J. Agric. Sci. Mansoura Univ., 34 (9): 9663 - 9672, 2009

EVALUATION OF THE BIOLOGICAL PARMATERS OF THE GREEN LACEWING, *Chrysoperla carnea* (NEUROPTERA: CHRYSOPIDAE) FED ON TWO APHID SPECIES AT TWO DIFFERENT TEMPERATURES

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ABSTRACT

Laboratory studies were conducted to evaluate the role of two aphid species (*Aphis craccivora* Koch and *Myzus persicae* Sultzer) and two temperature degrees on certain biological aspects of the green lacewing aphid *Chrysoperla carnea* (Neuroptera: Chrysopidae). In order to evaluate its potential as biological control agent, some biological parameters and its consumption capacity were studied on the two aphid preys under laboratory conditions. The biological parameters were the same when the predator fed on *M. persicae* and *A. craccivora*. There are no significant differences were observed in the biological parameters when *C. Carnea* was fed on the two tested aphid preys. The average aphid consumption of *C. carnea* larvae to complete its development was 537.23, 570.08 of *A. craccivora* while it was 507.73 and 519.42 of *M. Persicae* at 25 and 30 oC, respectively. Therefore, the larvae of *C. carnea* can be regarded as a biological control agent for controlling aphid species.

Keywords: Green lacewing aphid, *Chrysoperla carnea*, Biological control, *Aphis craccivora*, *Myzus persicae*.

INTRODUCTION

Chemical control generally provides only short-term solutions. Moreover, the overuse of pesticides, in controlling the destructive pests, has developed a resistance to many insecticides (Damásio, *et al*. 2007). Additionally, residues of pesticides in the environment and impact on the human health safety are also a concern, supported by consumers demand of pesticide-free food. Thus, many countries are trying to reduce their use of chemical pesticides by developing an alternative safety control methods(Carvalho, 2006). Currently, the increasing demand on augmentative releases of certain insect natural enemies to eliminate the most destructive pests, among biological control programs, constitutes a worthy priority (Tauber *et al.*, 2000). Among predatory insects, the green lacewing *Chrysoperla carnea* (Stephen) (Neuroptera: Chrysopidae) which can be considered one of the most polyphagous predators in biological control programs. (Sattar *et al.*, 2007; Zia *et al.*, 2008). Larvae of *C. carnea* are generalist predators that seem to reach higher larval performance when fed on some aphid species, in spite of their feeding on whiteflies, thrips, lepidopterous eggs and larvae, psyllids, mites and mealybugs (Legaspi *et al.*, 1994; Syed *et al.*, 2005; Sattar *et al.,* 2007). Due to their high larval voracity (Principi and Canard, 1984), as well as, their relative tolerance to many insecticides (Nasreen *et al.*, 2003; Zia *et al.*,2008), *C. carnea*, is potentially considered useful biological control agent of aphids and other soft-bodied

insects (Legaspi *et al.*, 1994; Daane, 2001; Mari *et al.,* 2007). The predator larval stages have got a considerable attention, because of having higher searching ability and wide adaptability in greenhouses and fields than other predators (Miller *et al.*, 2004). Certain Chrysopidae insect species mainly of the genus *Chrysoperla* have been successfully mass-reared and used in biological control programs either in greenhouses or in field (New, 1984). The biological control by using *C. carnea* has gained importance in IPM programs and paid attention of the entomologists around the world (Mochizuki and Mitsunaga, 2004; Corrales and Campos, 2004). Since, *C. carnea* is a widely distributed and abundant species world-wide, its important to determine the potential for generalist predators to suppress aphid species in agroecosystems, and the effect of host prey on its biological parameters.

MATERIALS AND METHODS

1. Stock colony of *Chrysoperla carnea:*

A stock colony of *C. carnea* was established with adults collected with a sweeping net from vegetable fields. Adults were maintained in cylindrical plastic cages (20 × 15 cm) and provided with water, sugar and honey. Larvae were reared in glass Petri-dishes (15 cm diameter) with plenty of *Aphis gossypii* (Glover) nymphs and adults offered daily as prey. The stock colony was maintained at 25 ± 1 °C and a photoperiod of 16:8 LD.

2. Prey species

Duration of different developmental larval stages, survival, adult longevity and fecundity of *C. carnea* were determined when larvae preyed upon two aphid species; the cowpea aphid, *Aphis craccivora* (Koch) and the green peach aphid, *Myzus persicae* (Sulzer) (Homoptera: aphididae) at two temperatures 25 and 30 oC. Prey nymphs and adults of *A. craccivora* and *M. persicae* were obtained from laboratory colonies maintained in an insectary on potted broad bean (*Phaseolus vulgaris* L.) and eggplants (*Solanum melongena* L.), respectively.

3. Effect of prey species on predator immature development and survival

In this experiment, 200 individuals of each aphid species were offered daily to each chrysopid larva throughout its larval development. Considering the non-prey species, every 24 h larval developmental stage and survival were recorded. All the experiments were carried out at 25 ± 1, 30± 1 °C and a photoperiod of 16:8 LD. For each treatment (aphid species as a tested prey), 50 replicates of newly hatched lacewing larvae were tested but only those that completed their development were included in data analysis. In further data analysis, each larva of *C. Carnea* was considered as one replicate.

4. Effect of larval prey species on adult longevity and fecundity

Females and males that fed throughout their larval development on the two aphid species were transferred in pairs on the day of emergence and maintained in cylindrical plastic cages where they had continuous access to water mixed with honey and yeast. The number of deposited eggs by each female as well as female survival were daily recorded. Males that died were

replaced with young ones. Egg hatchability was also estimated. Once a week during the first thirty days of the oviposition period, 15 randomly chosen eggs laid by each female were collected and transferred individually in plastic Petri dishes. Subsequently, predator eggs were maintained under the same temperature and photoperiodic conditions with the parental females. Daily deposited eggs and number of newly hatched larvae were recorded. The percentages of egg hatching at each sampling date were estimated for eggs laid by all tested females.

5. Data analysis

Analysis of variance (ANOVA) was used to compare the effect of prey species on developmental time of *C. carnea*. Within each treatment the *t*-test was used to compare total developmental times of females and males. ANOVA test was also used to compare longevity and fecundity of females as well as egg hatchability in the different treatments. Means were compared using Student–Newman–Keuls test ($P = 0.005$) (Costat, 1990).

RESULTS

1-A- Biological aspects of *Chrysoperla carnea* fed on the cowpea aphid, *Aphis craccivora* (Koch)*:*

Duration (in days) of developmental stages of *C. carnea* fed on *A. craccivora* is shown in Table (1). The average of the incubation period lasted 3.75±0.26 and 3.75±0.15 days at 25 and 30°C, respectively.

Regarding the larval stages, the duration of the 1st instar larvae of *C. carnea* averaged 3.40±0.58 at 25 °C and 2.51±0.16 days at 30°C. At 25 °C, the 2nd and 3rd larval instars lasted 2.58±0.058 and 3.65±0.15 days, respectively (Table 1). Meanwhile, the same instars required 2.22±0.15 days for the 2nd instars and 2.85±0.058 days for 3 rd instars at 30°C (Table 1). Accordingly, the total larval stages period of *C. carnea* were 8.96±0.55 at 25°C and 6.91±0.32 days at 30°C when fed on *A. craccivora*, respectively.

Data in Table (1) also revealed that the pupal stage period averaged 7.16±0.15 days at 25°C, while it lasted 5.67±0.058 days at 30°C, respectively.

In respect of the adulthood of *C. carnea* adults, the pre-oviposition period required 6.45±0.15 days at 25°C, and 5.88±0.18 days at 30°C. Meanwhile, the oviposition and the post-oviposition periods lasted 25.58±1.85, 6.97±0.18 days at 25°C, and 17.79±0.25, 4.65±0.25 days at 30°C , respectively (Table 1).

Females fecundity was also affected by temperature when fed on *A. craccivora*. A female deposited an average of 168.45±4.52 eggs at 25°C, and 131.43±6.25 eggs at 30°C respectively (Table 1).

Longevity of *C. carnea* female and male is represented in Figure (1). Female and male longevity lasted 37.33±1.57 and 30.75±0.15 days at 25°C and reached 26.67±1.53 and 20.35±0.55 days at 30°C , respectively. Whereas, the adult's lifespan at 25°C was obviously longer than that at 30°C, which recorded 38.67±0.58 and 31.65±0.55 days and 28.33±0.57 and 21.56±0.83 days at 25°C for female and male, respectively.

Table (1): Duration of different stages of *Chrysoperla carnea* fed on the cowpea aphid, *Aphis craccivora* at two temperature regimes (25 and 30°C).

Developmental stages	Duration (in days) (Means±SE)	
	at 25°C	at 30°C
Incubation period	3.75±0.26 a	3.75±0.15 a
1st stage larva	3.40±0.58 a	2.51±0.16 b
2nd stage larva	2.58±0.058 a	2.22±0.15 a
3rd stage larva	3.65±0.15 a	2.85±0.058 b
Total larval period	8.96±0.55 a	6.91±0.32 b
Pupal stage	7.16±0.15 a	5.67±0.058 ab
Pre-oviposition period	6.45±0.15 a	5.88±0.18 a
Oviposition period	25.58±1.85 a	17.79±0.25 b
Post-oviposition period	6.97±0.18 a	4.65±0.25 b
Total average of eggs/female (fecundity)	168.45±4.52 a	131.43±6.25 b

a - means followed by the same letter within a same row are not significantly different at (0.05 %) (Duncan Multiple Rang test)

Figure (1): Longivety of females and males of *Chrysoperla carnea* fed on *Aphis craccivora* at two temperature regiems.

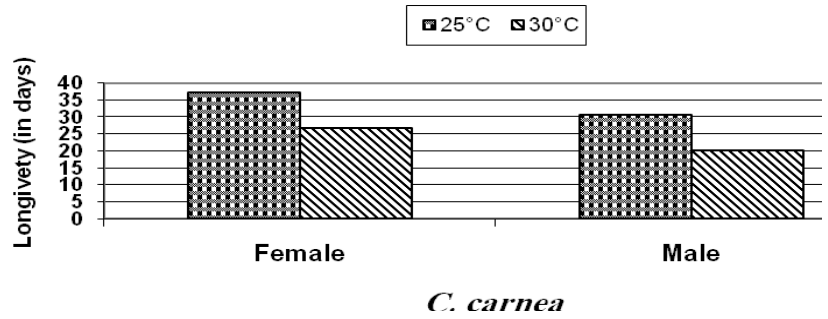
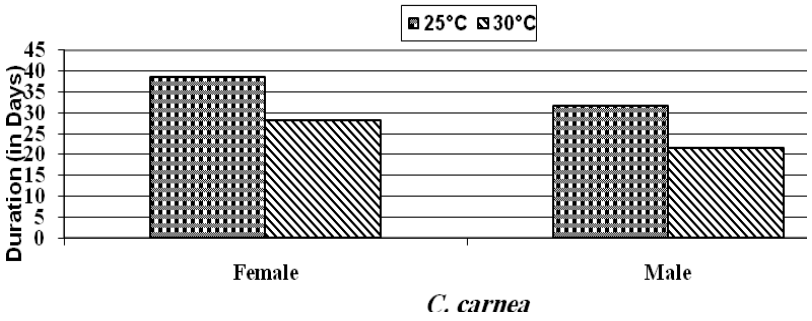


Figure (2): Life sapn of females and males of *Chrysoperla carnea* fed on *Aphis craccivora* at two temperature regiems.



1-B- Consumption rates of *Aphis craccivora* by larval stages of *C. carnea* at 25 and 30°C:

Data in Table (2) revealed that the larval stages of *C. carnea* consumed nymphs of *A. craccivora***.** The average number of consumed nymphs of *A. craccivora* by *C. carnea* 1st, 2nd and 3rd larval instars, at 25°C were 27.65±1.55, 158.23±1.25 and 351.35±0.58 individuals, respectively with an average of 537.23±1.98 individuals, while, they consumed 33.25±1.52, 175.31±3.12 and 361.52±2.15 nymphs at 30°C, respectively, with a total average of 570.08±3.54 individuals. From the previous results it can be said that *C. carnea* can use nymphs of *A. craccivora* to complete its lifespan and that may be considered as potential biological control agent against different species of aphids.

Table (2): Consumed numbers of *Aphis craccivora* nymphs by different larval instars of *Chrysoperla carnea* at 25 and 30°C.

Stages	No. of consumed *A. craccivora* nymphs/ larva of *C. carnea* (Means±SE)	
	at 25°C	at 30°C
1st instar	27.65±1.55 b	33.25±1.52 a
2nd instar	158.23±1.25 ab	175.31±3.12 a
3rd instar	351.35±0.58 ab	361.52±2.15 a
Total average	537.23±1.98 ab	570.08±3.54 a

a - means followed by the same letter within a same row are not significantly different at (0.05 %) (Duncan Multiple Rang test)

2-A- Biological aspects of *Chrysoperla carnea* fed on the green peach aphid, *Myzus persicae* (Sulzer);

Duration (in days) of developmental stages of *C. carnea* fed on *M. persicae* is shown in Table (3). The incubation period lasted 3.25±0.15 and 3.05±0.20 days at 25 and 30°C, respectively. Regarding larval stages, the duration of the 1st instar larvae of *C. carnea* averaged 3.42±0.25 at 25 °C and 2.45±0.15 days at 30°C. Whereas, the 2nd and 3rd larval instars lasted 2.55±0.15 and 3.41±0.18 days at 25°C, respectively. Meanwhile, the same instars required 2.01±0.22 and 2.56±0.15 days at 30°C ,respectively (Table 3). Accordingly, the total larval stages of *C. carnea* durated 8.89±0.50 at 25°C and 7.01±0.23 days at 30°C when fed on *M. persicae*. The pupal stage period averaged 8.01±0.15 days at 25°C, while it lasted 5.87±0.15 days at 30°C, respectively as shown in Table (3).

In respect of the biological parameters of *C. carnea* adults, the pre-oviposition period required 6.88±0.18 days at 25°C, and 5.15±0.12 days at 30°C. Meanwhile, the oviposition and post-oviposition periods averaged 26.14±1.74, 6.11±0.25 days at 25°C, and 17.10±0.15, 4.44±0.18 days at 30°C (Table 3).

Females fecundity was also affected by temperature when fed on *M. persicae*. A female laid an average of 164.31±4.28 eggs at 25°C, and 128.25±4.25 eggs at 30°C,respectively.

Table (3): Duration of different stages of *Chrysoperla carnea* fed on *Myzus persicae* at two temperature regimes (25 and 30°C).

Developmental stages	Duration (in days) (Mean±SE)	
	at 25°C	at 30°C
Incubation period	3.25±0.15 a	3.05±0.20 a
1st stage larva	3.42±0.25 a	2.45±0.15 b
2nd stage larva	2.55±0.15 a	2.01±0.22 a
3rd stage larva	3.41±0.18 a	2.56±0.15 b
Total larval period	8.89±0.50 a	7.01±0.23 b
Pupal stage	8.01±0.15 a	5.87±0.15 b
Pre-oviposition period	6.88±0.18 a	5.15±0.12 b
Oviposition period	26.14±1.74 a	17.10±0.15 b
Post-oviposition period	6.11±0.25 a	4.44±0.18 b
Total average of eggs/female (fecundity)	164.31±4.28 a	128.25±4.25 b

a - means followed by the same letter within a same row are not significantly different at (0.05 %) (Duncan Multiple Rang test).

Figure (3). Longevity of females and males of *Chrysoperla carnea* fed on *Aphis craccivora* at two temperature regiems.

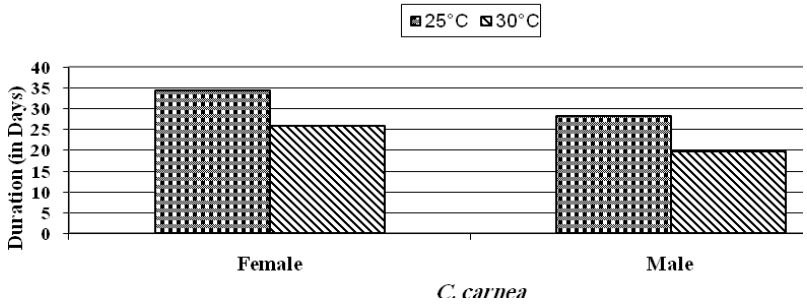
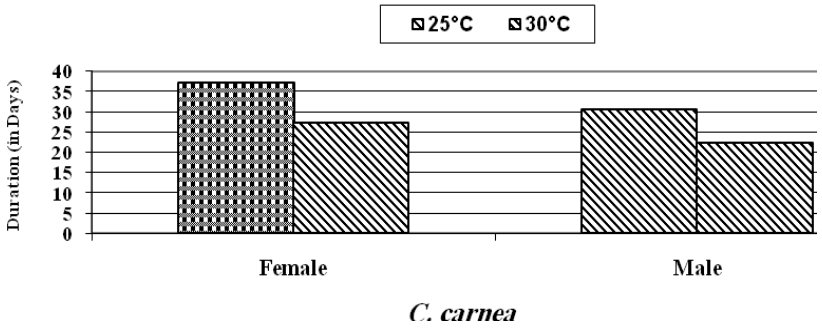


Figure (4): Life sapn of females and males of *Chrysoperla carnea* fed on *Myzus persicae* at two temperature regiems.



Female and male longevity lasted 34.35±1.65 and 28.25±0.25 days at 25°C and reached 25.66±1.25 and 19.55±0.55 days at 30°C (Fig.3). The adult's lifespan at 25°C was longer than that at 30°C, which lasted 37.25±0.56 and 30.65±0.58 days for female and male at 25°C, and 27.25±1.25 and 22.55±0.56 days for female and male at 30°C, respectively (Fig. 4).

2-B- Consumption rates of *Myzus persicae* by larval stages of *C. carnea* at 25 and 30°C:

Data in Table (4) revealed that the larval stages of *C. carnea* consumed nymphs of *A. craccivora.* The average number of consumed nymphs of *A. craccivora* by *C. carnea* 1st, 2nd and 3rd larval instars were 24.85±1.22, 147.21±1.55 and 335.67±0.15 individuals at 25°C, respectively. While they consumed 30.96±1.58, 166.35±2.15 and 352.11±2.18 eggs at 30°C, respectively.

From the previous results it can be noticed that *C. carnea* used nymphs of *A. craccivora* to complete its lifespan and may be therefore considered as a potential biological control agent against different species of aphids.

Table (4): Consumed numbers of *Myzus persicae* nymphs by different larval instars of *Chrysoperla carnea* at 25 and 30°C.

Stages	Consumed numbers of *M. persicae* nymphs/ larva of *C. carnea* (Means±SE)	
	at 25°C	at 30°C
1st instar	24.85±1.22 b	30.96±1.58 a
2nd instar	147.21±1.55 b	166.35±2.15 a
3rd instar	335.67±0.15 ab	352.11±2.18 a
Average (total)	507.73±3.78 a	519.42±3.62 a

a - means followed by the same letter within a same row are not significantly different at (0.05 %) (Duncan Multiple Rang test)

3. Effect of aphid species on the biological parameters of *Chrysoperla carnea*:

From the above mentioned results it could be concluded that both aphid species had an impact on the biological features of the predator (Tables 1 & 3). Both aphid species were equal in their effectiveness on the predator biological parameters, where no significant differences were observed when the predator fed on the two aphid species. In respect of the consumption numbers of the two aphid species, it could be noticed that *A. craccivora* was the preferred prey species. The predator larvae consumed an average of 537.23 and 570.52 individuals of *A. craccivora* and 507.73 and 519.42 of *M. persicae* at 25 and 30 oC, respectively.

DISCUSSION

Chrysoperla carnea larvae can prey on a variety of soft-bodied arthropods like aphids, coccids, leafhoppers, whiteflies, psyllids, thrips, psocids, tetranychid and eriophyid mites, eggs and young larvae of certain species of Lepidoptera and less commonly on eggs and larvae of certain

species of Coleoptera, and Diptera (Principi and Canard, 1984; New, 1984; and Miller *et al.,* 2004). Some species of the aforementioned preys could be optimal for development and reproduction of *C. Carnea*, resulting in high larval developmental rates and increased preimaginal survival and adult longevity (Principi and Canard, 1984). The larvae of *C. carnea* considered as polyphagous, since they prey upon a great variety of aphid .Therefore, the development of larvae, pupae and adults may be affected by the prey hosts and temperatures. In the present study, it was noticed that the aphid species and temperature had a strong influence not only on preimaginal development of the predator but also on the female longevity and fecundity (Tables 1, 3 and Figures 1- 4).

However, those prey species subserved rapid preimaginal development and high percentages of survival resulted in a better reproductive performance for *C. carnea* as well (Tables 2 and 4).

Moreover, the results clearly showed that nymphs of *A. craccivora* proved to be the most favourable for development and reproduction of *C. carnea* resulting in high immature survival rate, short larval developmental time and increased adult longevity and fecundity. The nymphs of *M. persicae* resulted in intermediate to low survival and reduced oviposition rates. Therefore, we cannot exclude the possibility that the highest suitability of *M. persicae* in relation to the other tested aphid species could be due to an adoption and/or preference that developed by the predator during the first generation, as it has also been reported for *Chrysopa quadripunctata* Burmeister (Albuquerque *et al*., 1994). However, similarly to our results a considerable variation has been found in the relative suitability of several aphid species when tested as prey for lacewing larvae. Great variation in developmental rate has been recorded for *Chrysoperla* species when fed on various aphid species (Principi and Canard, 1984). Development and reproduction of *C. rufilabris* (Burmeister) and *C. carnea* (Stephens) was favoured when fed on immature stages of *M. persicae* and *Aphis gossypii* Glover whereas *Lipaphis erysimi* (Kaltenbach) was of low nutritional value for both species (Chen and Liu, 2001). It could be also noticed that the total larval, pupal stages and adult longevity and life span of *C. carnea* at 25oC showed non similar pattern at 30 oC when fed on the two aphid species (Tables 1 & 3). This was in harmony with the results of Butler and Ritchie (1970) for *C. carnea* who noticed that the larval developmental time decreases with temperature elevation. Additionally, Cardoso and Lazzari (2003) showed that the development of *C. externa* (Hagen) was faster at 25oC than lower temperatures used (20 and 15 oC).

Therefore, further experiments are required in order to clarify the suitability of different potential food sources and their combinations as well as the level of their availability on the predator's food preference and performance.

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تقييم بعض المعايير الإحيائية للمفترس أسد المن الأخضر (Neuroptera: Chrysopidae) *Chrysoperla carnea* المغذى على نوعين من المن تحت تأثير درجتين مختلفتين من الحرارة .

وفاء عبد الله الخرب

كلية العلوم والآداب للبنات – جامعة القصيم – المملكة العربية السعودية

أجريت من خلال هذا البحث دراسة معملية لتقييم تأثير تغذية المفترس الحشري *Chrysoperla carnea* على نوعين مختلفين من المن وهما من البقوليات *Aphis craccivora* ومن الخوخ الأخضر *Myzus persicae* تحت تأثير درجتي حرارة مختلفتين (٢٥° م و٣٠ °م) على بعض الخصائص والمعايير الإحيائية لتقييم مدى كفاءة هذا المفترس عند استخدامه كأحد عناصر المكافحة الإحيائية الموجهة ضد نوعي المن موضع الدراسة ·

وقد أوضحت نتائج البحث عدم وجود فروق معنوية على المعايير الإحيائية لأسد المن الأخضر والتي اشتملت عليها هذه الدراسة عند التغذية على أي من نوعي المن موضع البحث حيث لم تؤثر نوعية التغذية على أي من طول فترة الأعمار غير الكاملة أو على طول فترة حياة الأطوار الكاملة و خصوبتها للمفترس الحشري وقد وجد أن متوسط استهلاك يرقات أسد المن الأخضر طوال فترة عمرها اليرقي من حشرات من البقوليات *A. craccivora* كان ٥٢٧٫٢٣ و٥٧٠٫٠٨ فرداً عند التغذية على درجتي حرارة ٢٥° م و٣٠ °م على الترتيب في حين سجل هذا المتوسط ٥٠٧٫٧٣ و ٥١٩٫٤٢ فرداً من حشرات من الخوخ الأخضر *M. persicae* على نفس درجتي الحرارة سابقتي الذكر على الترتيب . لذلك تشير نتائج هذا البحث إلى إمكانية الاعتماد على يرقات المفترس الحشري أسد المن الأخضر كأحد عوامل المكافحة الإحيائية لكل من نوعي حشرات المن موضع الدراسة .

الكلمات الافتتاحية : أسد المن الأخضر , المكافحة الإحيائية , من البقوليات , من الخوخ الأخضر .