EFFECTS OF THE INSECT GROWTH REGULATOR FENOXYCARB ON TWO LACEWING SPECIES IN THE LABORATORY AND FIELD

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SUMMARY

Effects of the insect growth regulator fenoxycarb on two beneficial lacewing species *Chrysoperla carnea* (Neuroptera: Chrysopidae) and *Micromus tasmaniae* (Neuroptera: Hemerobiidae) were investigated under laboratory and field conditions. Fenoxycarb prevented pupation of lacewing larvae in the laboratory and in the field. When used at a concentration of 0.01% in the laboratory tests, successful pupation was reduced by at least 70%. In the field, there was a 60% reduction of *C. carnea* pupal cocoons and a 83% reduction in *M. tasmaniae* cocoons.

Keywords: *Chrysoperla carnea*, *Micromus tasmaniae*, fenoxycarb, side effects

INTRODUCTION

Insect growth regulators (IGRs) differ in their mode of action from most commonly used pesticides. They interfere with insect development and often do not cause instantaneous mortality, but can reveal harmful effects in the long term. They are considered to be more selective and less harmful to non-target organisms, such as beneficial insects, than other pesticides. Therefore they are favoured for use in integrated pest management (IPM). One class of IGRs is the juvenile hormone analogues (JHA). They interfere with the development of the insect larval stages to the adult stage, by inducing the formation of larval-pupal intermediates (Mulye and Gordon 1989), or by promoting the formation of permanent or supernumerary larval instars (Gadenne *et al.* 1990; Villar *et al.* 1987). Short term mortality tests are a common way of assessing the effects of pesticides on beneficial insects, but these tests are not usually suitable for IGRs, which often do not kill the insect quickly.

The JHA fenoxycarb has been recommended for use in IPM systems in orchards, against lepidopteran pests (Charmillot and Blaser 1985; Solomon and Fitzgerald 1990). In this study the side effects of fenoxycarb on the development of two beneficial lacewing species *Chrysoperla carnea* (Neuroptera: Chrysopidae) and *Micromus tasmaniae* (Neuroptera: Hemerobiidae) were determined under laboratory and field conditions. A preliminary report on some aspects of this research has been published elsewhere (Rumpf *et al.* 1992; Vogt 1992).

MATERIAL AND METHODS

Insect rearing

Optimum rearing conditions were chosen for each species: the green lacewing *Chrysoperla carnea* was reared at 24°C, 60% R.H. and a photoperiod of 16 h. The same relative humidity and photoperiodic conditions were applied in the rearing of the brown lacewing *Micromus tasmaniae*, using a temperature of 18°C. Larvae of the green lacewing were reared on *Sitotroga cerealella* (Lepidoptera: Gelechiidae) eggs, larvae of the brown lacewing were reared on pea aphids (*Acyrthosiphon pisum*). Lacewing adults were fed on an artificial diet consisting of a mixture of honey, yeast and water (Hassan 1974). To provide the brown lacewing with fresh pea aphids, a small bean plant was added to the rearing container. The roots of the plant were wrapped in wet cotton wool and covered with parafilm to ensure fresh plant material for the aphids.

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The lacewings were kept in plastic containers, and the eggs were laid on a piece of linen cloth added to the container. The rearing was carried out every second day.

Laboratory trial

Glass plates (44x51 cm) were sprayed with 0.01% fenoxycarb (Insegar). The amount of active ingredient applied was $0.2 \pm 0.1 \mu\text{g}/\text{cm}^2$. Control plates were sprayed with water. After the glass plates had dried, they were covered with an acrylic glass plate, in which 30 holes (each 7.3 cm in diameter) had been drilled. 1.5 cm high Polystyrol rings were treated with Fluon and placed in the holes. Fifty green or brown lacewing larvae (end of second/beginning of third instar) were placed in these polystyrol receptacles (one per receptacle) per treatment. Fresh aphids for *M. tasmaniae* larvae and *S. cerealella* eggs for *C. carnea* larvae were supplied daily and the larvae were monitored every 24 h until they had either died or developed into adults. To determine whether or not a larva had pupated, the transparent cocoon was examined to detect larval moult skin. The experiments with *C. carnea* were carried out in Germany in 1990; the trials with *M. tasmaniae* in New Zealand in 1992.

Field test

Two field trials were conducted. The first was carried out on *C. carnea* in Germany in spring, May 1990. Weather conditions were mostly sunny and warm (27°C) during the trial. Four hundred second to third instar *C. carnea* larvae were released in each of twelve replicates prior to the application of fenoxycarb. A second trial with *M. tasmaniae* took place in New Zealand in autumn, March 1991. Temperatures were cooler than those in the first trial and weather conditions were mixed with sunny and overcast periods as well as some rainy days. The trial with *M. tasmaniae* consisted of five replicates, each with 500 second to third instar larvae. In both trials the replicates were randomised and consisted of one young apple tree (2 to 3 years). The larvae were released onto leaves, at various sites of the trees in both field tests. After the larvae had been released, the trees were sprayed with fenoxycarb (0.01%, with 150 g/ha) and the control trees with water to the point of run off, using a knapsack handsprayer.

Baitcards were attached to the trees 24 hours later. These baitcards allow recapture of surviving larvae and offer the larvae a hiding place for pupation (Vogt *et al.* 1992). They were made of velvet cardboard (4x5 cm pieces), which was folded like a fan and placed into small plastic tubes. The tubes were fixed to the branches of the trees by pegs (Vogt *et al.* 1992). For the experiment with *C. carnea* the bait cards contained *S. cerealella* eggs as an attractant and food source during the field trial, while for the experiment with *M. tasmaniae* they contained pea aphids. The number of larvae in the baitcards was counted daily and the larvae were put back onto the trees. The baitcards were also checked for cocoons. These were counted and taken to the laboratory for further observation.

RESULTS

Laboratory trial

At the recommended field rate (0.01%), fenoxycarb completely prevented pupation of *C. carnea* larvae. The lacewings remained in the larval state for 4 to 6 weeks before they died. At the same concentration of fenoxycarb, all *M. tasmaniae* larvae started to develop pupal features underneath their larval cuticle (such as complex eyes and swollen wing segments), but only 24% of those larvae managed to carry out the pupal moult, and only 4% of all larvae developed into adults.

Field test

The number of pupal cocoons found on the fenoxycarb treated trees was, for both lacewing species, significantly lower than the number of cocoons found on the water treated control trees (Figs. 1, 2). A 60% reduction of *C. carnea* pupal cocoons (Fig. 1) and a 83% reduction in *M. tasmaniae* pupal cocoons (Fig. 2) was detected. These results correlate with the number of larvae recaptured from the trees. There was a rapid decline in larval numbers on the untreated control trees, as larvae pupated, whereas the number of larvae found on the fenoxycarb treated trees declined at a much slower rate (Fig. 3).

Figure 1: Number of pupal cocoons of *C. carnea* recovered from apple trees treated with fenoxycarb in a field trial in Germany.

Figure 2: Number of pupal cocoons of *M. tasmaniae* recovered from apple trees treated with fenoxycarb in a field trial in New Zealand.

Figure 3: Number of *M. tasmaniae* larvae recovered from apple trees treated with fenoxycarb in a field trial in New Zealand.

DISCUSSION

Fenoxycarb has been promoted as a selective pesticide with few side effects on beneficials, which is therefore suitable for IPM (Charmillot and Blaser 1985; Solomon and Fitzgerald 1990). However, studies have revealed that fenoxycarb may not be so selective. For example, Grenier and Plantevin (1990) showed that fenoxycarb causes high mortality on the larvae of the tachinid parasitoid *Pseudoperichaeta nigrolineata* (Diptera: Tachinidae), contrary to results reported by Stäubli *et al.* (1984). Moreno *et al.* (1993) found fenoxycarb to be very harmful to larvae and pupae of the parasitic hymenopteran *Phanerotoma ocularis* (Braconidae).

In this study fenoxycarb also proved to be harmful to the larvae of both lacewing species, under laboratory and field conditions. Because it caused a significant reduction in the successful formation of pupae under laboratory conditions, the number of pupae was used to evaluate the harmful effects of fenoxycarb in the field. However, the impact of fenoxycarb under field conditions can vary, depending on the weather, time of year and other parameters. Comparison with other fenoxycarb field and semi - field trials (Rumpf 1990; Rumpf *et al.* 1992) with the green lacewing, has shown how variable the results can be in different weather conditions.

In conclusion, this study showed that fenoxycarb causes serious deleterious side effects on the two beneficial lacewing species, *C. carnea* and *M. tasmaniae*, under both laboratory and field conditions, through the inhibition of metamorphosis. These results have important implications concerning the need for a re-evaluation of the use of this JHA in IPM systems where these beneficials have an important role as predators. Furthermore, whilst IGRs, such as fenoxycarb, might not cause as severe short term mortality of beneficials as do broad spectrum pesticides, careful studies on the long term effects of such chemicals should be carried out before final conclusions on their selectivity can be made.

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