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Development and reproductive performance of *Chrysoperla externa* (Neuroptera: Chrysopidae) using preys from wheat crop

Preferencia, desarrollo y desempeño reproductivo de *Chrysoperla externa* (Neuroptera: Chrysopidae) utilizando presas provenientes de trigo

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Abstract: Biological parameters of *Chrysoperla externa* were assessed in laboratory. The effect of the preys on biological parameters and reproductive performance were assessed when the following food treatments were provided: *Sitobion avenae* in all larval instars; *Rhopasosiphum padi* in all larval instars; *Anagasta kuehniella* eggs in the first and second instars and *Dichelops melacanthus* eggs in the third; *R. padi* in the first and second instars and *D. melacanthus* in the third instar. All foods provided satisfactory development and reproductive performance. Changing larvae food from *A. kuehniella* to *D. melacanthus* did not affect its survival. However, changing larvae food from *R. padi* to *D. melacanthus* reduced survival. When larvae were fed with *R. padi* (1st and 2nd instars) and *D. melacanthus* (3rd instar), *C. externa* laid more eggs than when larvae were fed only with aphids. Other parameters either were not affected, or were little affected by the diet change. Results showed that aphis are important food sources for *C. externa,* and this predator may also predate and develop on *D. melacanthus* eggs.

Key words: Aphids. Biological control. Lacewing. Integrated pest management. Stink bug.

Resumen: Se evaluaron los parámetros biológicos de *Chrysoperla externa* en condiciones de laboratorio. El efecto de las presas sobre los parámetros biológicos y el comportamiento reproductivo fueron evaluados cuando se proporcionaron los siguientes alimentos: *Sitobion avenae*; *Rhopasolsiphum padi* (ambos en los tres estadios larvales); huevos de *Anagasta kuehniella* del primero al segundo estadio y huevos de *Dichelops melacanthus* en tercer estadio; *R. padi* del primero al segundo estadio y huevos de *D. melacanthus* en tercero. Todos los alimentos determinaron desarrollo y desempeño reproductivo satisfactorios. El cambio de presa de *A. kuehniella* a *D. melacanthus* no afectó la viabilidad de las larvas, pero sí la redujo el cambio de *R. padi* a *D. melacanthus*. Cuando las larvas se alimentaron con *R. padi* (primer y segundo estadio) y *D. melacanthus* (tercer estadio), *C. externa* puso más huevos que cuando se proporcionaron los áfidos. Como consecuencia del cambio de dieta, otros parámetros no fueron afectados o sólo ligeramente. Los resultados mostraron que los áfidos son importantes fuentes de alimento para *C. externa* y que este depredador también puede consumir y desarrollarse con huevos de *D. melacanthus*.

Palabras clave: Áfidos. Control biológico. Crisópidos. Manejo integrado de plagas. Chinche.

Introduction

Chrysopidae family includes some common predator species that occur in agroecosystems, and they play important role in regulating populations of phytophagous organisms. These species prey on eggs, neonate larvae, aphids, mealybugs, mites and other arthropods of small size and of easily penetrable tegument (Carvalho & Souza 2009). Propositions of using lacewings in integrated management programs include *Alabama argillacea* (Hubner, 1818) (Lepidoptera: Noctuidae); aphids *Aphis gossypii* (Glover, 1877), *Schizaphis graminum* (Rondani, 1852) and *Rhodobium porosum* (Sanderson, 1900) (Hemiptera: Aphididae); some citrus mealybugs *Coccus* sp (Hemiptera: Coccidea), *Orthezia* sp. (Hemiptera: Orthezidae) *Pinnaspis* sp. and *Selenaspidus* sp. (Hemiptera: Diaspididae); thrips *Enneothrips flavens* Moulton (Rodrigues *et al*. 2014) and *Thrips tabaci* Lind. (Thysanoptera: Thripidae) (Abbas *et al.* 2012); leafhopper *Amarasca devastans* Dist. (Hemiptera: Cicadellidae) (Abbas *et al.* 2012); and rubber tree lacebug *Leptopharsa heveae* Drake & Poor, 1935 (Hemiptera: Tingidae) (Carvalho & Souza 2009).

Chrysoperla externa (Hagen, 1861) (Neuroptera: Chrysopidae) occurs in superior populations in wheat crop and has been reported feeding and developing on several aphid species (Fonseca *et al*. 2000; Costa *et al.* 2002; Macedo *et al.* 2010; Costa *et al.* 2012). However, studies on the biology of this predator feeding on wheat aphids preys were not found. These studies are important since some aphid species, such as the citrus pest *Toxoptera citricidus* (Kirk, 1907) (Hemiptera: Aphididae), do not provide satisfactory conditions for *C. externa* development, despite the abundance of the predator in citrus orchards (Godoy *et al*. 2004). In addition, although *C. externa* presents several traits that may allow its use in biological control (Albuquerque *et al.* 1994).

In integrated pest management (IPM) programs, aphid populations may have a positive effect in attracting and maintaining natural enemies in crops (Gravena 1992). Besides, these natural enemies may keep other pest populations below damage threshold. *Rhopasolsiphum padi* (L.) and *Sitobion avenae* (Fabricius) (Hemiptera: Aphididae) are ordinary abundant preys for *C. externa* in wheat fields. In the field, *C. externa* larvae were observed also predating green belly stink bug *Dichelops melacanthus* (Dallas, 1851) (Hemiptera: Pentatomidae) eggs (Pitwak J., personal observation). This seed sucker is reported as a soybean secondary pest. Due to the massive use of no tillage system, and to late cropping maize (autumn cropping) in Brazil, *D. melacanthus* becomes

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a primary pest of wheat and maize, damaging the seedlings of these crops. This species is favored by crop debris, which provide shelter and food (soybean grains not collected by the combine harvester). Although *D. melacanthus* does not develop feeding on wheat or maize plants, it does on tropical spiderwort (*Commelina benghalensis*) that occurs in these fields and contributes to the high occurrence of the pest (Silva *et al*. 2013).

We studied the capacity of *C. externa* in feeding and developing on some wheat pests. To assess the effect of these pests on biological parameters, four preys or combinations were provided as food: a) *S. avenae* in all larval stages of *C. externa;* b) *R. padi* in all larval stages of *C. externa*; c) *Anagasta kuehniella* (Zeller, 1879) (Lepidoptera: Pyralidae) eggs [which is considered standard food for *C. externa* (Carvalho & Souza 2009)] in the first and second instars and *D. melacanthus* eggs in the third; and d) *R. padi* in the first and second instars and *D. melacanthus* in the third instar.

Material and methods

Chrysoperla externa adults were collected from a wheat field in the Universidade Estadual de Londrina farm school (23°19'S, 51°12'W) and kept in an environmental chamber (25 ºC, 70 % RU and 12:12 L:D). Adult cages were made using PVC tubes (20 cm height x 10 cm diameter) covered with white bond paper. Yeast and honey (1:1), together with water, were provided as food. Eggs were collected in the rearing cages when they reached 24 h of age. Pedicel was removed using fine-tipped scissors and placed in microtitration plates sealed with laminated PVC film. Newly hatched larvae were transferred to plastic vessels (3 cm diameter x 1,7 cm height) in which preys were available.

The biology of *C. externa* larvae and adults were investigated in four food combinations: *S. avenae* (Sa) in all larval instars of the predator; *R. padi* (Rp) in all larval instars of the predator; *A. kuehniella* eggs in the first and second instar and *D. melacanthus* eggs in the third instar (Ak + Dm); and *R. padi* in the first and second instar and *D. melacanthus* eggs in the third instar (Rp + Dm). The treatment *A. kuehniella* in the two first instars, and *D. melacanthus*, in the third instar, were used to simulate occasional laboratory rearing and predator field release when the predator could feed on eggs. *R. padi* (two first intars) + *D. melacanthus* (third instar) is probably an ordinary situation in the field. Preys were made available *ad libitum* in rearing cages. Cages were observed twice a day to provide food without limitation. Aphids were reared in wheat plants cv. Alcover in greenhouse. *A. kuehniella* eggs not sterilized were obtained from rearing facilities in the IAPAR- Instituto Agronômico do Paraná. Seven replications with six larvae per replication were used.

After emergence, adults lacewings were kept in refrigerator (9 ºC) in order to reduce movements, and were weighted (mg) and separated by sex, by external genitalia observation. Couples were kept inside PVC cages (10 x 10 cm), using the method proposed by Ribeiro (1988). Yeast mixed with honey and water were provided as food. For adults, ten randomly chosen couples were used per treatment. Larvae and adults were removed from container and weight using an analytical balance (resolution 0.0001 g) (Bel Engineering, Italy) after kept in refrigerator (9 ºC) in order to reduce movements. Duration and survival of larvae, pre-pupae (larvae cease feeding to make the cocoon) and pupae, and weight (mg) after 24 h in each stage were assessed. For adult stage, it was evaluated weight, pre-oviposition, oviposition (interval between the first and last laying), effective oviposition (number of days in which females oviposited) and post-oviposition periods; total number of eggs, and longevity and survival of eggs .

Completely randomized design was used. To verify the assumptions for the analysis of variance, tests of the variance homogeneity and normality were carried out. Thereafter, analysis of variance was carried out, and Tukey test was used to compare means. Variables percentage were transformed using the constant arc sen $\sqrt{(x/100)}$. SASM - Agri (Canteri *et al.* 2001) software package was used.

Results and discussion

In general, results showed that preys used in the present study provided suitable nutritional quality for *C. externa* development and reproduction since unsuitable nutritional quality causes negative effects in the biology of the predator. Duration of the second instar was shorter than in the other ones, and Sa was the longest (Table 1). In the third instar, Ak + Dm was shorter than the others. The values reported here are quite similar to those reported when *C. externa* was fed on *Sitotroga cerealella* (Olivier, 1789) (Lepidoptera: Gelechiidae) eggs: 3.04 (± 0.02), 2.55 (± 0.08) and 3.67 (± 0.07) days, respectively (Costa *et al*. 2002); or *A. gossypii*, 3.89 (± 0.06), 2.55 (± 0.09) and 4.19 (± 0.07) (Ribeiro 1988) for the first, second and third instars, respectively. The periods found for 2nd and 3rd instars in the *S. avenae* treatment were similar to those found previously for the aphid *Neotoxoptera*

Table 1. Duration (days) ($\bar{X}$ ± SE) of *Chrysoperla externa* instars, whose larvae were fed with different preys, in laboratory (25 ºC, RU 70 %, Photophase 12 h), DF = 27.

Prey	Instar		
	1	2	3
Ak + Dm[1]	3.29 ± 0.07 a (42)[5]	2.17 ± 0.06 a (42)	3.93 ± 0.14 a (41)
Sa[2]	3.29 ± 0.07 a (42)	3.00 ± 0.00 c (42)	5.12 ± 0.16 c (41)
Rp + Dm[3]	3.29 ± 0.00 a (42)	2.66 ± 0.10 b (41)	4.63 ± 0.17 bc (27)
Rp[4]	3.43 ± 0.08 a (42)	2.54 ± 0.08 b (37)	4.47 ± 0.08 b (36)
CV (%)	12.58	16.88	18.81

[1] *A. kuehniella* eggs for the first and second instars, and *D. melacanthus* eggs for the third instar. [2] *S. avenae.* [3] *R. padi* for the first and second instars, and *D. melacanthus* eggs for the third instar. [4] *R. padi.* [5] Number of larvae. Means followed by the same letter in the columns did not differ by the Tukey test (P < 0.05).

Table 2. Duration (days) ($\bar{X}$ ± SE) of larvae, pre pupae, pupae and from larvae to adult of *Chrysoperla externa* larvae fed on different preys, in laboratory (25 ºC, RU 70 %, Photophase 12 h). DF = 27.

Prey	Larvae	pre pupae	pupae	larvae to adult
Ak + Dm[1]	9.63 ± 0.10 a (41)[5]	3.83 ± 0.15 c (41)	5.66 ± 0.08 a (38)	19.13 ± 0.18 a (38)
Sa[2]	11.41 ± 0.19 c (41)	3.73 ± 0.08 bc (40)	6.30 ± 0.11 b (37)	21.16 ± 0.20 c (37)
Rp + Dm[3]	10.33 ± 0.08 b (27)	3.30 ± 0.09 b (27)	6.36 ± 0.10 b (25)	19.77 ± 0.20 a (26)
Rp[4]	10.47 ± 0.08 b (36)	2.67 ± 0.09 a (36)	6.57 ± 0.09 b (35)	19.71 ± 0.13 a (35)
CV(%)	8.07	19.42	8.98	5.22

[1] *A. kuehniella* eggs for the first and second instars, *D. melacanthus* eggs for the third instar. [2] *Sitobion avenae.* [3]*Rhopalosiphum padi* for the first and second instar, and *D. melacanthus* eggs for the third instar. [4] *Rhopalosiphum. padi.* [5] Number of larvae. Means followed by the same letter in the columns did not differ by the Tukey test (P < 0.05).

formosana (Takahashi, 1921) (Homoptera: Aphididae) [4.7 (± 0.14) and 6.0 (± 0.15) days, respectively] (Costa *et al.* 2012).

Duration of larval stage was longer when *C. externa* was fed on Sa than with the remainder treatments (Table 2). The shortest period was found for Ak + Dm. Similar duration was previously reported for *C. externa* when reared using *S. cerealella* eggs (9,18 days) (Costa *et al*. 2002) or the aphid *A. gossypii* [10.62 or 10.28 days (Costa *et al*. 2002; Ribeiro 1988)]. A longer duration of larval period was found for the aphid *N. formosana* [(14.1 days (± 0.38)] (Costa *et al*. 2012).

Pre-pupae period was shorter in the treatment Rp than in the other treatments (Table 2). Ak + Dm treatment showed shorter pupae period than the other ones. Total period from larvae to pupae was longer in Sa than in the other treatments (Table 2). Similar results were reported to *C. externa* reared on *S. cerealella* eggs and *A. gossypii* (2.68 and 3.0; 7.01 and 6.73; 19.3 and 20 days to pre-pupae, pupae and larvae to pupae, respectively) (Costa *et al.* 2002).

Larvae fed with Rp + Dm presented lower larval survival than Ak + Dm and Sa (Table 3). Similar result was found for pre-pupae and pupae survival among treatments. In the second instar, *C. externa* larvae that feed on Ak + Dm presented lower weight when compared to the other treatments. In the third instar, *C. externa* larvae that fed on Sa were heavier than other treatments (Table 4). However, when insects reached pupae stage, similar weights were recorded. These results were quite similar to those found when *C. externa* was reared feeding on *Bemisia tabaci* (Gennadius, 1889) (Hemiptera: Aleyrodidae) originating from milkweed (*Euphorbia heterophylla* L.) (Linnaeus) plants (Silva *et al.* 2004b). However, in the same study, when *B. tabaci* was reared on green collard (*Brassica oleracea* L.) (Linnaeus) plants, greater weights on the third instars [1.00 (± 0.15), 3.57 (± 0.22) mg, respectively)] were found when compared to that found in this study [2.50 (± 0.10)] (Table 4). Satisfactory pupae weight represents suitable ovaries development, and thus oviposition capacity. In general, females were heavier than males (Fig. 1A), which contradicts earlier results in which similar weights for males and females were found when larvae were fed with *B. tabaci* nymphs (Silva *et al.* 2004a). Adults weights are important traits associated with higher egg production (Carvalho & Souza 2009).

The higher survival in Ak + DM than than Rp + Dm (Table 3) suggests that the predator adapted itself more quickly to feed on Dm eggs when they had been previously fed on *A. kuehniella* eggs. Otherwise, the high longevity in the treatment Ak + Dm suggests suitable nutritional value of Dm eggs. High survival of *C. externa* larvae when feeding on several preys was also previously reported (Ribeiro 1988; Costa *et al*. 2002). Predators, in general, can consume more than one kind of prey during their development, which contributes to fulfill nutritional requirements for *C. externa* development (Fonseca *et al.* 2000; Ecole *et al*. 2002).

Longer oviposition period was found for larvae fed with Rp + Dm than for those fed with Sa (Table 5). Similar pre, effective and post-oviposition periods were observed among treatments. Higher longevity was recorded for males reared on Rp + Dm than on the other treatments (Table 6). Females reared on Rp + Dm also showed higher longevity than on Sa treatment. In previous studies, adults longevity (males and females recorded together) varied quiet similarly to the present results, ranging from 34.96 (± 7.60) to 69.75 (± 4.21),

Table 3. Survival (% ± SE) of larvae, pre pupae, pupa and larvae to adult *Chrysoperla externa*, whose larvae were fed with different preys, in laboratory (25 ºC, RU 70 %, Photophase 12 h). DF = 27.

Prey	Larvae	pre pupae	Pupa	larvae to adult
Ak + Dm[1]	97.62 ± 2.38 a	100.00 ± 0.00 a	92.69 ± 3.62 a	90.48 ± 4.96 a
Sa[2]	97.62 ± 2.38 a	97.56 ± 2.38 a	91.89 ± 4.96 a	88.10 ± 4.76 a
Rp + Dm[3]	64.29 ± 7.65 b	100.00 ± 0.00 a	92.00 ± 3.07 a	61.90 ± 7.90 a
Rp[4]	85.71 ± 5.67 ab	100.00 ± 0.00 a	97.14 ± 2.38 a	83.33 ± 7.27 a
	17.41	5.06	15.24	23.68

[1] *A. kuehniella* eggs for the first and second instars, and *D. melacanthus* eggs for the third instar. [2]*S. avenae.* [3]*R. padi* for the first and second instar, and *D. melacanthus* eggs for the third instar. [4]*R. padi.* [5] Number of larvae. Means followed by the same letter in the columns did not differ by the Tukey test (P < 0,05).

Table 4. Weight (mg) ($\bar{X}$ ± SE) of *Chrysoperla externa* larvae, pre pupae and pupae whose larvae were fed with different preys, in laboratory (25 ºC, RU 70 %, Photophase 12 h). DF =27.

Prey	3 instar	Pre-pupae	Pupae
Ak + Dm[1]	2.29 ± 0.09 b	8.96 ± 0,62 a	7.67 ± 0,65 a
Sa2	3.33 ± 0.12 a	7.90 ± 0,45 a	7.82 ± 0,24 a
Rp + Dm[3]	2.19 ± 0.13 b	8.19 ± 0,21 a	7.57 ± 0,21 a
Rp[4]	2.17 ± 0.07 b	9.22 ± 0,01 a	8.56 ± 0,13 a
	11.36	12.43	12.34

[1] *A. kuehniella* eggs for the first and second instars, and *D. melacanthus* eggs for the third instar. [2] *S. avenae.* [3] *R. padi* for the first and second instar, and *D. melacanthus* eggs for the third instar. [4] *R. padi.* [5] Number of larvae. Means followed by the same letter in the columns did not differ by the Tukey test (P < 0.05).

depending on the host in which the prey was developed (Silva *et al.* 2004a).

The number of eggs produced by females whose larvae were fed with Rp + Dm was higher than those fed with Sa (Fig. 1B). In Sa treatment, higher males than females were observed (Fig. 1A) what can explain this result. In general, the number of eggs reported here [ranging from 763.30 (± 121.88) to 1269.70 (± 202.77)] are higher than those previously recorded for *C. externa* reared on *B. tabaci* [from 293.83 (± 97.08) to 592.08 (± 62.96)] (Silva *et al.* 2004a) and 711.8 (± 10.57) (Auad *et al.* 2005)] and *A. gossypii* [428.5 (± 85.2)] (Macedo *et al*. 2010). Similar egg survival rate was found among treatments [72.20 (± 6.68] (Fig. 1C). Higher mean values were previously observed for *C. externa* larvae fed with *A. kuehniella* and *A. argillacea* eggs (89.15 and 86.62 %, respectively) (Ribeiro 1988).

In general, the biological parameters recorded in this study are close to those previously reported for *C. externa.* The high performance of the predator when feeding on wheat aphid species confirms the importance of these species to provide food for superior populations of *C. externa* that have been found in fields. This situation probably occurs in other crops in which aphids develop early, and may be the basis for *C. externa* population growth, such as maize and cotton (Gravena 1992). This fact reinforces the need to avoid spraying insecticides or even using selective products to manage aphids. In addition, other strategies may be eventually tested in further studies in order to improve and maintain its populations in the field.

The performance obtained when Rp + Dm was provided as food shows that *C. externa* may develop using stink bug eggs as alternative food source, and may control itin the beginning of the pest cycle development. It was not found previous reports on predation of Pentatomidae eggs by *C. externa*. Although *C. externa* reduces its survival when it changes the diet from aphid to *D. melacanthus* eggs (Table 2), a greater fecundity (Fig. 1B) apparently compensates this reduction. The quick adaptation of *C. externa* from *A. kuehniella* eggs to *D. melacanthus* eggs suggests that insects reared in laboratory could be tested in further studies for the control of stink bug and other preys in the field. The capacity to feed on different aphid and *D. melacanthus* eggs is also a very favorable trait which suggests effectiveness of *C. externa* to control plant feeding insects in the field where population density of preys is seasonal (Carvalho & Souza 2009). Besides aphids and *D. melacanthus* eggs, pollen grains and honeydew may be other alternative food sources, and future studies could investigate this hypothesis.

In wheat field crops, aphids are controlled by natural occurrence of Aphidiinae (Hymenoptera: Braconidae) parasitoids. However, misguided spraying insecticides have been currently carried out to control them. Moreover, pesticides currently registered to wheat crop do not include selective insecticides to natural enemies (IAPAR 2013). Predation on Lepidoptera eggs by *C. externa* has also been previously reported [*Alabamma argilacea* (Hubner, 1818) (Lepidoptera: Noctuidae) (Carvalho *et al.* 1988)]. This suggest that judicious management of aphids in early stages of wheat crop are fundamental for the establishment of *C. externa* populations, not only for aphid control, but also for *D. melacanthus* control, and other Lepidoptera pests that may occasionally occur, such as *Spodoptera frugiperda* (J.E. Smith and *Pseudaletia sequax* (Franclemont, 1951) (Lepidoptera: Noctuidae). Laboratory rearing and liberation of *Chrysoperla carnea* (Stephens, 1836) (Neuroptera: Chrysopidae) for the control of *Heliothis virescens* (Fabricius, 1781) (Lepidoptera:

Table 5. Duration (days) of pre-oviposition, oviposition, effective oviposition, and post-oviposition (± SE) of *Chrysoperla externa* females, whose larvae were fed with different preys, in laboratory (25 ºC, RU 70 %, Photophase 12 h). DF = 39.

Prey	Pre-oviposition	Oviposition	Effective	Post-oviposition
Ak + Dm[1]	5.60 ± 0.81 a	56.90 ± 3.77 ab	54.80 ± 3.13 a	2.60 ± 0.52 a
Sa[2]	5.70 ± 0.33 a	45.00 ± 4.07 b	47.00 ± 3.98 a	2.20 ± 0.92 a
Rp + Dm[3]	8.00 ± 1.57 a	60.20 ± 4.56 a	59.00 ± 4.39 a	2.80 ± 0.93 a
Rp[4]	7.20 ± 0.53 a	49.00 ± 1.54 ab	48.20 ± 1.53 a	4.10 ± 1.24 a
CV(%)	30.2	22.66	21.04	101.37

[1] *A. kuehniella* eggs for the first and second instars, and *D. melacanthus* eggs for the third instar. [2] *S. avenae.* [3] *R. padi* for the first and second instar, and *D. melacanthus* eggs for the third instar. [4] *R. padi.* [5] Number of larvae. Means followed by the same letter in the columns did not differ by the Tukey test (P < 0.05).

Table 6. Longevity (days) (X̄ ± SE) of *Chrysoperla externa* males and females of, whose larvae were fed with different preys, in laboratory (25 ºC, RU 70 %, Photophase 12 h). DF = 39.

Prey	Male	Female
Ak + Dm[1]	39.30 ± 4.66 b	65.10 ± 3.75 ab
Sa[2]	49.10 ± 6.41 b	53.20 ± 3.70 b
Rp + Dm[3]	82.00 ± 9.47 a	71.0 ± 4.54 a
Rp[4]	5.2 ± 3.47 b	60.30 ± 1.63 ab
CV	36.27	18.1

[1] *A. kuehniella* eggs for the first and second instars, and *D. melacanthus* eggs for the third instar. [2]*S. avenae.* [3]*R. padi* for the first and second instar, and *D. melacanthus* eggs for the third instar. [4]*R. padi.* [5] Number of larvae. Means followed by the same letter in the columns did not differ by the Tukey test (P < 0.05).

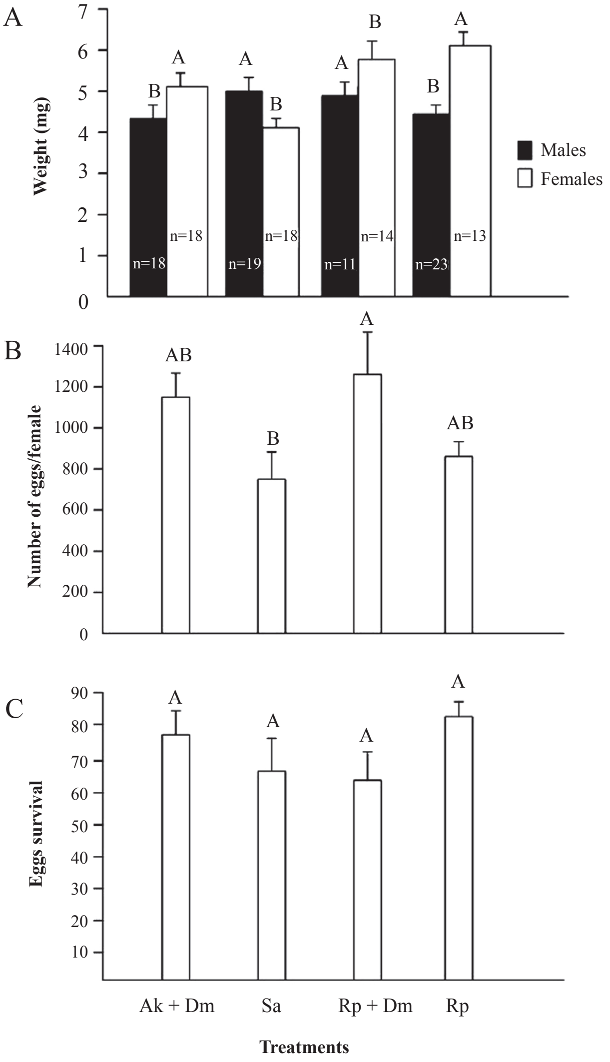

Figure 1. Weight of males and females (mg) (X ± EP) (**A**), number of eggs (X ± SE) (**B**) and survival of eggs (% ± EP) (**C**) of *Chrysoperla externa*, whose larvae were fed on different preys, in laboratory (25 ºC, RU 70 %, Photophase 12 h).
Ak + Dm = *A. kuehniella* eggs for the first and second instars, and *D. melacanthus* eggs for the third instar. Sa = *S. avenae.* Rp + Dm = *R. padi* for the first and second instar, and *D. melacanthus* eggs for the third instar. *R. padi.* Bars with the same letter in the columns did not differ by the Tukey test (P < 0.05).

Noctuidae) and *Helicoverpa zea* (Boddie, 1850) (Lepidoptera: Noctuidae) was previously successfully achieved (Macedo *et al*. 2010). However, providing conditions for *C. externa* development and conservation by feeding on aphis is probably an easier, cheaper and safer way to reduce some pests of wheat crop.

Conclusions

Results reported here evidenced that aphid preys *S. avenae* and *R. padi* present in wheat crop provided satisfactory resources for *C. externa* development and reproduction. *D. melacanthus* eggs also provided suitable performance of *C. externa.* Changing food (*R. padi* to *D. melacanthus* eggs) in the third instar reduced *C. externa* larval survival. Other parameters were not affected or were little affected by the diet change. However, when they were fed with *A. kuehniella* eggs in the first two instars, the food change (*D. metacanthus* eggs) did not affect the biological parameters. This implies that preserving *C. externa* populations which developed feeding on aphids may reduce not only aphids but also *D. melacanthus* and eventually Lepidoptera pests in wheat crop.

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