EFFECT OF SUB-LETHAL CONCENTRATIONS OF PERMETHRIN ON OVARY ACTIVATION IN THE PREDATOR *Supputius cincticeps* (HETEROPTERA: PENTATOMIDAE)

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(With 1 figure)

ABSTRACT

Insecticides may cause mortality and deleterious effects on predatory stinkbugs. For this reason, the effect of five concentrations of permethrin applied on third instar nymphs of *Supputius cincticeps* (Stål) (Heteroptera: Pentatomidae) was investigated on ovary activation in this predator. The nymphs received topical application of permethrin in the following concentrations (mg a.i./ml): 10^{-7}, 10^{-6}, 10^{-5}, 10^{-4}, and 10^{-3}. Ovary lengths and oocyte numbers were quantified following first egg mass. Ovary length of *S. cincticeps* varied from 5.7 mm with 10^{-4} mg a.i./ml, to 6.4 mm with 10^{-7} mg a.i./ml, with similar values for the other permethrin concentrations and for the control. The number of oocytes per female varied from 13.5 with 10^{-3} mg a.i./ml, to 29.2 for the control, with significant differences. The number of oocytes per female of nymphs exposed to a permethrin concentration of 10^{-5} mg a.i./ml was similar to that of the control. However, the lower number of oocytes per female from nymphs exposed to other concentrations of permethrin suggests that this insecticide may affect the reproductive capacity of this predator. The results obtained are discussed in relation to tolerance of Heteroptera predators to insecticides and possible hormesis occurrence.

Key words: hormesis, insecticide insect tolerance, reproduction.

RESUMO

Efeito de concentrações subletais de permetrina na ativação ovariana do predador *Supputius cincticeps* (Heteroptera: Pentatomidae)

Inseticidas podem causar mortalidade e efeitos deletérios em percevejos predadores. Por isso investigou-se o efeito de cinco concentrações de permetrina aplicadas em ninfas de terceiro estádio de *Supputius cincticeps* (Stål) (Heteroptera: Pentatomidae) em sua ativação ovariana. Essas ninfas receberam aplicação tópica de permetrina nas seguintes concentrações (mg i.a./ml): 10^{-7}, 10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}. O comprimento dos ovários e o número de ovócitos foram quantificados após a primeira postura. O comprimento do ovário variou de 5,7 mm na concentração de 10^{-4} mg i.a./ml a 6,4 mm na concentração de 10^{-7} mg i.a./ml, com valores semelhantes para as outras concentrações de permetrina e controle. O número de ovócitos por fêmea variou de 13,5 (10^{-3} mg i.a./ml) a 29,2 no controle, com diferenças significativas entre concentrações. O número de ovócitos por fêmea, proveniente de ninfas expostas a concentração de 10^{-5} mg i.a./ml, foi semelhante àquele do controle. No entanto, o menor número de ovócitos por fêmea, provenientes de ninfas expostas a outras concentrações de permetrina, sugere que esse inseticida pode afetar a capacidade reprodutiva. Esses resultados são discutidos em relação à tolerância de Heteroptera predador aos inseticidas e a possível ocorrência de hormese.

Palavras-chave: hormese, inseticida, tolerância a inseticida, reprodução.

INTRODUCTION

Predatory Pentatomidae (Asopinae) are present in Brazilian homogeneous forests, and *Supputius cincticeps* (Stål) (Heteroptera: Pentatomidae) is an important natural enemy of defoliator caterpillars of Eucalyptus (Zanuncio *et al*., 1994), which suggests its use in biological control (Azevedo & Ramalho, 1999; Wanderley & Ramalho, 1999). In spite of this, research on this possibility in pest management is recent (Zanuncio *et al*., 1996/97, 1998; Aldrich *et al*., 1997; Silva *et al*., 1997).

Studies on stinkbug predators have been increasing, but few data on the impact of insecticides on their functioning and reproduction are available (Zanuncio, 2001). Using natural enemies in pest management programs requires the use of insecticides, which are both efficient against pests and safe for beneficial arthropods, e.g., predators and parasitoids (Guedes *et al*., 1992).

Deltamethrin, fenitrothion, malathion, and permethrin are the main insecticides used to control Lepidoptera defoliators in Eucalyptus plantations (Zanuncio, 2001). In addition, they are selective with respect to the predators *S. cincticeps* and *Podisus nigrispinus* (Dallas) (Heteroptera: Pentatomidae) (Guedes *et al*., 1992; Suinaga *et al*., 1996; Batalha *et al*., 1997; Zanuncio *et al*., 1998). However, the effect of these compounds has not been studied on ovary activation in stinkbug predators exposed to insecticides during their nymphal phase. For this reason, the effect of sub-lethal permethrin concentrations on ovary activation of *S. cincticep*, when applied on third instar nymphs was studied. The purpose was to evaluate this insecticide's impact on predator reproduction.

MATERIAL AND METHODS

The research was carried out at the Laboratory of Biological Control of Insects, of the Instituto de Biotecnologia Aplicada à Agropecuária (BIOAGRO), of the Universidade Federal de Viçosa (UFV), in Viçosa, Minas Gerais State, Brazil. Morphometric data were obtained from the Laboratory of Molecular and Cell Biology of UFV. Laboratory conditions were as follows: 25 ± 1ºC, 65 ± 10% R.H. and L:D (12:12).

A total of 180 *S. cincticeps* second instar nymphs obtained from mass rearing at the Laboratory of Biological Control of Insects (UFV) were placed in Petri dishes (9.0 x l.2 cm) (10 nymphs per Petri dish) and fed *ad lib*. on *Tenebrio molitor* L. (Coleoptera: Tenebrionidae) pupae obtained through mass rearing in the same laboratory. At third instar beginning, nymphs were placed individually in transparent plastic cups (40 ml) where, with the exception of the control insects that were given 1 µl of distilled water, each received dorsally, through a calibrated microsyringe, 1 µl of permethrin (96% purity, from Zenica-Agro (Holambra, SP, Brazil), in the following concentrations (mg a.i./ml): 10^{-7}, 10^{-6}, 10^{-5}, 10^{-4}, and 10^{-3}. These concentrations were used because all nymphs of this predator had died when exposed to concentrations above the highest (10^{-3} mg a.i./ml), while concentrations below the lowest (10^{-7} mg a.i./ml) showed a mortality similar to the control (Zanuncio, 2001). After receiving either insecticide or water, the nymphs were maintained in the conditions previously described until death or emergence as adults.

The adults obtained were mated, and females were transferred to a 4% paraformaldehyde solution of phosphate buffer 0.1 M, pH 7.2, after laying their first egg mass. Ovaries were measured and number of oocytes counted. Data were submitted to variance analysis using SAEG version 5.0 (Gomes, 1985).

RESULTS

Ovary lengths of *S. cincticeps* ranged from 5.7 mm with 10^{-4} mg a.i/ml, to 6.42 mm with 10^{-7} mg a.i./ml (Fig. 1A), with similar values for females obtained from nymphs exposed to different permethrin concentrations ($F = 0.78$; $df = 5,18$; $p = 0.58$). This suggested no effect of insecticide concentrations used on ovary length. Number of oocytes per female varied from 13.5 at 10^{-3} mg a.i./ml, to 29.2 in the control (Fig. 1B), with significant differences registered for concentrations of permethrin ($F = 4.36$; $df = 5,18$; $p = 0.008$). Females obtained from nymphs exposed to higher concentrations of permethrin showed a lower number of oocytes than those of the control (Fig. 1B).

DISCUSSION

Ovary length of nymphs exposed to different permethrin concentrations was similar, which suggests insecticide tolerance such as that observed in *P. nigrispinus* (Guedes *et al*., 1992; Batalha *et al*., 1997) and *Podisus maculiventris* (Say) (Heteroptera: Pentatomidae) (Yu, 1988). The data agree with Zanuncio (2001) who found that only the preoviposition period of *S. cincticeps* was affected by sub-lethal permethrin concentrations.

Tolerance to synthetic pyrethroids may be due to the lower penetration rate of these insecticides into the cuticle, to faster metabolization, and/or to changes in the effects of these compounds in heteroptera (Chang & Plapp, 1983; Yu, 1988).

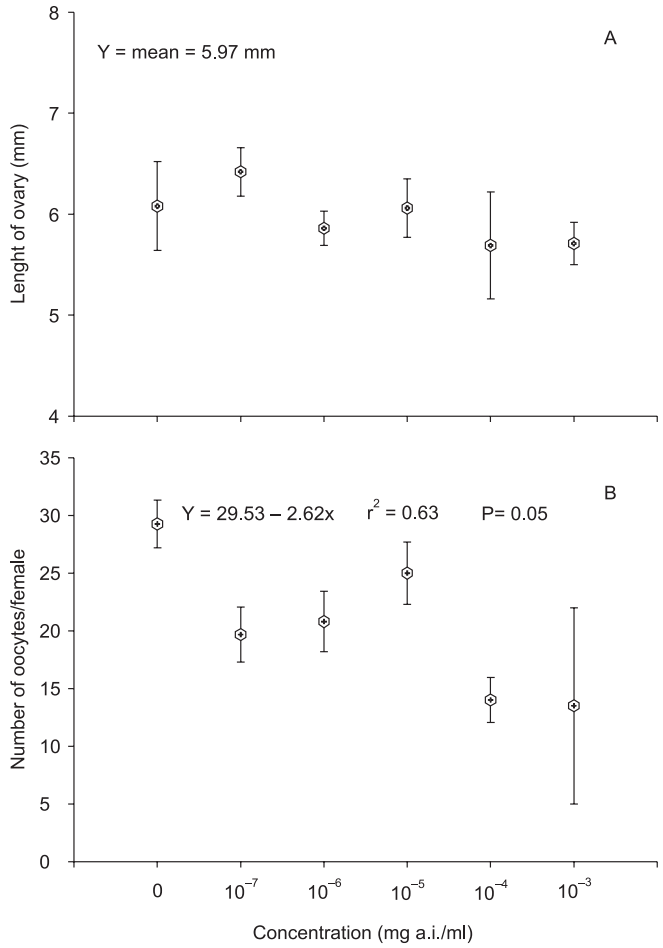

Fig. 1 — (A) Ovary length (mm) and (B) number of oocytes per female of *Supputius cincticeps* (Heteroptera: Pentatomidae) exposed to sub-lethal doses of permethrin in the third instar. 25 ± 1ºC, 65 ± 10% RH and L:D (12:12).

Knowing the limits at which tolerance ends is vital, because some groups of insecticides may cause high mortality and deleterious effects on stinkbug predators, even at sub-lethal doses (Zanuncio, 2001). Insecticides can also affect reproduction and behavior of non-target species, which may cause their suppression locally (Matsumura, 1985).

The number of oocytes varied with permethrin concentrations. However, the number of oocytes per female treated with intermediary concentrations (10^{-5} mg a.i./ml) was similar to that of the control, suggesting that these concentrations were not high enough to affect fecundity. Zanuncio (2001) found a shorter duration of third instar and higher weight in *S. cincticeps* exposed to intermediary sub-lethal permethrin doses. Furthermore, Jusselino Filho (2002) observed a higher number of eggs and nymphs per female of *Podisus distinctus* (Stål) (Heteroptera: Pentatomidae) when they were exposed to different sub-lethal doses of permethrin during the nymph stage, which may indicate hormesis occurrence in these predatory stinkbugs.

Intermediary permethrin concentrations showed reduced impact on the number of oocytes. Insecticides used in integrated pest-management programs may have a stimulating effect or a lower impact on arthropod populations, but incorrect use of synthetic insecticides may eliminate useful insects. Sub-lethal doses of insecticides may increase (Yokama & Pritchard, 1984; Jusselino Filho, 2002) or reduce (Alford & Holmes, 1986) fecundity of insects, depending on the dose and chemical used (Jackson & Wilkins, 1985).

In *P. maculiventris*, longevity and oviposition period were not affected in fifth instar nymphs exposed to sub-lethal concentrations of diflubenzuron and pyriproxyphen (De Clercq *et al*., 1995). Females of

S. cincticeps exposed to sub-lethal permethrin doses laid 50% of its eggs in the first 16 days of adult life, followed by decreasing egg production until the females died, implying a greater reproductive effort by this predator under chemical stress (Zanuncio, 2001).

Although the number of oocytes of *S. cincticeps* with 10^{-5} mg a.i./ml was similar to that of the control, further studies are recommended in order to characterize hormesis occurrence with respect to this reproductive variable. Studies of hormesis on stinkbug predators exposed to sub-lethal doses of insecticides are scarce (Zanuncio, 2001; Jusselino Filho, 2002), indicating a need for further studies on Heteroptera predators. Since the number of oocytes in exposed third instar nymphs was low, additional studies should be carried out on female fertility to evaluate the impact of different permethrin doses on fertility of *S. cincticeps*.

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