



Effect of the Insecticides Thiamethoxam and chlorantraniliprole in adults of *Chrysoperla Externa* (Neuroptera: Chrysopidae)

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Abstract – The specie *Chrysoperla externa* is most studied in Brazil due to be strong as potential agent of pest biocontrol. This specie shows good climate adaptation and is founded in various agroecosystems. The insecticides thiamethoxam and chlorantraniliprole are largely used, but, although they have low toxicity, eventually shows dangers to non-targeted organisms, as the crisopidae. Thus, the objective of this study was to evaluate the toxicity of this insecticides in adults of *C. externa*. Was provided to insects a diet with solution in different dosages of the insecticides. Was used five concentrations of each insecticides and a control with distilled water and evaluated after 24, 48 and 72 hours. Of the used concentrations, only 0.59 ng a.i./ µl thiamethoxam, 19.62 ng i.a/µL and 7.87 ng ia./ µl chlorantraniliprole caused mortality of less than 50% of adults. The used concentration 0.59 ng a.i/µl of thiamethoxam caused abdominal distension in insects. Both insecticides cause high mortality in adults of *C. externa*. However, thiamethoxam presented higher toxicity to insects compared to results obtained from chlorantraniliprole treatment.

Keywords – Chrysopods, Chemical Compounds, Neonicotinoides, Diamidas.

I. INTRODUCTION

The Chrysopidae family stands out because they have species that appear as potential pest control agents, since their larvae are predatory predators with a wide spectrum of prey [1], [2]. Because they are primitive insects with complete metamorphosis, adults differ radically from the immature stages of habit, since larvae and adults explore different ecological niches that gives them an evolutionary advantage and can explore several agroecosystems [3].

According to Freitas [1], chrysopods are considered generalist predators, using small arthropods and fine cuticle such as prey, aphids, scale insects, triplets, whiteflies, lepidopteran eggs and caterpillars, mites and small spiders are part of the chain of predation of the chrysopods.

In Brazil, studies on aspects of the biology of chrysopods are restricted to a few species, with emphasis on *Chrysoperla externa* (Hagen) [4], aiming at their inclusion in biological control programs [5]. This species presents great adaptability to climate and adverse conditions, high reproductive potential, tolerance to certain groups of insecticides [6], breeding facility in the laboratory and its larvae possess high search capacity [7], [8]. The eating habits of adults are variable and can feed on pollen, sugary exudates from plants, honeydew and nectar [9].

Although a priority of integrated pest management (IPM) is the use of biological control, often this method is not effective enough to control large populations of pests [10], [11]. Thus, multiple applications of phytosanitary products are carried out in crops with beneficial insect occurrences. It is important to use insecticides that do not cause harmful effects to natural enemies, therefore the need to seek and use selective, innocuous or non-toxic products to chrysopods [12], [13].

Among the insecticides widely used in agriculture are thiamethoxam and chlorantraniliprole, belonging to two different groups, neonicotinoids and anthranilic diamides, respectively. In addition, thiamethoxam acts as a nicotinic acetylcholine receptor in the insect's central nervous system, causing stimulation of the insect's muscular contractions [14], [15]. excessive concentration at low concentrations, receptor blockade, paralysis and death at higher concentrations [16]. Despite the premise of being selective and possessing low toxicity, these insecticides eventually also affect non-target insects [17], [18].

Both classes of compounds present potential risks to non-target organisms such as chrysopods due to their ability to contaminate pollen and floral and extrafloral nectar [19], the main source of *C. externa* adults.

A large number of studies demonstrating the toxicity of insecticides to *C. externa* can be found in the literature, given the scientific interest shown by several research groups to elucidate the implications of toxic properties on the different biological parameters of this insect. However, there is a lack of studies on the toxicity of sublethal concentrations of thiamethoxam and chlorantraniliprole insecticides in *C. externa*. Thus, the objective of this work was to evaluate the toxicity of this species exposed to sublethal concentrations of thiamethoxam and chlorantraniliprole insecticides.

II. MATERIAL AND METHODS

The adults of *C. externa* used were from the maintenance of the Laboratory of Entomology of the Federal University of Lavras (UFLA), where they were kept in a refrigerated room at 24 ± 2 °C, 70% of relative humidity and 12 hours of photoperiod. In this breeding, the larvae were fed with eggs of the *Angara kuehniella* (Zeller). Adults are fed beer and honey (1: 1 ratio), following techniques described by Freitas [3].

Insecticidal solutions were obtained by calculations of

dilution of the commercial doses of the compounds Thiamethoxam (Actara 250WG) and Chlorantraniliprole (Altacor 350WG). Toxicity assays to establish concentrations causing mortality (LC50) were performed at 30 ng a.i./ μL ; 16.66 ng a.i./ μL ; 3.33 ng a.i./ μL ; 0.66 ng a.i./ μL ; 0.59 ng a.i./ μL thiamethoxam and 78.75 ng a.i./ μL ; 52.75 ng a.i./ μL ; 32.75 ng a.i./ μL ; 19.62 ng a.i./ μL ; 7.87 ng a.i./ μL chlorantraniliprole. Evaluations were performed at 24, 48, 72 hours after exposure and the number of deaths counted and subjected to statistical analysis to determine LC50.

Probit analysis [20] was used to obtain the LC50 values and respective 95% confidence intervals (IC-95%). The SAS Proc PROBIT program was used to perform Probit analyzes [21].

The bioassay was performed through ingestion exposure, where an aliquot of 1mL of diet containing the solution of each doses of insecticides was offered to the insects. The control treatment was composed only by diet. The diet was offered by a cotton swab soaked in the insecticide solution deposited on the bottom of cut disposable cups (3 cm high x 1.5 cm diameter).

After exposure to insecticides and diet, each pair was transferred to a PVC cage (7.5 cm in diameter x 8 cm) internally coated with white filter paper, closed at the upper end with organza fabric, attached to a plastic carrier (40 cm long x 20 cm wide x 10 cm high). The experimental design was completely randomized with eleven treatments and five replicates, each one consisting of four adults. Each treatment consisted of twenty adult insects with 24h of emergency.

III. RESULTS AND DISCUSSION

The results showed that the insecticides thiamethoxam and chlorantraniliprole caused mortality of less than 50% at concentrations of 0.59 ng a.i./ μL thiamethoxam, 19.62 ng a.i./ μL and 7.87 ng a.i./ μL to chlorantraniliprole after 72 hours of evaluation (Table 1).

Table 1. CL₅₀ and CL₉₀ of thiamethoxam e chlorantraniliprole em *C. externa* (Neuroptera: Chrysopidae)

Insecticide	CL ₅₀	CL ₉₀	χ^2	Slope	P
THM	1.49 (1.12-3.09)	4.67 (4.67-4.33)	26.68	2.12±0.34	0.08
CHN	0.56 (1.38-2.61)	278.62 (82.81-1.12)	78.70	0.75±0.37	0.05

At concentrations of 30 ng a.i./ μL ; 16.66 ng a.i./ μL ; 3.33 ng a.i./ μL ; 0.66 ng a.i./ μL of thiamethoxam, high insect mortality occurred, reaching 100% in 48 hours after exposure to the insecticide. Similar results were obtained by Godoy et al. [22], in which the adult survival rate of *C. externa* was 22.7% after 4 days of exposure to the insecticide, suggesting high toxicity of this product to adults of this species. These results corroborate with those reported by Rocha [23] when evaluating the selectivity of thiamethoxam (0.5 g/L of a.i.) in adults of *C. externa* collected in the field. In the study, the compound provoked 100% insect mortality and made it impossible to perform fertility and egg viability evaluations of subsequent

generations.

In the treatments performed using the concentrations 78.75 ng a.i./ μL ; 52.75 ng a.i./ μL and 32.75 ng a.i./ μL chlorantraniliprole produced mortality between 70 and 100% after 72 h of exposure to the compound. Studies by Gontijo et al. [24] showed that adults of *Chrysoperla carnea* fed sunflower stems grown from seeds treated with thiamethoxam and chlorantraniliprole had their survival time significantly lower than control (with distilled water) treatment.

In this study, reproductive parameters of *C. externa* were not obtained in the toxicity tests due to the high mortality of females: 90% to 100% after 72 hours of diet fed with both insecticides. Until the end of the evaluations it was verified that, in none of the concentrations used, the insecticides were innocuous to adults of *C. externa*.

The present work demonstrated that both insecticides cause high mortality to adults of *C. externa*. However, thiamethoxam presented higher toxicity to insects in relation to the results obtained from chlorantraniliprole treatment, in less time of evaluation. In a study by Gontijo et al. [24], the mean survival times (LT50) of *C. carnea* were lower in treatment with thiamethoxam than in treatment with chlorantraniliprole.

Although not quantitated statistically in this study, it was observed that in the treatment performed with the concentration 0.59 ng a.i. / μL thiamethoxam, a change occurred in the abdominal region of many insects after 24 h of exposure to this compound (Figure 1A, Figure 1B, Figure 1C). However, it was possible to verify that the females were the most affected by this distension in the abdomen.

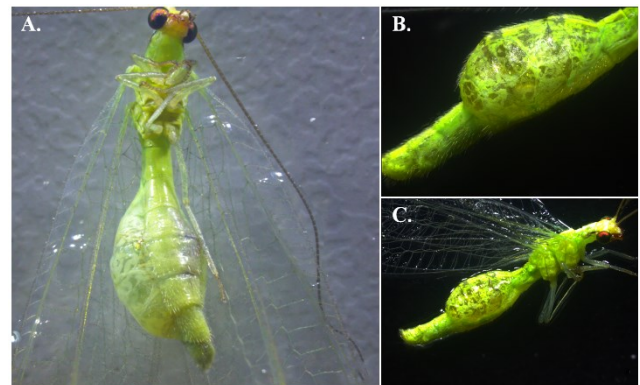


Fig. 1. Abdominal distension observed in females of *C. externa* after feeding with diet treated with the concentration 0.59 ng a.i./ μL of thiamethoxam. A. Ventral view of the female abdomen after 24 hours of insecticide feeding. B. Side view of the female abdomen after 48 hours of feeding with the insecticide. C. Side view of female after 48 h of insecticide ingestion.

The abdominal distension was observed in the first hours after exposure to the insecticide treated food and remained unchanged until the last evaluation. Insects with abdominal distension remained alive, but lethargic and lost their ability to fly, remaining almost inert at the bottom of the cage. Deformations caused by exposure to concentrations of chemical compounds were demonstrated by Moura et al. [25], in *C. externa* in which females presented deformations

of the distal region of the abdomen after exposure to sulfur fungicide.

The explanation of the causes of the distension observed in the abdominal region of *C. externa* treated with the concentration 0.59 ng a.i./ μ L of thiamethoxam was compromised, since there was no use of specific technical analysis to visualize the internal structure of the abdomen.

Considering that the bioassays were carried out under laboratory conditions and with the maximum exposure of the insects to the food containing insecticides, it was possible to verify that, of the insecticides evaluated, the chlorantraniliprole in the concentrations 19,62 ng a.i./ μ L and 7,87 ng a.i./ μ L present low toxicity to this species of chrysopods. In the present study, the use of chlorantraniliprole in the presence of chloroplasts in the presence of chlorantraniliprole was not observed. This low toxicity of chlorantraniliprole can be explained by its high affinity for ryanodine receptors and its structure and conformation of the insecticide molecule [26], [27].

IV. CONCLUSIONS

The insecticides thiamethoxam and chlorantraniliprole caused mortality of less than 50% of *C. externa* adults at concentrations of 0.59 ng a.i./ μ L and 19.62 ng a.i./ μ L, 7.87 ng a.i./ μ L, respectively. Thiamethoxam in concentration 0.59 ng a.i./ μ L is responsible for abdominal distension in adults of this species. Chlorantraniliprole at concentrations of 19.62 ng a.i./ μ L and 7.87 ng a.i./ μ L showed low toxicity to *C. externa*.

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