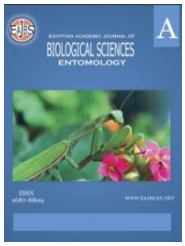
Egypt. Acad. J. Biolog. Sci., 13(1):165-171 (2020)

Egyptian Academic Journal of Biological Sciences
A. Entomology

ISSN 1687- 8809
http://eajbsa.journals.ekb.eg/



Biological Control Using Some Predators for Tomato Pests Under Greenhouse Conditions

Iman I. Imam[1]and Mohamed A. Nawar[2]
1- Economic Entomology Unit, Plant Protection Department, Desert Research Center.
2- Animal Pest Unit, Plant Protection Department, Desert Research Center.
Email: imann_7298@yahoo.com

ARTICLE INFO
Article History
Received:20/2/2020
Accepted:14/3/2020

Keywords:
Bemisia tabaci. *Tetranychus urticae*, *Phytoseiulus persimilis*, *Chrysoperla carnea*, Predators, tomato, Greenhouses.

ABSTRACT

Bemisia tabaci Genn. (Hemiptera: Aleyrodidae) and *Tetranychus urticae* Koch. (Acari: Tetranychidae) are major pests in tomato greenhouses. The combination and different release regimes of 2 predators; *Chrysoperla carnea* (Steph.), and *Phytoseiulus persimilis* Athias- Henriot in commercial tomato greenhouses during the winter plantation of the two seasons, 2018 and 2019. five release rates were evaluated; 1 individuals of *C. carnea* + 2 individuals of *P. persimilis* /m2 biological control greenhouse 1 (1C / 2P), 2 individuals of *C. carnea* + 4 individuals of *P. persimilis* /m2 (2C/4P) , 4 individuals of *C. carnea* + 4 individuals of *P. persimilis* /m2 (4C/8P),1 Insect predator (*C. carnea*) only and 1 mite predator (*P. persimilis*) . The greatest suppression of the pest population was recorded in 4C/8P (the combination of the 2 predators).

The population of *B. tabaci* reached 3.3, 1, 1, 4.5 and 0.5 individuals/ plant in 2018 and 5, 2, 1, 3.5 and 5 individuals/ plant in 2019 in 1C/2P, 2C/4P, 4C/8P, *C. carnea* and *P. persimilis*, respectively, in the 11th week.
Correspondent population of *T. urticae* reached 2.2, 2, 1, 2.4 and 4 individuals/ plant in 2018 and 1, 2, 0.4, 4,6 and 4 individuals/ plant in 2019. There was a significant difference between 1C/2P, 2C/4P, 4C/8P, *C. carnea* and *P. persimilis* for the whitefly and mite populations.

Generally, the pest populations in the 4C/8P decreased treatments compared with the *P. persimilis* in the two seasons. Use of the combination of the 2 predators (4C/8P) is recommended as a pest management practice at the plantation of tomato in the greenhouses.

INTRODUCTION

Tomato (*Lycopersicon esculentum* L.) is one of the most popular vegetable crops in the world (Mukhtar *et al*., 2009). Mainly grown for human consumption, in 2012, the total area has grown with tomatoes in the world was about 11.2 million feddans and the total world production was 161,793,834 tons. Egypt is ranked as the fifth country in the world in terms of the total production of tomatoes. The cultivated area reached 59, 384 feddans produced 8, 625, 219 tons Tomatoes are grown in three seasons - winter, summer, and autumn - on about 3 percent of Egypt's total planted area. Losses in tomato crops have been large as a result of Pest (Food and Agriculture Organization Statistics, 2014).

Tomato plants are attacked by many insects and pests in the field. The most important insect and pests include the mole-cricket, *Gryllotalpa gryllotalpa* (L.); the white grubs,

Pentodon bispinosus (Küster); the black cutworm, *Agrotis ipsilon* (Hufnagel); cotton leafworm, *Spodoptera littoralis* (Boisduval); tomato whitefly, *Bemisia tabaci* (Gennadius); aphids {cotton aphid, *Aphis* gossypii (Glover) and green peach aphid, *Myzus persicae* (Sülzer)}; Green stink bug, *Nezara viridula* (L.); potato leafhopper, *Empoasca decipiens* (Poali); American tomato budworm, *Helicoverpa armigera* (Hübner); potato tuberworm *Phthorimaea operculella* , and Spider Mite, *Tetranychus urticae* Koch (Berlinger *et al*., 1988). The climate in greenhouses is essentially warm, humid and wind-free which encourages pest development. (Saad, 2002).

Numerous studies have confirmed that whiteflies (*Bemisia tabaci* and the two-spotted spider mite (*Tetranychus urticae* Koch are pests with great economic impacts on many crops in greenhouses as well as in open fields worldwide (Aslan *et al*., 2004).

B. tabaci is a small, 1–3 mm, sap-sucking pest from the family Aleyrodidae, order Hemiptera. Although whiteflies have a worldwide distribution, cause economic damage to horticulture and field crops (Carlos *et al.,* 2016& Barro *et al*., 2006), Whiteflies feed on plant sap, causing stunted growth, especially in young plants. Whiteflies secrete large amounts of honeydew during feeding, which may stimulate the growth of black mildew (sooty mould) and interfere with light absorption during photosynthesis in plants. Moreover, whiteflies transmit several kinds of plant viruses (Lapidot *et al*.,2006).

T. urticae are oval-shaped, approximately 0.4-mm-long pests from the family Tetranychidae, order Trombidiformes, that attack 1200 plant species in warm regions around the world (Fasulo**,** & Denmark 2000). The availability of host plants and favorable climates support rapid increases in its populations. The adults have a long-life span and high birth rate, which causes maximum losses to host plants over a short time (Hance & Van 1999). Adults persist on the underside of leaves and suck the sap throughout their lifetime. It has been estimated that each individual damage 18–22 plant cells per minute, causing white spot symptoms on leaves and premature leaf fall (Thomas. & Denmark, 2009). The individuals make a ball with their silk threads and are then dispersed by wind or attach to the surface of other organisms (Gwendoline, 2011).

The genus *Chrysoperla* is one of the most important naturally occurring predators found in many cropping systems, including vegetables, fruits, nuts, fiber and forage crops, ornamentals, greenhouse crops, and forests. Its larvae are predatory of mite and insect pests, including; aphids, thrips, mealybugs, whiteflies, small caterpillars and insects' eggs (Tauber *et al.,* 2000). *Chrysoperla carnea* (Stephens) larvae feed on immature stages of whiteflies (Jokar and Zarabi, 2012).

The predatory mite, *Phytoseiulus persimilis* Athias-Henriot (Acari: Phytoseiidae) has been shown to be an effective natural enemy to the mite, *Tetranychus urticae* Koch (Acari: Tetranychuidae), in the Mediterranean greenhouse crops (Vaeante and Nucifora, 1987).

Therefore, the use of biological control in greenhouse crops is necessary because crops are harvested frequently at close intervals, and thus the intensive use of chemicals becomes questioned due to the possible contamination of products with chemical residues (Perdikis *et al*., 2008). Biological control of pest species has traditionally mainly focused on specific natural enemies for each pest (Hoy, 1994). The use of more than one natural enemy is also a recent topic in biological control because the crop can be affected by several pests simultaneously. The combining use of natural enemies is expected to increase the efficacy of the bioagents as the specific pests can be controlled and the risk of virus infection is reduced (Lucas and Alomar, 2002).

The tomato crop is an important vegetable crop grown in Egypt and is often attacked by whitefly and two-spotted spider mite. In the present study using *C. carnea* and *P. persimilis* as a biological control agent in managing the two preys.

MATERIALS AND METHODS

The experiments were carried out at the farm in new Salhia in Ismailia, Egypt, using two plastic greenhouses. The greenhouses were planted by the tomato *Solanum lycopersicum* in two growing plantation seasons, 2018 and 2019.

Greenhouses:

The greenhouses were used in the experiments. They were divided into six sectors, separated by white nets, and fixed to the greenhouse frame. This allowed complete isolation among the six sectors and avoided entry of pests from one sector to another. This greenhouse was used only for the predator's release treatments. Each greenhouse consisted of 5 rows of tomato.

Sources of the Predators:

Second larval instar of *C. carnea* used against *B. tabaci*, were obtained from the Mass Rearing Unit, Plant Protection Department, Desert Research Center, while adults of *P. persimilis*, used against *T. urticae*, were obtained from the Plant Protection Research Institute, Agricultural Research Center, Giza, Egypt

Experimental Design:

This experiment had six treatments with five replicates

- 1 insect predators (*C. carnea*) + 2 mite predators (*P. persimilis*) per / plant
- 2 insect predators (*C. carnea*) + 4 mite predators (*P. persimilis*) per / plant
- 4 insect predators (*C. carnea*) + 8 mite predators (*P. persimilis*) per / plant
- 1 Insect predator (*C. carnea*) only
- 1 mite predator (*P. persimilis*) only
- Control

Sampling:

Population density of *B. tabaci* and *T. urticae* were estimated weekly in the experimental greenhouses for 11 weeks, started from the 2nd-week post cultivation date in the two tomato Winter season that extended from October to December in 2018 and 2019. Leaves were removed from one of the plants in each week, choosing a different plant each week. Samples were taken to the laboratory where whitefly and *T. urticae* were counted on the lower leaf surfaces with the aid of a stereomicroscope. Three leaves represented (upper, middle and bottom level) / plant was selected in each of 15 random plants directly inspected sector/sampling date (each plant represented one replicate), then, the mean number of the 2 pests was calculated / plant.

RESULTS AND DISCUSSION

When the predators were released on whitefly and spider mite-infested tomato in different ratios, populations of the spider mite and whitefly declined with time compared to the control plants on which no predators were released. On 11 weeks old plants, before the release of the predators, spider mite and whitefly populations were similar in all the treatments. To avoid the increase of the pest's population, predators were released in the at 3 weeks post cultivation date in 2018 and 2019.

The estimated population of *B. tabaci* / plant in the 1C/2P, 2C/4P, 4C/8P, *C. carnea* and *P. persimilis* in 2018 and 2019 as illustrated in figure (1). Few numbers of *B. tabaci* appeared in the 3rd and 4th weeks post cultivation in 2018 and 2019, respectively, then increased gradually to reach its peak in the 7th week in 2018 (6, 5, 3, 6.5 and 7.5 individuals / /plant in treatments 1C/2P, 2C/4P, 4C/8P, *C. carnea*, and *P. persimilis* respectively). While in the 7th week of season 2019 these numbers were (6, 5, 3, 6 and 8 individuals/plant in treatments of 1C/2P, 2C/4P, 4C/8P, *C. carnea* and *P. persimilis* respectively). The 5

treatments releases decreased the population of *B. tabaci* to 3.3, 1, 1,4.5 and 0.5 individuals / plant in 2018 and to 5, 2, 1, 3.5 and 5 individuals / in 2019 for 1C/2P, 2C/4P, 4C/8P, *C. carnea* and *P. persimilis* , respectively, in the 11th week.

Estimated population of *T. urticae* /plant in the 1C/2P, 2C/4P, 4C/8P, *C. carnea* and *P. persimilis* in 2018 and 2019 was illustrated in figure (2). Few numbers of *T. urticae* observed in the 4th and 3rd weeks post cultivation in 2018 and 2019, respectively. In the 6th week of 2018, *T. urticae* numbers increased gradually to reach its peak 7.7, 4.4, 3.4, 7 and 9 individuals / plant in treatments for 1C/2P, 2C/4P, 4C/8P, *C. carnea*, and *P. persimilis*, respectively. At 2019, they were 7, 6, 5, 10, and 7 individuals/plant in treatments 1C/2P, 2C/4P, 4C/8P, *C. carnea*, and *P. persimilis*, respectively, in the 6th week. Releases of treatment suppressed the mite population to lower levels compared with that in 1C/2P, 2C/4P, 4C/8P, *C. carnea* and *P. persimilis* 3, 2, 5, 0.5 4 and 6 individuals/plant in 2018 and to 2, 3, 0.5, 6.6 and 6.5 individuals/plant in 2019 for 1C/2P, 2C/4P, 4C/8P, *C. carnea,* and *P. persimilis* respectively, in the 11th week.

In this study, the lowest suppression of the pest population was recorded in *P. persimilis*. The greatest suppression of the pest population was recorded in 4C/8P (the combination of 4 insect predators (*C. carnea*) + 8 mite predators (*P. persimilis*).

The use of more than one predator can be positive and promote a synergistic effect (Lucas and Alomar, 2002). Obtained data showed that the potential suppression of the whitefly population by *C. carnea* was decreased; (Scopes, 1969). (Younes *et al*. 2013) found that the 2nd larval instar of *C. carnea* reduced the population of the whitefly by (83.07%) under semi-field conditions on cantaloupe. *P. persimilis* proved to be sufficiently effective against *T. urticae* under greenhouse conditions in Egypt (Rasmy and Ellaithy, 1988). (Adly 2015) evaluated the combination of the releases of the parasitoid, *Aphidius colemani* Viereck against aphids; the predators of *C. carnea* against the aphids and the whitefly and of *P. persimilis* against *T. urticae* where it was recommended using the parasitoids and predators as a successful management control in the cucumber greenhouse at the winter plantation.

In rose, complete elimination spider mites were recorded within 3 weeks (Onkarappa, 1999 and Mallik *et al*., 1998) at the ratio of 1: 300 predators: prey, but the same was not observed even at 1: 50 predators: prey ratio in tomato. It is possible that the different types of glandular trichomes located on tomato leaves (Maluf *et al*., 2007), but not in rose leaves, or some volatiles emitted from tomato plants, as also the plant architecture, reduce the efficacy of predators, which needs to be ascertained. It is suggested that prey-predator interactions vary from plant to plant. (Dalia Adly 2016**)** stated that, this study revealed that the release of predators not only showed significant control of pests but also increased crop yield as compared to pesticide application. The utilization of biological control agents can prove to be an admirable strategy in pest management. Use of a combination of the predators *C. carnea*, *O. albidipennis* and *P. persimilis* is recommended for pest management practice in cucumber greenhouses, particularly in summer plantation.

In conclusion, greenhouse experiments that, evaluate that the use of *P. persimilis* and *C. carnea* for controlling both *T. urticae* and *B. tabaci* on tomato revealed similar efficiency regardless they were used only or in combination under greenhouse conditions. So, using either of them as an available natural enemy can be recommended.

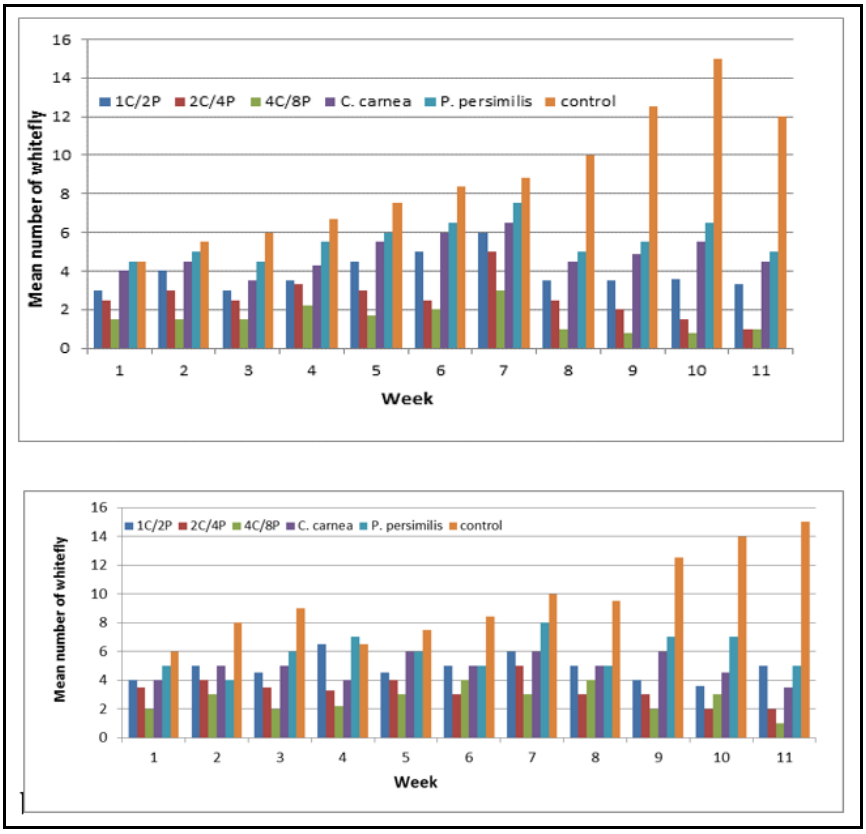


Fig. 1: Mean number of whitefly 1C/2P, 2C/4P, 4C/8P, *C. carnea* and *P. persimilis* tomato in the plantation, 2018 and 2019

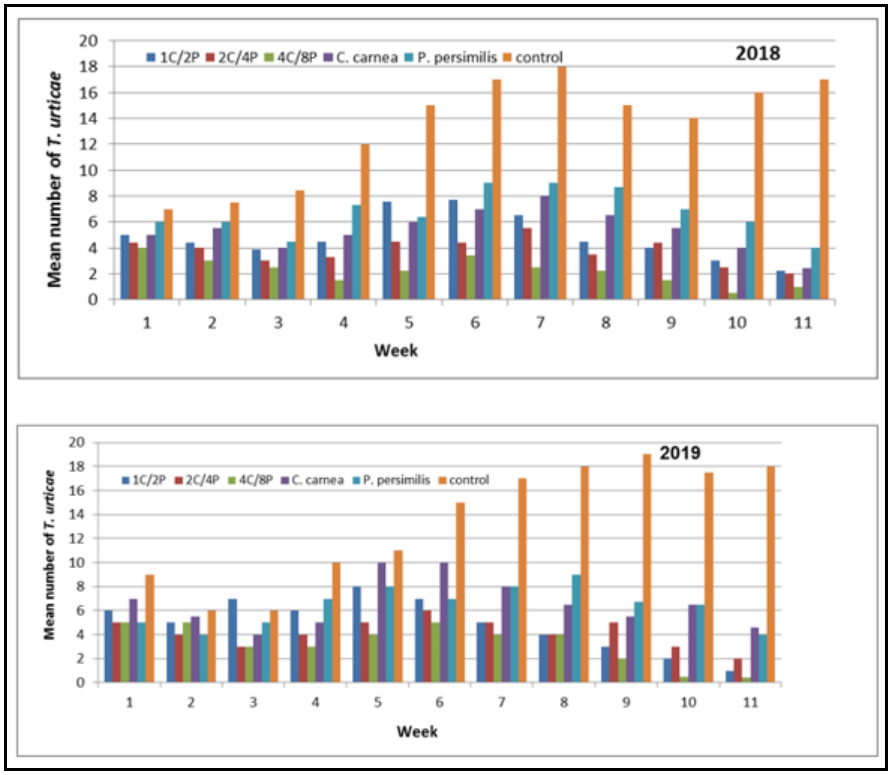


Fig. 2: Mean number of *T. urticae* 1C/2P, 2C/4P, 4C/8P, *C. carnea* and *P. persimilis* tomato in the plantation, 2018 and 2019

REFERENCES

Adly, D. (2015): Comparative study of biological and chemical control programs of certain cucumber pests in greenhouses. Egypt. J. Biol. Pest Cont. 25(3): 691-696. Proceeding of 4th International Conference, ESBCP, Cairo, Egypt, 19-22 October 2015.

Aslan I, Ozbek H, Calmasur O, Sahin F (2004): Toxicity of essential oil vapours to two greenhouse pests, Tetranychus urticae Koch and Bemisia tabaci Genn. Ind Crops Prod 19:167–173.

Barro, P. J. D., Liebregts, W. & Carver, M. (1998): Distribution and identity of biotypes of *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae) in member countries of the Secretariat of the Pacific Community. *Aust. J. Entomol.* 37, 214–218.

Berlinger, M. J., Dahan, R. and Mordechi, S. (1988): Integrated pest management of organically grown tomatoes in Israel. Applied Agriculture Research, 3(5), 233-238.

Carlos, E., Bográn & Kevin M. Heinz (2016): White flies. The Texas A&M University system.

Dalia Adly (2016): Use of Predators for Controlling the Whitefly, *Bemisia tabaci* Genn. and the Two Spotted Spider Mite, *Tetranychus urticae* Koch., in Cucumber Greenhouses in Egypt, Egyptian Journal of Biological Pest Control, 26(4), 2016, 701-706

FAO, (2014): Food and Agriculture Organization Statistics 110 pp.

Fasulo, T. R. & Denmark, H. A (2000): Two-spotted spider mite, Tetranychus urticae Koch. UF/IFAS Featured Creatures EENY, 150.

Gwendoline C.,Anne-C. M.,Aina A. F.,Jean-Louis D.,Claire D.,and Thierry H.(2011) The Formation of Collective Silk Balls in the Spider Mite Tetranychus urticae Koch. PLoS ONE 6, e18854,

Hance, T. & Van Impe, G. (1999): The influence of initial age structure on predatorprey interaction. *Ecol. Model.* 144, 195–211.

Hoy, M.A. (1994): Parasitoids and predators in management of arthropod pests, In: Introduction to insect pest management, R.L. Metcalf and W.H. Luckmann, pp. 129-198, John Wiley & Sons, ISBN 978-0-471-58957-0, New York.

Jokar, M. and Zarabi, M. (2012): Surveying effect kind of food on biological parameters on *Chrysoperla carnea* (Neuroptera: Chrysopidae) under laboratory conditions. Egypt. Acad. J. Biol. Sci.Entomol., 5(1): 99–106.

Lapidot, M., & Polston, J. E. (2006). Resistance to tomato yellow leaf curl virus in tomato, pp. 503–540 In (eds) Loebenstein, G. & J. P. Carr Natural Resistance Mechanisms of Plants to Viruses, *Springer Verlag*, New York.

Lucas, E. and Alomar, O. (2002): Impact of presence of *Dicyphus tamaninii* Wagner (Heteroptera: Miridae) on whitefly (Homoptera: Aleyrodidae) predation by *Macrolophus caliginosis* (Wagner) (Heteroptera: Miridae). Biol. Control, 25: 123-128.

Mallik B, Onkarappa S, and Kumar HM, (1998): Management of spider mites, Tetranuchus urticae Koch on rose using phytiseiid predators, Amblyseius longispinosus (Evans) in polyhouse. Pest Mangt. Hort. Ecosyst., 4 (1): 46 -48.

Maluf WR, Inoue IF, Ferreira RPD, Gomes LAA, De Castro EM and Cardoso MG (2007): Higher glandular trichome density in tomato leaflets and repellence to spider mites. Pesq. Agropec. Bras., Brasília, 42 (9): 1227-1235.

Mukhtar SK, Hashim A, Peterschmitt M & Abdrahman MK, (2009): Field screening and molecular identification of tomato leaf curl virus in Sudan source. Arab J. Plant Protection 27, 95-98.

Onkarappa S. (1999): Management of two spotted spider mite, Tetranychus Urticae Koch. (Acari: Tetranychidae) on rose. Ph.D Thesis. Department of Entomology, University

of Agricultural Sciences, Bangalore. 190 – 195 pp.
Perdikis, D., Kapaxidi, E. and Papadoulis, G. (2008): Biological control of insect and mite pests in greenhouse solanaceous crops. Eur. J. Plant Sci. Biotechnol., 2(1): 125-144.
Rasmy, A. H. and Ellaithy A. Y. M. (1988): Introduction of *Phytoseiulus persimilis* for two spotted spider mite control in greenhouses in Egypt [*Acari: Phytoseiidae, Tetranychidae*]. Entomophaga, 33(4): 435–438.
Saad, H. N., (2002): Economics of the integrated pest management of certain insect and animal pests in most important vegetable crop production under plastic greenhouse. M. Sc. Thesis, Moshtohor, Zagazig Univ., Banha Branch, 143 PP.
Scopes, N. E. A. (1969): The potential of *Chrysopa cornea* as a biological control agent of *Myzus persicae* on Glasshouse chrysanthemums. Ann. Appl. Biol., 64(3): 433-439.
Tauber, M.J., Tauber, C.A., Daane, K.M. and Hagen, K.S. (2000): Commercialization of predators: Recent lesson from green lacewings (Neuroptera: Chrysopidae: *Chrysoperla*). Am. Entomol., 46(1): 26-38.
Thomas, R. F. & Denmark, H. A. (2009): Two spotted spider mite *Tetranychus urticae* Koch (Arachnida: Acari: Tetranychidae). Department of Agriculture and Consumer Services, University of Florida.
Vaeante, V. and Nucifora, A. (1987): Possibilities and perspectives of the biological and integrated control of the two spotted spider mites in the Mediterranean greenhouse crops. IOBC/WPRS Bull., 170-173.
Younes, M. W. F., Shoukry, I. F., Metwally, S. A. A.G. and Abd-Allah, Y. N. M. (2013): Efficiency of second instar larvae of *Chrysoperla carnea* to suppress some piercing sucking insects infesting cantaloupe under semi-field conditions. Egypt. J. Agric. Res., 91 (1): 169- 179.
Zhang, S., Reddy, M. and Kloepper, J.W., (2002): Development of assays for assessing induced systemic resistance by plant growth-promoting rhizobacteria against blue mold of tobacco. Biological Control. 23(1), 79-86.

ARABIC SUMMARY

المكافحة البيولوجية باستخدام بعض المفترسات لآفات الطماطم تحت ظروف الصوبة.

إيمان ابراهيم إمام [١] و محمد عادل نوار [٢]
١ وحدة الحشرات الاقتصادية –قسم وقاية النبات – مركز بحوث الصحراء
٢ وحدة الافات الحيوانية –قسم وقاية النبات – مركز بحوث الصحراء

تعتبر *Bemisia tabaci* Genn و *Tetranychus urticae* Koch. من الآفات الرئيسية في صوب الطماطم. تم إطلاق المفترسان *Chrysoperla carnea* (Steph) و*Phytoseiulus persimilis* Athias - Henriot على محصول الطماطم فى الصوبة خلال للموسمين، ٢٠١٨ و٢٠١٩. تم تقييم خمسة معدلات إطلاق مفترس حشري واحد من *C. carnea* الي ٢ فرد من المفترس الاكاروسي *P. persimilis* و ٢ فرد *C. carnea* الي ٤ افراد من *P. persimilis* و ٤ افراد C. *carnea* الي ٨ افراد *P. persimilis* و ١ مفترس الحشري (*C. carnea*) فقط و ١ مفترس اكاروسي (*P. persimilis*). تم تسجيل أكبر قدر من تخفيض الآفات في ٤ افراد *C. carnea* الي ٨ افراد *P. persimilis* .

بلغ تعداد *B. tabaci* ٣,٣ و ١ و ١ و ٤,٥ و ٠,٥ أفراد / نبات في موسم ٢٠١٨ و ٥ و ٢ و ١ و ٣,٥ و ٥ أفراد / نبات في عام ٢٠١٩ في C / 2P، 2C / 4P، 4C / 8P و *C. carnea* و *P. persimilis* ، على التوالي ، في الأسبوع الحادي عشر. بلغ تعداد *T. urticae* ٢,٢ و ٢ و ١ و ٢,٤ و ٤ أفراد / نبات في عام ٢٠١٨ و ١ و ٢ و ٠,٤ و ٤,٦ و ٤ أفراد / نبات في عام ٢٠١٩. كان هناك فرق كبير بين 1C / 2P و 2C / 4P و 4C / 8P و *C. carnea* و *P. persimilis* بالنسبة للذباب الأبيض والسوس.

بشكل عام، انخفض عدد الآفات في المعامله 4C / 8P مقارنة مع *P. persimilis* في الموسمين. يوصى باستخدام مزيج من المفترسين (4C / 8P) لإدارة مكافحة الآفات في مزرعة الطماطم في الصوب الزراعية.