Preference and Predatory Potential of *Chrysoperla carnea* (Stephens) and *Coccinella undecimpunctata* Linnaeus on *Phenacoccus solenopsis* Tinsley: A New Threat to the Egyptian Economic Crops

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ABSTRACT

The predatory potential and preference of *Chrysoperla carnea* (Stephens) larvae and both larvae and adult females of *Coccinella undecimpunctat*a Linnaeus to the cotton mealybug, *Phenacoccus solenopsis* Tinsley and cotton aphid, *Aphis gossypii* Glover were investigated under laboratory conditions at Sakha Agricultural Research Station, Egypt. In no choice trails, 3^{rd} instar larvae of *C. carnea* were the most voracious feeder comparing to 1^{st} and 2^{nd} instar larvae and consumed 673.3± 6.38, 2756.3 ± 20.10, 326.9 ± 5.07 and 115.2 ± 3.45 insects of aphid, 1^{st}, 2^{nd}, and 3^{rd} instar nymphs of the mealybug, respectively. Similarly, 4^{th} instar grubs of *C. undecimpunctata* proved to be the most voracious as compared to the younger instar grubs and devoured 112.4 ± 1.63, 546.4 ± 3.69, 174.1 ± 1.07 and 40.2 ± 1.22 individuals of aphid, 1^{st}, 2^{nd}, and 3^{rd} instar nymphs of the mealybug, respectively. First instar nymphs of *P. solenopsis* were significantly the most consumed prey by both predators in the no choice feeding. Adult females of *C. undecimpunctata* exhibited more feeding potential than its larval stages on all the studied hosts. In free choice tests, *A. gossypii* was significantly the most preferred host for both predators comparing to the different instar nymphs of *P. solenopsis*. When *C. carnea* and *C. undecimpunctat*a larvae were fed in free choice tests, the durations of their larval stages were significantly shorter than that of no choice feeding. The obtained results suggest that both predators could be successfully used as biological control agents for *P. solenopsis* management under the Egyptian conditions.

Key words: Preference, predatory potential, *Chrysoperla carnea, Coccinella undecimpunctata, Phenacoccus solenopsis, Aphis gossypii*.

INTRODUCTION

The cotton mealybug, *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae) is considered of the most recent invasive sap sucking insects in Egypt attacking cotton (El-Zahi *et al*., 2016), vegetables (Ibrahim *et al.,* 2015) and many other field crops of economic importance. This insect feeds on all the green parts of the infested plants which become stunted, weak with distorted and yellow leaves and die in sever infestations (Culik and Gullan, 2005). *Phenacoccus solenopsis* had a high reproductive potential in wide ranges of temperature (Prasad *et al*., 2012; Shehata, 2017) and relative humidity (Hameed *et al.*, 2012) and it is predicted to become one of the most dangerous economic pests in Egypt during the next few years where the agro-ecosystem is closely adequate to its development and spread (El-Zahi and Farag, 2017). The farmers mainly rely upon synthetic chemicals to control the pests infest their crops, but this solenopsis mealybug is difficult to be chemically controlled due to the waxy secretion which covers its body (Joshi *et al*., 2010). Since the intensive use of chemical and synthetic insecticides in the pest control lead to many serious problems in the environment components and biodiversity (Bellows, 2001), so there is an urgent need to explore alternate measures such as biological control agents for *P. solenopsis* management. During surveys grubs and adults of coccinellids and larvae of chrysopids were found feeding on *P. solenopsis* (Ram *et al.,* 2008). The green lacewing larvae, *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae) is a generalist predator of a wide range of pest species including aphids, thrips, whiteflies, immature scales and mealybugs (Saminathan and Baskaran, 1999), while adult lacewings are free living and feed on honeydew and pollen grains. The eleven- spotted coccinellid beetles, *Coccinella undecimpunctata* Linnaeus (Coleoptera: Coccinellidae) have extensive dispersal power on majority of field crops (Khan and Suhail, 2001). Both grubs and adults of *C. undecimpunctata* feed on aphids, many soft-bodied insects and mealybugs. The present work was conducted to compare the preference and predatory potential of *C. carnea* and *C. undecimpunctata* on cotton aphid, *Aphis gossypii* and different instar nymphs of *P. solenopsis* under laboratory conditions.

MATERIALS AND METHODS

Rearing of *Phenacoccus solenopsis* and *Aphis gossypii*

To establish cultures of *P. solenopsis* and *A. gossypii*, adult females of *P. solenopsis* and cotton leaves infested with *A. gossypii* were collected from unsprayed cotton fields and separately inoculated on cotton plants potted under laboratory conditions of 32 ±

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2 ^{o}C, 65 ± 5 RH and 13:11 (L :D) photoperiod. After few days, both insects settled on the cotton leaves and started producing progenies for the next experiments.

Cultures of *Chrysoperla carnea* and *Coccinella undecimpunctata*

The fresh eggs of *C. carnea* were obtained from Predators Mass Rearing Laboratory, Faculty of Agriculture, Cairo University, Egypt. The adults of *C. undecimpunctata* were collected from cotton fields and reared in 10 liter glass jars on *A. gossypii* as food until oviposition. The newly hatched larvae of both predators and the newly emerged adult females of *C. undecimpunctata* were used in this study. All trails were laid out in a Complete Randomized Design with six replications and under laboratory conditions of 32 ± 2 ^{o}C, 65 ± 5 RH and 13:11 (L :D) photoperiod.

Preference and predatory potential of *C. carnea* and *C. undecimpunctata* larvae on *P. solenopsis* and *A. gossypii*

No choice feeding

The newly moulted larvae of each larval instar of *C. carnea* and *C. undecimpunctata* were singly placed in 9 cm diameter glass Petri dishes and provided with sufficient and counted numbers of *A. gossypii* nymphs, 1st, 2nd or 3rd instar nymphs of *P. solenopsis.* Fresh small cotton leaf was placed daily in each Petri dish for settling of the insects. The dishes were covered with their lids to prevent the escape of the insects. The introduced numbers of the prey were increased daily until the completion of each larval instar of the predators. The left over and the consumed numbers of prey per each larval instar of both predators were recorded daily to calculate the predatory potential.

Free choice feeding

To study the preference and predatory potentials of *C. carnea* and *C. undecimpunctata* larvae on nymphs of aphids and mealybugs under free choice conditions, a single larva of both predators from each larval instar was placed in 9 cm diameter glass Petri dish along with known numbers of aphid nymphs, , 1st, 2nd and 3rd instar nymphs of *P. solenopsis* together. The numbers of offered prey were gradually increased till the end of each larval instar of the predators. The left over and the consumed numbers of prey per each larval instar of both predators were recorded daily to calculate the predatory potential.

Preference and predatory potential of adult females of *C. undecimpunctata* on *P. solenopsis* and *A. gossypii*

No choice feeding

The newly emerged adult females of *C. undecimpunctata* were individually placed in 9 cm diameter glass Petri dish. Known numbers of aphid nymphs, 1st, 2nd or 3rd instar nymphs of *P. solenopsis* were introduced separately to the predator. The left over and the consumed numbers of the prey were recorded daily until the death of the predator to calculate its feeding potential.

Free choice feeding

The same procedures followed in no choice feeding above were adopted but in this test, the different instar nymphs of both *P. solenopsis* and *A. gossypii* were offered together to the adult females of *C. undecimpunctata* to evaluate its preference and predatory potentials.

Statistical analysis

Means of total and daily consumption of *P. solenopsis* and *A. gossypii* and durations of larval and adult stages were subjected to one-way analysis of variance. Significant differences were determined according to Duncan's Multiple Range Test (Duncan, 1955) at 0.05 probability level using CoStat system for Windows, Version 6.311.

RESULTS AND DISCUSSION

Predation activity of *Chrysoperla carnea*

Chrysoperla carnea larvae proved to be a highly voracious feeder on different instar nymphs of both *P. solenopsis* and *A. gossypii* and its feeding potential was significantly prey-stage and predator-stage dependent (Table 1). The consumption rate of *P. solenopsis* and *A. gossypii* significantly increased with the advancement in the larval stage of the predator. The third larval instar of *C. carnea* exhibited the highest predatory potential comparing to the first and second larval instars, where in no choice feeding the third instar larvae of *C. carnea* preyed on the highest number of 2756.3 ± 20.10 first instar nymphs of *P. solenopsis* which differed significantly from 673.3 ± 6.38 aphids, 326.9 ± 5.07 second instar and 115.2 ± 3.45 third instar nymphs of the mealybug. Gautam and Tesfaye (2002) and Atlihan *et al*. (2004) reported that the third instar larvae of *C. carnea* had a higher predation potential than younger ones on different kinds of prey and this may be due to the large size of the third instar larvae and increased nutritional requirements. The high feeding potential of *C. carnea* on the 1st instar nymph of *P. solenopsis* could be attributed to the absence of the waxy coating on the prey and its small size and high mobility comparing to the 2nd and 3rd instar nymphs of *P. solenopsis,* where *C. carnea* prefers feeding on the fast moving prey than slow ones (Huang and Enkegaard, 2010). During the entire larval stage of *C. carnea*, the single larva consumed 990.8 ± 19.08, 3457.4 ± 28.31, 521.1 ± 9.79 and 144.0 ± 15.12 insects of aphid, 1st, 2nd and 3rd instar nymphs of *P. solenopsis*, respectively; with mean daily consumption of 132.1 ± 7.08, 379.9 ± 8.13, 65.1 ± 1.87 and 18.0 ± 0.89 individuals of aphid, 1st, 2nd and 3rd instar nymphs of *P. solenopsis*, respectively. These results are in accordance with the findings of Rashid *et al*. (2012) and Panth *et al*. (2017). Sattar *et al*. (2007) informed that *C. carnea* in its entire larval period consumed an average of 1064.0, 689.0 and 144.7 of 1st, 2nd and 3rd instar nymphs of *P. solenopsis*, respectively in no choice feeding. In the current study, the duration of the *C. carnea* larval stage significantly prolonged to 9.1 ± 0.37 days when the larvae were fed on 1st instar nymphs of the mealybug comparing to the larval duration ranged from 7.5 ± 0.18 — 8.0 ± 0.41 days when the larvae were fed on either aphids or 2nd and 3rd instar nymphs of the mealybug. Hameed *et al*. (2013b) found that the duration of *C. carnea* larval instar was prolonged by feeding on 1st instar nymphs of *P. solenopsis* as compared to 2nd and 3rd instar nymphs under no choice feeding.

In the free choice feeding, when aphids and different instar nymphs of mealybug were offered together to larval instars of *C. carnea*, aphid was significantly the most preferred for the three instars of the predator comparing to the different instar nymphs of *P. solenopsis* (Table 2). The third larval instar of *C. carnea* was significantly the most voracious and consumed a total of 246.3 ± 3.03 aphids in addition to 211.7 ± 4.17, 162.7 ± 2.62 and 22.5 ± 1.14 insects from 1st, 2nd and 3rd instar nymphs of *P. solenopsis*, respectively. The duration of larval stage was significantly shorter in the free choice feeding (6.5 days) than that in the no choice feeding (ranged from 7.5 ± 0.18 – 9.1 ± 0.37 days). Zheng *et al.* (1993) reported that the larval duration of *C. carnea* was shorter coincided with fast growth and high fertility when the larvae fed on various prey species varied in their body contents of carbohydrates, lipids, amino acids and vitamins. During the entire larval

Table 1. Predatory potential of *Chrysoperla carnea* larvae on *Aphis gossypii* and *Phenacoccus solenopsis* under laboratory conditions, (No choice feeding)

Prey	Average number of prey ± SE consumed by single larva of *C. carnea*					
				Entire larval stage		
	1st larval instar	2nd larval instar	3rd larval instar	Duration (days)	Total consumption	Mean daily consumption
Nymphs of *A. gossypii*	141.5 ± 2.72 b	176.0 ± 2.77 b	673.3 ± 6.38 b	7.5 ± 0.18 b	990.8 ± 19.08 b	132.1 ± 7.08 b
1st instar nymphs of *P. solenopsis*	250.9 ± 1.37 a	450.2 ± 7.07 a	2756.3 ± 20.10 a	9.1 ± 0.37 a	3457.4 ± 28.31 a	379.9 ± 8.13 a
2nd instar nymphs of *P. solenopsis*	48.7 ± 2.65 c	145.5 ± 2.36 c	326.9 ± 5.07 c	8.0 ± 0.32 b	521.1 ± 9.79 c	65.1 ± 1.87 c
3rd instar nymphs of *P. solenopsis*	10.8 ± 0.66 d	18.0 ± 1.08 d	115.2 ± 3.45 d	8.0 ± 0.41 b	144.0 ± 15.12 d	18.0 ± 0.89 d
LSD value at 0.05	6.57	13.45	32.40	0.91	55.06	12.41

In the same column, figures followed by the same letters are not significantly differed by Duncan's Multiple Range Test, P= 0.05

Table 2. Predatory potential of *Chrysoperla carnea* larvae on *Aphis gossypii* and *Phenacoccus solenopsis* under laboratory conditions, (Free choice feeding)

Prey	Average number of prey ± SE consumed by single larva of *C. carnea*					
				Entire larval stage		
	1st larval instar	2nd larval instar	3rd larval instar	Duration (days)	Total consumption	Mean daily consumption
Nymphs of *A. gossypii*	104.5 ± 1.87 a	138.3 ± 3.88 a	246.3 ± 3.03 a	6.5	489.1 ± 16.31 a	75.2 ± 2.03 a
1st instar nymphs of *P. solenopsis*	52.4 ± 1.02 b	112.3 ± 1.96 b	211.7 ± 4.17 b	6.5	376.4 ± 6.89 b	57.9 ± 3.01 b
2nd instar nymphs of *P. solenopsis*	24.7 ± 1.70 c	47.0 ± 0.87 c	162.7 ± 2.62 c	6.5	234.4 ± 3.31 c	36.1 ± 1.53 c
3rd instar nymphs of *P. solenopsis*	3.3 ± 0.09 d	7.8 ± 0.32 d	22.5 ± 1.14 d	6.5	33.6 ± 2.38 d	5.2 ± 0.32 d
LSD value at 0.05	4.07	6.37	9.81	–	22.92	5.11

In the same column, figures followed by the same letters are not significantly differed by Duncan's Multiple Range Test, P= 0.05

Table 3. Predatory potential of *Coccinella undecimpunctata* (larvae and adult females) on *Aphis gossypii* and *Phenacoccus solenopsis* under laboratory conditions, (No choice feeding)

Average number of prey ± S E consumed by different larval instars and adult females of *C. undecimpunctata*

Prey	1st larval instar	2nd larval instar	3rd larval instar	4th larval instar	Entire larval stage: Duration (days)	Entire larval stage: Total consumption	Entire larval stage: Mean daily consumption	Adult stage (females): Duration (days)	Adult stage (females): Total consumption	Adult stage (females): Mean daily consumption
Nymphs of *A. gossypii*	30.2 ± 1.03 c	69.8 ± 2.09 c	101.3 ± 2.23 c	112.4 ± 1.63 c	5.4 ± 0.17 c	313.7 ± 3.61 c	57.6 ± 1.17 c	27 ± 0.37 b	2441.5 ± 115.80 c	90.4 ± 1.23 c
1st instar nymphs of *P. solenopsis*	80.1 ± 2.98 a	167.3 ± 3.38 a	250.2 ± 2.0 a	546.4 ± 3.69 a	9.2 ± 0.10 a	1053.0 ± 18.08 a	114.5 ± 2.09 a	32 ± 0.32 a	7438.5 ± 132.70 a	232.5 ± 5.19 a
2nd instar nymphs of *P. solenopsis*	45.0 ± 1.59 b	95.8 ± 1.94 b	156.3 ± 1.53 b	174.1 ± 1.07 b	6.0 ± 0.21 b	471.2 ± 4.00 b	78.5 ± 0.86 b	28 ± 0.37 b	3667.2 ± 66.33 b	131.5 ± 3.18 b
3rd instar nymphs of *P. solenopsis*	4.8 ± 0.71 d	10.9 ± 1.03 d	16.2 ± 0.58 d	40.2 ± 1.22 d	6.0 ± 0.09 b	72.1 ± 2.30 d	12.0 ± 0.81 d	27 ± 0.32 b	546.0 ± 15.20 d	20.2 ± 1.05 d
LSD value at 0.05	4.39	7.04	6.03	6.60	0.48	25.47	5.41	1.29	238.99	9.73

In the same column, figures followed by the same letters are not significantly differed by Duncan's Multiple Range Test, P= 0.05

Table 4. Predatory potential of *Coccinella undecimpunctata* (larvae and adult females) on *Aphis gossypii* and *Phenacoccus solenopsis* under laboratory conditions, (Free choice feeding)

Average number of prey ± S E consumed by different larval instars and adult females of *C. undecimpunctata*

Prey	1st larval instar	2nd larval instar	3rd larval instar	4th larval instar	Entire larval stage: Duration (days)	Entire larval stage: Total consumption	Entire larval stage: Mean daily consumption	Adult stage (females): Duration (days)	Adult stage (females): Total consumption	Adult stage (females): Mean daily consumption
Nymphs of *A. gossypii*	26.4 ± 0.40 a	48.7 ± 1.29 a	69.5 ± 1.07 a	89.3 ± 1.52 a	4.21	233.9 ± 2.92 a	55.6 ± 1.08 a	29	1429.7 ± 19.39 a	49.3 ± 1.77 a
1st instar nymphs of *P. solenopsis*	17.6 ± 0.51 b	37.9 ± 0.89 b	43.2 ± 1.16 b	67.1 ± 1.08 b	4.21	165.8 ± 3.39 b	39.4 ± 0.51 b	29	1107.8 ± 6.82 b	38.2 ± 2.25 b
2nd instar nymphs of *P. solenopsis*	8.4 ± 0.45 c	21.3 ± 0.74 c	30.5 ± 1.21 c	56.7 ± 1.08 c	4.21	116.9 ± 1.87 c	27.8 ± 0.68 c	29	896.1 ± 9.27 c	30.9 ± 1.84 c
3rd instar nymphs of *P. solenopsis*	0.7 ± 0.02 d	2.0 ± 0.05 d	2.3 ± 0.07 d	4.2 ± 0.11 d	4.21	9.2 ± 0.37 d	2.2 ± 0.07 d	29	75.4 ± 1.84 d	2.6 ± 0.16 d
LSD value at 0.05	1.26	2.72	3.85	3.09	—	7.35	1.94	—	29.40	5.39

In the same column, figures followed by the same letters are not significantly differed by Duncan's Multiple Range Test, P= 0.05

period, the *C. carnea* larva consumed a total of 489.1 ± 16.31, 376.4 ± 6.89, 234.4 ± 3.31 and 33.6 ± 2.38 individuals of aphid, 1st, 2nd and 3rd instar nymphs of *P. solenopsis*, respectively.

Predation activity of *Coccinella undecimpunctata*

Data presented in Table 3 indicated that as the grubs of *C. undecimpunctata* developed from 1st to 4th larval instars, the consumption rate from aphids and mealybugs increased. In no choice trails, the *C. undecimpunctata* 4th instar grub was significantly the most voracious eater and devoured the highest number of 546.4 ± 3.69 first instar nymphs of the mealybug comparing to 112.4 ± 1.63, 174.1 ± 1.07 and 40.2 ± 1.22 insects of aphid, 2nd and 3rd instar nymphs of the mealybug, respectively. Hameed *et al.* (2013a) reported that *C. undecimpunctata* larvae consumed more 1st than 2nd and 3rd instar nymphs of *P. solenopsis*. The larval duration was significantly affected by the kind of the consumed prey and it was the shortest when *C. undecimpunctata* grubs preyed on aphids recording 5.4 ± 0.17 days as compared to the range of 6.0 ± 0.09 – 9.2 ± 0.10 days when grubs were fed on the mealybug nymphs. During its entire larval period, the single *C. undecimpunctata* larvae gormandized a daily average of 57.6 ± 1.17, 114.5 ± 2.09, 78.5 ± 0.86 or 12.0 ± 0.81 individuals of aphid, 1st, 2nd or 3rd instar nymphs of mealybug, respectively. Also, the results of Table 3 revealed that the adult females of *C. undecimpunctata* had more feeding potential than its larval stage translated in mean daily consumption of 90.4 ± 1.23, 232.5 ± 5.19, 131.5 ± 3.18 or 20.2 ± 1.05 of aphids, 1st, 2nd and 3rd instar nymphs of the mealybug, respectively, taking into consideration the long lifetime of adult *C. undecimpunctata* (27 – 32 days) comparing to the short duration of the larval stage (5.4 – 9.2 days). Ali and Rizvi (2007) and Arshad *et al*. (2017) found that adults of *Coccinella septempunctata* consumed more aphids than grubs.

In free choice trails, aphid was significantly the most preferred host of both *C. undecimpunctata* grubs and adult females compared to the mealybug (Table 4). This may be because aphids are soft- bodied insects while mealybugs are coated with a waxy secretion which makes the mealybugs less palatable for consumption by predators. Preference of the predator to a particular host is mostly attributed to morphological and physiological variations among hosts and chemical characteristics of their hemolymph. Shera *et al*. (2010) concluded that aphids were more preferred than mealybug when both were exposed to *C. septempuncatat* in free choice test. The fourth instar grubs were more voracious feeder than 1st, 2nd and 3rd instar grubs, and ate 89.3 ± 1.52 aphids, 67.1 ± 1.08 first instar, 56.7 ± 1.08 second instar and 4.2 ± 0.11 third instar nymphs of mealybug. As it was observed in case of *C. carnea*, the larval duration of *C. undecimpunctata* was also shorter in free choice feeding than that in no choice feeding. Adult females of *C. undecimpunctata* possessed more predatory potential than grubs in free choice test recording mean daily consumption of 49.3 ± 1.77 aphids, 38.2 ± 2.25 first instar, 30.9 ± 1.84 second instar and 2.6 ± 0.16 third instar nymphs of *P. solenopsis*.

CONCLUSION

From the obtained results in this study, it could be concluded that both C. *carnea* and *C. undecimpunctata* are very voracious feeders on *P. solenopsis* and representing a promising biological control agents for *P. solenopsis* management. The preference of both predators to aphids more than mealybugs makes the success of *P. solenopsis* biological control under field conditions depends upon the prevailing of *P. solenopsis* population comparing to aphid infestation, where aphid population must be as low as possible or completely absent at the time of release. Also, it was observed that C. *carnea* consumed large numbers of prey comparing to *C. undecimpunctata* in all trails. This may be due to the variations in feeding behavior of both predators where C. *carnea* sucks the insect hemolymph while *C. undecimpunctata* devours the entire body of the prey.

REFERENCES

Ali, A. and P.Q. Rizvi. 2007. Development and predatory performance of *Coccinella septempunctata* L. (Coleoptera: Coccinellidae) on different aphid species. Journal Biological Sciences 7: 1478 – 1483.

Arshad, M., H. A. A. Khan, F. Hafeez, R. Sherazi and N. Iqbal. 2017. Predatory potential of *Coccinella septempunctata* L. against four aphid species. Pakistan Journal of Zoology 49(2): 623 – 627.

Atlihan, R., B. Kaydan and M. S. Ozgokee. 2004. Feeding activity and life history characteristics of generalist predator, *Chrysoperla carnea* (Neuroptera: Chrysopidae) at different prey densities. Journal of Pest Science 77: 17 – 21.

Bellows, T.S. 2001. Restoring population balance through natural enemy introductions. Biological Control 21: 199 – 205.

Culik, M.P. and P.J. Gullan. 2005. A new pest of tomato and other records of mealybugs (Hemiptera: Pseudococcidae) from Espirio Santo, Brazil. Zootaxa 964: 1– 8.

Duncan, D.B. 1955. Multiple range and multiple f-test. Biometrics, 11: 1- 42.

El-Zahi, E.S. and A.E. Farag. 2017. Population dynamic of *Phenacoccus solenopsis* Tinsley on cotton plants and its susceptibility to some insecticides in relation to the exposure method. Alexandria Science Exchange Journal 38(2): 231– 237.

El-Zahi, E.S., S.A. Aref and S.K.M. Korish. 2016. The cotton mealybug, *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae) as a new menace to cotton in Egypt and its chemical control. Journal of Plant Protection Research 56 (2): 111 – 115.

Gautam, R.D. and A. Tesfaye. 2002. Potential of green lacewing *Chrysoperla carnea* (Stephens) in crop pest management. New Agriculturist 13(1/2): 147 – 158.

Hameed, A., M. Saleem, H. Karar, S. Ahmad, M. Hussain, W. Nazir, M. Akram, H. Hussain and S. Freed. 2013a. Life history and predatory potential of eleven spotted beetle (*Coccinella undecimpunctata* Linnaeus) on cotton mealybug (*Phenacoccus solenopsis* Tinsley). African Journal of Agricultural Research 8(48): 6142 – 6148.

Hameed, A., M. Saleem, S. Ahmad, M.I. Aziz and H. Karar. 2013b. Influence of prey consumption on life parameters and predatory potential of *Chrysoperla carnea* against cotton mealybug. Pakistan Journal of Zoology 45(1): 177 – 182.

Hameed, A., M.A. Aziz and G.M. Aheer. 2012. Impact of ecological conditions on biology of cotton mealybug, *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae) in laboratory. Pakistan Journal of Zoology 44 (3): 685 – 690.

Huang, N. and A. Enkegaard. 2010. Predation capacity and prey preference of *Chrysoperla carnea* on *Pieris brassicae*. BioControl 55: 379 – 385.

Ibrahim, S.S., F.A. Moharum and N.M. Abd El-Ghany. 2015. The cotton mealybug, *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae) as a new insect pest on tomato plants in Egypt. Journal of Plant Protection Research 55 (1): 48 – 51.

Joshi, M.D., P.G. Butani, V.N. Patel and P. Jeyakumar. 2010. Cotton mealybug, *Phenacoccus solenopsis*. Agriculture Review 31: 113 – 119.

Khan, H. and A. Suhail. 2001. Feeding efficacy, circadian rhythms and oviposition of ladybeetle (Coleoptera: Coccinellidae) under controlled conditions. International Journal of Agricultural and Biology 4(3): 384 – 386.

Panth, M., S. Giri and K. Kafle. 2017. Biology and predatory potential of *Chrysoperla carnea* S. (Neuroptera: Chrysopidae) reared on different species of aphid under laboratory condition. International Journal of Advanced Research in Science, Engineering and Technology 4(5): 3847 – 3851.

Prasad, Y.G., M. Prabhakar, G. Sreedevi, G.R. Rao and B. Venkateswarlu. 2012. Effect of temperature on development, survival and reproduction of the mealybug, *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae) on cotton. Crop Protection 39 (9): 81 – 88.

Ram, P., R.K. Saini and Ombir. 2008. Record of natural enemies of mealy bugs, *Phenacoccus* sp. (Hemiptera: Pseudococcidae) and *Cerococcus* sp. (Hemiptera: Cerococcidae). In: Joia, B.S., D.R. Sharma, V.K. Dilawari, P.C. Pathania (eds). Proceedings of the 2nd congress on insect science: Contributed papers, February 21 – 22, 2008, INAIS, PAU, Ludhiana, India, P. 334.

Rashid, M.M.U., M.K. Khattak, K. Abdullah, M. Amir, M. Tariq and S. Nawaz. 2012. Feeding potential of *Chrysoperla carnea* and *Cryptolaemus montrouzieri* on cotton mealybug, *Phenacoccus solenopsis*. The Journal of Animal & Plant Sciences 22(3): 639 – 643.

Saminathan, V.R. and R.K.M. Baskaran. 1999. Biology and predatory potential of green lacewing *Chrysoperla carnea* (Neuroptera: Chrysopidae) on different insect hosts. Indian Journal of Agricultural Sciences 69(7): 502 – 505.

Sattar, M., M. Hamed and S. Nadeem. 2007. Predatory potential of *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae) against cotton mealybug. Pakistan Entomologist 29(2): 103 – 106.

Shehata, I. 2017. On the biology and thermal developmental requirements of the cotton mealybug, *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae) in Egypt. Der Pharma Chemica 9 (10): 39 – 46.

Shera, P.S., A.K. Dhawan and A. Aneja. 2010. Potential impact of ladybird beetle, *Coccinella septumpunctata* L. on cotton mealy bug, *Phenacoccus solenopsis* Tinsley and aphid, *Aphis gossypii* Glover. Journal of Entomological Research 34(2): 139 – 142.

Zheng, Y., S. Hagen, K.M. Danne and T.E. Mittler. 1993. Influence of larval dietary supply on the food consumption, food utilization efficiency, growth and development of the lacewing, *Chrysoperla carnea*. Entomologia Eperimentalis et Applicata 67(1): 1– 7.

الملخص العربي

التفضيل والكفاءة الإفتراسية لأسد المن وأبو العيد ذو ١١ نقطة على بق القطن الدقيقي : التهديد الجديد لمحاصيل مصر الإقتصادية

الزاهي صابر الزاهي

تم دراسة الكفاءة الإفتراسية وتفضيل كل من يرقات أسد المن واليرقات وإناث الحشرات الكاملة لمفترس أبو العيد ذو ١١ نقطة على بق القطن الدقيقي *Phenacoccus solenopsis* ومن القطن *Aphis gossypii* تحت الظروف المعملية بمحطة البحوث الزراعية بسخا – مصر. في تجارب التغذية غير الإختيارية وجد أن يرقات العمر اليرقي الثالث لأسد المن كانت الأكثر شراسة في التغذية مقارنة بالعمرين الأول والثاني و أنها إفترست ٦٧٣,٣ ± ٦,٣٨، ٢٧٥٦,٣ ± ٢٠,١٠، ٣٢٦,٩ ± ٥,٠٧، ١١٥,٢ ± ٣,٤٥ حشرة من حشرات من القطن و حوريات العمر الأول والثاني والثالث من بق القطن الدقيقي على الترتيب. كذلك كانت يرقات العمر اليرقي الرابع لمفترس أبو العيد ذو ١١ نقطة هي الأشد سراسة إفتراسية مقارنة بباقي الأعمار اليرقة وإلتهمت ١١٢,٤ ± ١,٦٣، ٥٤٦,٤ ± ٣,٦٩ ، ١٧٤,١ ± ١,٠٧، ٤٠,٢ ± ١,٢٢ فرد من حشرات من القطن و حوريات العمر الأول والثاني والثالث من بق القطن الدقيقي على الترتيب. كان كلا المفترسين أكثر إستهلاكا لحوريات العمر الأول من بق القطن عن باقي أعمار الحوريات والمن. أثبتت إناث الحشرات الكاملة لأبو العيد ذو ١١ نقطة أنها أكثر كفاءة إفتراسية عن الطور اليرقي لها على كل العوائل تحت الدراسة. في تجارب التغذية الإختيارية وجد أن من القطن هو العائل المفضل لكلا المفترسين مقارنة بالأعمار المختلفة من حوريات بق القطن الدقيقي. عند التغذية الإختيارية ليرقات كل من أسد المن وأبو العيد ذو ١١ نقطة كان طول فترة الطور اليرقي أقصر عنه في حالة التغذية غير الإختيارية. تقترح هذه النتائج أن كلا المفترسين من الممكن أن يستخدم بنجاح كأحد عناصر المكافحة الحيوية في مكافحة بق القطن الدقيقي تحت الظروف المصرية.