

## Handling time and predation efficiency of certain insect predators on cotton aphid, *Aphis gossypii* Glover

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### Abstract

**Keyword:**  
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The predation efficiency of *Chrysoperla carnea* (Stephens), *Coccinella undecimpunctata* Linn. and *Coccinella septempunctata* Linn. larvae on *Aphis gossypii* (Glover) nymphs was studied under laboratory conditions. Also, handling time of prey by all larval instars of the three predators was calculated. Handling time (Ht), the time needed by *Ch. carnea* to consume a prey of *A. gossypii* was 70.00, 30.56 and 28.50 minutes per one aphid for 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> instars, respectively. However, it was 74.54, 34.56, 22.69 and 18.85 minutes per one aphid for 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> instars of *C. undecimpunctata* respectively. Also it was 60.91, 27.61, 20.17 and 17.43 minutes per one aphid for 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> instars of *C. septempunctata* respectively. The total and daily consumption, also the duration of all larval instars of the three predators were estimated. These results showed that, the handling times of predators are a good indicator of the predation rate and could be used on the biological control of cotton aphid program.

## INTRODUCTION

Cotton, *Gossypium barbadense* L. is one of the most important economical crops in Egypt and all over the world where it is employed in several industrial productions i.e. ginning, textile, food oil, soap, furniture and many other industries, as well as a source of foreign currencies when exported to other countries (Al-Shannaf, 2010). Cotton plants are attacked by several insect pests starting from germination of seedlings till harvest, causing different levels of damages to the

vegetation, flowers, fibers and seeds (Afzal *et al.*, 2003). During the last few years, populations of some sap sucking insect species which were known as unimportant organisms, started to increase reaching pest status on cotton plants. This might be due to the indiscriminate pesticidal applications which destroyed large portions of natural enemies, causing upset of the natural balance in the favor of previously known as secondary pests (Fayad *et al.*, 1990). The cotton aphid, *A. gossypii* Glover (Homoptera: Aphididae) is one of the

most serious insect pests in agro-ecosystem causing damages either directly by feeding which resulted in curling and deformation of young leaves and twigs, or indirectly by contaminating the fruits with honeydew which in turn may cause, the growth of black sooty mould which inhibits photosynthesis and therefore causes substantial yield loss (Jacobson and Croft, 1998; Andrews *et al.*, 2004). Biological control is a method used worldwide in pest management. It has been considered as a sustainable, economical and environmental attractive alternative for chemical pest control (Hokkanen and Lynch, 1995). Anonymous (1997) found that both the adult and larval stages of many coccinellid species feed on insects harmful to plants, such as aphids. (Syed *et al.* 2008) found that the predaceous larvae of *Ch. carnea* feed on their prey by sucking its body fluids through their sickle-shaped mouth parts. Minoretta and Weisser (2000) stated that handling time is the time needed by a ladybird to consume a prey after capture. Athan and Guldal (2009) reported that handling time of predator is a good indicator of the predation rate. The present study was therefore conducted to study the larval duration, predation efficiency and handling time of *Ch. carnea*, *C. undecimpunctata* and *C. septempunctata* larvae on *A. gossypii*.

## MATERIALS AND METHODS

Biological studies were carried out at the biological control laboratory of Shandaweel Research Station, Sohag Governorate, Egypt, to find out the predation efficiency of *Ch. carnea*, *C. undecimpunctata* and *C. septempunctata* larvae on *A. gossypii* nymphs. All laboratory studies were run under room conditions where ambient temperature ranged between 11 and 25 °C, and RH varied from 44% to 60% and photo period was 14 Light : 10 Dark. Larvae of *C. septempunctata* and *Ch. carnea* were originally obtained from Aswan Biological Control Center. The larvae were reared under laboratory conditions on cotton leaves infested with *A. gossypii*. For *C. undecimpunctata*, adults were collected from cotton field in the Farm of Shandweel Agricultural Research Station, Sohag Governorate. Adults of three predators were held in tube containers that were moistened with cotton pads and covered with fine polyester mesh and provided with cotton leaves infested with *A. gossypii*. Adults lay their eggs on paper that covered inside surface of the tube. The eggs were collected and kept in Petri dishes for hatching. Twenty larvae of each predator were singly confined in Petri dishes (9 cm diameter) and provided with satisfied number of *A. gossypii* nymphs which reared on cotton plants in the

laboratory. The dishes were inspected every morning, and provided with additional numbers of aphids nymphs. Duration of all larval instars of the three predators was recorded. Total numbers of consumed aphids were recorded, from which the percentage of consumed aphids and average daily

$$H_t = \frac{T}{N}$$

Ht: Handling time T: Time duration by minuets

N: Number of prey consumed by the predator stage.

## RESULTS AND DISCUSSION

### *Ch. carnea* larvae:

Data presented in Table (1) show the predation status of *Ch. carnea* reared on *A. gossypii* nymphs. The larval stage of *Ch. carnea* was completed three instars, that lasted 2.8, 3.4 and 4.3 days for the 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> instars, respectively. Total number of consumed aphids for the 1<sup>st</sup> instar was 57.6 aphids, with an average of 20.57 aphids / day. The 2<sup>nd</sup> and 3<sup>rd</sup> instars consumed 160.2 and 217.3 aphids with daily averages of 47.12 and 50.53 aphids / day. Thus, the 1<sup>st</sup> larval instar consumed 13.1 % out of total consumed aphids throughout the larval stage. However the 2<sup>nd</sup> and 3<sup>rd</sup> instars consumed 36.82 and 49.94 % out of total consumed aphids, respectively. Handling time ( $H_t$ ), the time needed by *Ch. carnea* to consume a prey of *A. gossypii* were 70.00, 30.56 and 28.50 minuets per

consumption was calculated to every larval instar. Handling time of prey by all larval instars was calculated by taking the ratio of time duration and number of prey consumed by the predatory stages **Omkar and Srivastava, (2003)**.

one aphid for 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> instars, respectively. These results are almost in agreement with those of **Singh and Hamid (1998)** who found that the *Ch. carnea* consumed an average of 21.68, 76.92 and 160.92 cabbage aphids in its 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> instar larvae, respectively. A single larvae consumed about 29.22 aphids during its total larval period of 15.57 days. **Singh and kumar (2000)** revealed that the larvae of *Ch. carnea* consumed an average of 11.48, 79.52 and 83.00 aphids of *L. erysimi* during its 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> instar, respectively. **El-Agamy et al. (2010)** reported that the duration of the three larval instars of *Ch. carnea* were 2.6, 3.2 and 4.0 days, respectively. The total larval period lasted for an average of 9.8 days. The daily consumed aphids were 20.08, 46.41 and 45.55 nymphs for the three instars, respectively. **Chakraborty and Korat (2010)** found that first, second and third

instar grubs predated an average of  $\pm 4.33$  of *L. erysimi*.  
 $11.73 \pm 2.23$ ,  $77.86 \pm 5.32$  and  $85.03$

**Table 1. Duration, predation efficiency and handling time of *Ch. carnea* larvae reared on *A. gossypii* nymphs under laboratory conditions in 2012 season.**

Larval instars	Instar duration (Day $\pm$ SD)	Total consumed aphid	Average daily consumption	Handling time (H <sub>t</sub> ) (Minutes)
		% Consumption		
1 <sup>st</sup>	2.8 $\pm$ 0.76	13.1	20.57	70.00
2 <sup>nd</sup>	3.4 $\pm$ 0.58	36.82	47.12	30.56
3 <sup>rd</sup>	4.3 $\pm$ 0.87	49.94	50.53	28.50
<b>Total</b>	10.5	100%	--	--

### *C. undecimpunctata* Larvae:

Data presented in Table (2) show the predation status of *C. undecimpunctata* reared on *A. gossypii* nymphs. The larval stage of *C. undecimpunctata* was completed four instars, that lasted 2.2, 3.1, 3.5 and 4.1 days for the 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> and fourth instar, respectively. Total number of consumed aphids for the 1<sup>st</sup> instar was 42.50 aphids, with an average of 19.32 aphids / day. The 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> instars were consumed 129.18, 222.08, and 313.20 aphids respectively, with daily averages of 41.67, 63.45 and 76.39 aphids / day, respectively. Thus, the 1<sup>st</sup> larval instar was consumed 6.01 % out of total consumed aphids throughout the larval stage. The 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> instars were consumed 18.27, 31.41 and 44.30 % out of total consumed aphids, respectively. As shown in table (2) handling time (H<sub>t</sub>), the time needed by *C. undecimpunctata* to consume a prey of *A. gossypii* were 74.54, 34.56, 22.69 and 18.85 minutes per one

aphid for 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> instars, respectively. These findings are in agreement with those of **Marie *et al.* (2005)** who found that the feeding rate of all four larval instars (grubs) of 11-spotted beetle were 10.6, 18.4, 38.1 and 52.6 aphids per day. The aphid feeding efficiency rate stage of 11-spotted for all four instars were 55.10, 81.00, 175.20 and 278.80, respectively. **El-Heneidy *et al.* (2008)** found that total larval durations of *C. undecimpunctata* were  $13.6 \pm 0.08$ ,  $13.02 \pm 0.12$ ,  $11.2 \pm 0.12$  and  $10.18 \pm 0.09$  days when it was consumed 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> nymphal instars of *A. cracivora*, respectively. Feeding capacity of the larval stage of *C. undecimpunctata* was  $1440.68 \pm 12.17$ ,  $1149.36 \pm 9.65$ ,  $809.65 \pm 6.68$  and  $661.14 \pm 4.74$  nymphs.

### *C. septempunctata* larvae:

Data presented in Table (2) show the predation status of *C.*

*sempunctata* reared on *Aphis gossypii* nymphs. The larval stage of *C. sempunctata* was completed four instars, that lasted 2.7, 3.8, 4.2 and 5.4 days for the 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> instars, respectively. Total number of consumed aphids for the 1<sup>st</sup> instar was

63.83 aphids, with an average of 23.64 aphids / day. The 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> instars of *C. sempunctata* consumed 198.17, 299.80 and 446.15 aphids with daily averages of 52.15, 71.38 and 82.62 aphids / day, respectively.

**Table 2. Duration, predation efficiency and handling time of *Coccinella undecimpunctata* larvae reared on *A. gossypii* nymphs under laboratory conditions in 2012 season.**

Larval instars	Instar duration (Day ± SD)	Total consumed aphid	Average daily consumption	Handling time (H <sub>i</sub> ) (Minutes)
		% Consumption		
1 <sup>st</sup>	2.2 ± 0.43	6.01	19.32	74.54
2 <sup>nd</sup>	3.1 ± 0.62	18.27	41.67	34.56
3 <sup>rd</sup>	3.5 ± 0.74	31.41	63.45	22.69
4 <sup>th</sup>	4.1 ± 0.68	44.30	76.39	18.85
<b>Total</b>	12.9	100	--	--

**Table 3. Duration, predation efficiency and handling time of *C. sempunctata* larvae reared on *A. gossypii* nymphs under laboratory conditions in 2012 season.**

Larval instars	Instar duration (Day ± SD)	Total consumed aphid	Average daily consumption	Handling time (H <sub>i</sub> ) (Minutes)
		% Consumption		
1 <sup>st</sup>	2.7 ± 0.68	6.33	23.64	60.91
2 <sup>nd</sup>	3.8 ± 0.47	19.66	52.15	27.61
3 <sup>rd</sup>	4.2 ± 0.65	29.74	71.38	20.17
4 <sup>th</sup>	5.4 ± 0.73	44.30	82.62	17.43
<b>Total</b>	16.1	100	--	--

Thus, the 1<sup>st</sup> larval instar consumed 6.33 % out of total consumed aphids throughout the larval stage. The 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> instars of *C. sempunctata* consumed 19.66, 29.74 and 44.3 % out of total consumed aphids, respectively. Handling time (H<sub>t</sub>), the time needed by *C. sempunctata* to consume a

prey of *A. gossypii* were 60.91, 27.61, 20.17 and 17.43 minutes per one aphid for 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> instars, respectively. These results are almost in agreement with those of **Prabhakar and Roy (2010)** indicated that *C. sempunctata* have high consumption rate (Number of Prey/ 1 hr) on *Aphis cracivora* (65.6±3.01,

52±4.2 on nymphs, 58.42±2.1, 47.2±2. on adults) in comparison to *Myzus persicae* and *Lipaphis erysimi*

and low on *Aphis gossypii* (59.2±2.3, 46±4.50 on nymphs, 47.3±1.21, 39±3.2 on adults).

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