of *M. persicae*. By a release ratio 1:10, *A. bipunctata* larvae were also decreased aphid numbers by half in 10 days. Whereas, a release ratio of 1:20 was inadequate to prevent aphid increase. The cotton aphid could be successfully controlled by releasing *H. axyridis* at the predator: prey ratio of 1:100-200 in cotton fields without the need to apply insecticides (Dong, 1988). Raupp *et al.,* (1994) mentioned that a field release of the coccinellid, *Hippodamia convergens* Guerin-Mineville was followed by reduced aphid populations. Release of the first instar larvae of *Harmonia dimidiate* (F.) is a highly effective against *Macrosiphum euphorbiae* Thom. on cucumbers at the predator: prey ratio varying from 1:50 to 1:100 (Semyanov, 1997). Zaki *et al*. (1999) reported that a single release of *C. undecimpunctata* (1:50 predator: aphids) resulted in 99.97% reduction of *A. gossypii*. Al-Eryan *et al*. (2001) indicated that results of releasing *C. undecimpunctata* against *A. gossypii* at predator: prey ratios of 1:100, 1:50 and 1:25 resulted in reduction of aphid populations by about 99.6, 99.4 and 99.4%, respectively, within 28 days. Zibai and Hatami (2001) pointed out that the predator:prey ratios of 1:30 and 1:90 significantly reduced the population of *A. gossypii*. At 1:30, there was no difference in efficacy between the use of the predators alone or in combination. At 1:90, control using *Hippodamia variegata* (Goeze) alone, or in combination with *C. carnea* was equally effective. Omkar and James (2003) noted that the predator:prey ratio of 1:50 may be considered optimum for the augmentative release of *Coccinella transversalis* Fabricius for the biological control of *A. gossypii*. Biological control agents were used in a ratio

of 1:50 predator: aphid. The use of *C. septempunctata* resulted in a 58% reduction in the level of aphid infestation (Acheampong and Stark, 2004).

Our results assured that the proper ratios were 1:15 and 1:30 for the chrysopid, *C. carnea* larvae after one day of release under field cage conditions. In addition, when the ratio of 1:75, it was clearly seen that there was a surplus of prey population that could not be controlled by the chrysopid within seven days, whereas, the reduction percentage was increased to 100% after ten days from the release. These results are in completely agreement with those of Bondarenko and Moiseev (1972) who evaluated the effectiveness of chrysopids in control of aphids. As a result of a further release of 200 larvae of *Chrysopa* at the rate of one per 40 plants, increase of aphids was prevented until the end of the season. In addition, Ishankulieva (1980) reported that at a ratio of 1:50 or 1:55, *C. carnea* reduced numbers of *A. gossypii* by 99.5%, whereas the untreated population of *A. gossypii* doubled in size. Radzivilovskaya (1980) suggested that *C. carnea* was most effective against aphids on cotton at a ratio of 1:10. Meanwhile, at a ratio of 1:25, aphid numbers were not reduced and a ratio of 1:50, the populations of aphid increased. According to Shuvakhina (1983), second instar larvae of *C. carnea* were effective only when released at 1:20. In addition, Hassan *et al.* (1985) reported that control of *M. persicae* on sugarcane by *C. carnea* for 5-6 weeks when predator: prey ratios were 1:5 and 1:10. At higher predator: prey ratios (1:20 and 1:40), control was adequate for 3-4 weeks only. Also, Hagley (1989) stated that greater reduction in *Aphis pomi* DeGear numbers by releasing *C. carnea* at the predator: prey ratio 1:10 and 1:19. The similar results were obtained by Sazonov *et al.* (1990) who noted that releases of *C. carnea* at a 1:10 predator: prey ratio resulted in over 90% reduction in aphid numbers within about a week. Al-Arnaouty and Sewify (1998) demonstrated that successful control (reduction by at least 95%) was obtained by releases of *C. carnea* second instar larvae. Also, Zaki *et al.* (1999) concluded that double releases of *C. carnea* (1:5 predator:aphids) achieved 100% reduction in *A. gossypii* after 12 days. Whereas, release of *C. carnea* at 1:50 (predator: prey ratio) was found to be more effective in suppressing the aphid population than at 1:100 (Venkatesan *et al.,* 2000). Meanwhile, Zibai and Hatami (2001) recorded that the predator:prey ratios of 1:30 and 1:90 significantly reduced the population of *A. gossypii*. At 1:30, there was no difference in efficacy between the use of the predators alone or in combination. At 1:90, control using *H. variegata* alone, or in combination with *C. carnea* was equally effective.

Based on regression analysis between P: p ratios of *C. undecimpunctata* (larvae and adults) and larvae of *C. carnea* and reduction percentage of the cotton aphid, there were negatively strong relationship after one, four and seven days from the release of both predators. The reduction rate increased with lower P: p ratios and vice versa. This result closely matches with those of Rautapaa (1977) who indicated that there was a significantly negative relationship between P: p ratio of *C. septempunctata* and aphid indices and that a 50% decrease in the aphid, *Rhopalosiphum padi* (L.) is achieved when the initial P: p ratio is at least 1: 5.

In conclusion, *C. undecimpunctata* (larvae and adults) and *C. carnea* (larvae) could be employed as the biological control agents against *A.*

gossypii under field cage conditions at the predator: prey ratios of 1: 15 and 1: 30.

REFERENCES

Abdel-Salam, A. H. 1995. The biotic factors: "evaluation of their performance under natural conditions in cotton plantation". Ph. D. Thesis, Fac. Agric., Mansoura Univ. 175 pp.

Acheampong, S. and Stark, J. D . 2004. Can reduced rates of pymetrozine and natural enemies control the cabbage aphid, *Brevicoryne brassicae* (Homoptera: Aphididae), on broccoli. International J. Pest Management. 50: 275-279.

Adashkevich, B. P. 1975. Entomophages and acariphages in vegetable pest control in the USSR. VIII. Int. Cong. Pl. Protect. Moscow III:7-12.

Al-Arnaouty, S. A. and Sewify, G. H. 1998. A pilot experiment for using eggs and larvae of *Chrysoperla carnea* (Stephens) against *Aphis gossypii* (Glover) on cotton in Egypt. Acta Zool. Fennica 209:103-109.

Al-Eryan, M. A. S.; Zaitoon, A. A. and Rezk, H. A. 2001. The use of *Coccinella 11-punctata* (Coleoptera: Coccinellidae) against *Aphis gossypii* (Homoptera: Aphididae) on Okra plant. Alex. J. Agri. Res. 46: 107-114.

Bondarenko, N. V. and Moiseev, E. G. 1972. Evaluation of the effectiveness of Chrysopids in the control of aphids. Zashchita Rastenii. 17: 19-20.

CoStat Software 1990. Microcomputer program analysis Version 4.20, CoHort Software, Berkeley,CA.

Dong, Y. G. 1988. Trials on the control of *Aphis gossypii* Glover with *Coccinella axyridis* Pallas. Zhejiang Agri. Sci. 3: 135-139.

Ebert, T. A. and Cartwright, B. 1997. Biology and ecology of *Aphis gossypii* Glover (Homoptera: Aphididae). Southwest. Entomol. 22: 116-153.

Ehler, L. E. 1996. Structure and impact of natural enemy guilds in biological control of insect pests. *In* "Food webs: Integration of patterns and dynamics" (Polis, G. A. and Winemiller, O. *Ed*.) pp. 337-342. Champman and Hall, New York.

Eraky, S. A. and Nasser, M. A. K. 1993. Effect of constant temperatures on the development and predation prey efficiency of the ladybird beetle, *Coccinella undecimpunctata* L. (Coleoptera: Coccinellidae). Assiut J. Agric.Sci. 24: 223-231.

Ghanim, A. A. and El-Adl, M. A. 1987. The role of *Coccinella undecimpunctata* L. in suppressing the population level of *Schizaphis graminum* Rond and increase the yield in wheat plantation at Dakahlia Governorate, Egypt. J. Agric. Sci. Mansoura Univ. 12: 965-974.

Gurney, B. and Hussey, N. B. 1970. Evaluation of some coccinellid species for the biological control of aphids in protected cropping. Ann. Appl. Biol. 65:451-458.

Hagley, E. A. C. 1989. Release of *Chrysoperla carnea* (Neuroptera : Chrysopidae) for control of the green apple aphid, *Aphis pomi* DeGear (Homoptera: Aphididae). Can. Entomol. 121: 309-314.

Hamalainen, M. 1977. Control of aphids on sweet peppers, Chrysanthemums and roses in small greenhouses using the ladybeetles *Coccinella*

septempunctata and *Adalia bipunctata* (Col., Coccinellidae). Ann. Agric. Fenn. 16: 117-131.

Hasegawa, M. ; Matsuka, M. and Niijima, K. 1989. Rearing *Chrysoperla carnea* (Neuroptera: Chrysopidae) on chemically defined diets. Appl. Ent. Zool. 24: 96-102.

Hassan, S. A..; Klingauf, F. and Shahin, F. 1985. Role of *Chrysopa carnea* as an aphid predator on sugar beet and the effect of pesticides. J. Appl. Ent. 100: 163-174.

Hodek, I.; Hagen, K. S. and van Emden, H. F. 1972. Methods for studying the effectiveness of natural enemies, pp. 147-188. *In* van Emden, H. F. (*ed*.), Aphid technology. Academic, New York.

Hydron, B. and Whitcomb, W. H. 1979. Effects of larval diet on *Chrysopa rufilabris*. Fla. Entomol. 60: 393-398.

Ishankulieva, T. 1980. The use of larvae of the common lacewing in the control of pests of cotton. Izvestiya Akademii Nauk Turkmenskoi SSR, Biologicheskikh Nauk. 1 : 17-21.

Omkar and James, B. E. 2003. Searching and feeding efficiency of a ladybeetle, *Coccinella transversalis* Fabricius on aphid, *Aphis gossypii* Glover. J. Biol. Control. 17: 107-112.

Radzivilovskaya, M. A. 1980. The chrysopid against aphids on cotton. Zashchita Rastenii. 10: 26.

Ragab, M. E.; Abdel-Salam, A. H. and Abdel-Baky, N. F. 2002. Effect of some tomato varieties on the relative occurrence and population densities of predators and parasitoids associated with *Bemisia* spp. and *Aphis gossypii*. J. Union Arab. Biol. 17 (A): 2903-312.

Raupp, M. J.; Hardin, M. R.; Braxton, S. M. and Bull, B. B. 1994. Augmentative releases for aphid control on landscape plants. J. Arboriculture, 20:241-249.

Rautapaa, J. 1977. Evaluation of predatory-prey ratio using *Chrysopa carnea* Steph. in control of *Rhopalosiphum padi* L. Ann. Agric. Fenn. 16:103-109.

Rosenheim, J. A.; Kaya, H. K.; Ehler, L. E.; Marios, J. J. and Jaffee, B. A. 1995. Intraguild predation among biological control agents: theory and evidence. Biol. Control 5: 303-335.

Sazonov, A. P.; Karelina, T. N. and Voinyak, V. I. 1990. Increasing the effectiveness of the common lacewing. Zashchita Rastenii (Moskva), 4:19-20.

Semyanov, V. P. 1997. Some results and perspectives of the use of tropical coccinellids (Coleoptera, Coccinellidae) against aphids in greenhouses. Entomologicheskoe Obozrenie, 76: 467-472.

Shands, W. A.; Simpson, G. W. and Gordon, C. C. 1972. Insect predators for controlling aphids in potatoes. 5. Numbers of eggs and schedules for introducing them in large field cages. J. Econ. Entomol. 65: 810-817.

Shuvakhina, E. Y. 1983. *Chrysopa sinica* an effective natural enemy. Zashchita Rastenii. 9: 20.

Symondson, W. O. C.; Sunderland, K. D. and Greenstone, M. H. 2002. Can generalist predators be effective biocontrol agenst? Annu. Rev. Entomol. 47:561-594.

Tauber, M. J. and Tauber, C. A. 1993. Adaptations to temporal variation in habitats. *In* "Evolution of insect pests": the patterns of variation (*Eds*. Kim. K. C. and McPheron, B. A.), pp. 103-127, Wiley, New York.

Venkatesan, T.; Singh, S. P. and Jalali, S. K. 2000. Rearing of *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae) on semi-synthetic diet and its predatory efficiency against cotton pests. Entomon. 25: 81-89.

Zaki, F. N.; El-Shaarawy, M. F. and Farag, N. A. 1999. Release of two predators and two parasitoids to control aphids and whiteflies. Anzeiger fur Schadlingskunde, 72:19-20.

Zibai, K. and Hatami, B. 2001. Singular and joint usage of third larval instars of *Hippodamia variegata* (Goeze) and *Chrysoperla carnea* (Steph.) in biological control of *Aphis gossypii* Glover in greenhouse. J. Sci. Tech. Agric. Natural Res. 4: 119-128.

إطلاق كل من مفترسي أبى العيد ذى الأحدى عشرة نقطة وأسد المنّ الأخضر كوسيلة مكافحة بيولوجية لحشرة منّ القطن على نباتات الطماطم تحت ظروف الأقفاص الحقلية

عادل حسن عبد السلام – محمد السيد رجب – ليلى عبدالستار البطران – أحمد راشد أحمد

قسم الحشرات الإقتصادية - كلية الزراعة - جامعة المنصورة

هدفت هذه الدراسة إلى تحديد تأثير إطلاق كل من اليرقات والحشرات الكاملة لمفترس أبو العيد ذى الإحدى عشرة نقطة واليرقات فقط لمفترس أسد المنّ الأخضر وذلك بنسب إطلاق مختلفة لمكافحة حشرة منّ القطن بيولوجياً على نباتات الطماطم تحت ظروف الأقفاص الحقلية وذلك خلال صيف ٢٠٠٣.

أظهرت الدراسة تحقيق مكافحة حيوية مؤثرة لحشرة منّ القطن بعد يوم واحد من إطلاق يرقات أبى العيد ذى الإحدى عشرة نقطة وذلك عند نسبة إطلاق ١: ١٥ ، ١: ٣٠ بينما عند نسب الإطلاق المرتفعة (١: ٦٠ ، ١: ٧٥) إنخفضت أعداد المنّ بعد سبعة أيام من الإطلاق . وبناءاً على تحليل جدول التباين ، إتضح وجود فرق معنوي بين أعداد المنّ عند نسب الإطلاق المختلفة وكذلك بين المدد الزمنية (الأيام) بعد إطلاق يرقات أبىالعيد ذى الإحدى عشرة نقطة.

وأوضحت النتائج أن أعداد حشرة منّ القطن قد إنخفضت بنسبة ٩٦,٧ ، ٧٧,٥% عند نسب الإطلاق ١: ١٥ ، ١: ٣٠ على التوالى وذلك عندما تم إطلاق الحشرات الكاملة لمفترس أبىالعيد ذى الإحدى عشرة نقطة. ولم تتواجد إى أعداد لحشرة منّ القطن حتى ١٣ يوم من الإطلاق ، أما عند نسبة ١: ٤٥ كان معدل الإنخفاض ٤٧,٨ ، ٨٦,١% بعد ١ ، ٤ أيام من الإطلاق على التوالى.بينما عند نسب الإطلاق المرتفعة (١: ٦٠ ، ١: ٧٥) كانت نسب الإنخفاض : (٣٧,١ ، ٣٣%) ، (٧٧,١ ، ٦٢%) ، ٩٢,١ ، ٨٨%) بعد ١ ، ٤ ، ٧ أيام من الإطلاق على التوالى للنسبتين معاً.

أشارت نتائج الدراسة إلى أن إطلاق يرقات مفترس أسد المنّ الأخضر عند نسبة ١: ١٥ أعطى مكافحة مرضية لحشرة منّ القطن حيث كان الإنخفاض فى أعداد المنّ ٨٨,٣% بعد يوم واحد من الإطلاق. بينما كان هناك إنخفاضاً مرتفعاً عند نسب الإطلاق ١: ٣٠ ، ١: ٤٥ . وبينتّ النتائج أن معدل الإنخفاض كان (٦٤,٢ ، ٣٩,٤%) ، (٩٦,٧ ، ٨١,٧%) بعد ١ ، ٤ أيام من الإطلاق.

وبناءاً على تحليل الإنحدار بين نسب الإطلاق المختلفة لكل من اليرقات والحشرات الكاملة لمفترس أبىالعيد ١١ نقطة واليرقات لمفترس أسد المنّ الأخضر من ناحية ونسب الإنخفاض فى أعداد حشرة منّ القطن من ناحية أخرى ، إتضح وجود علاقة قوية سالبة بينهما وهذا يعنى أن نسب الإنخفاض تتزايد مع نسب الإطلاق المنخفضة والعكس صحيح.