The effects of chlorfluazuron (Helix™) on the development of the parasitoid *Microplitis demolitor* (Braconidae) and its host *Helicoverpa armigera* (Noctuidae).

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Introduction

Microplitis demolitor (Hymenoptera: Braconidae) is a mid to late season parasitoid of *Helicoverpa spp*. larvae. Female *M. demolitor* prefer to lay eggs in second instar larvae. The host larva is killed before serious damage has been done to the crop and where any reasonable reduction in numbers will be important. Parasitised larvae effectively stop feeding and consume only about 10% of that consumed by healthy larvae (Murray and Rynne, 1992). Numbers of *M. demolitor* can build up very rapidly in the field.

The cotton industry is committed to reducing the use of insecticides because of the economic and environmental costs. With the imminent release of Bt cotton, a very real reduction in insecticide use is expected. Due to reduced expression of Bt toxins in Bt cotton late season (Fitt, 1996), the action of natural enemies should be encouraged at this time. Use of insecticides that disrupt natural enemies should be reduced, however, data on the effects of many insecticides on beneficial insects are lacking under Australian conditions.

The purpose of this study was to investigate the effects of chlorfluazuron (Helix™) on the development of the parasitoid *M. demolitor* and it's host *H. armigera*. Helix was proposed for late season use on cotton, so it's effects on *M. demolitor* were the original focus of this project. Helix is a moulting inhibitor which does not exercise a knock-down effect on the target insect. Therefore, the sub-lethal and lethal effects on both unparasitised and parasitised *H. armigera* were examined. The direct effects of Helix on adult parasitoids were also examined.

Materials and Methods

Insects

Both *M. demolitor* and *H. armigera* were maintained as laboratory cultures at the QDPI Toowoomba.

Dosing

Toxicity was assessed using a diet incorporation method which preliminary investigations showed was the most convenient and reliable way of delivering a standard stomach poison dose to each larva. Helix was diluted in distilled water to the desired concentration and then mixed with standard diet (Teakle and Jensen, 1985). This solution was poured into 12-well tissue culture trays. Second instar *H. armigera* larvae were confined on the diet.

Sub-lethal effects

Pupation of non-parasitised *H. armigera* larvae was the criterion used to determine survival. Extensive preliminary work determined a range of 8 doses which produced a range of mortality between 0-100%. Data were analysed using Probit5 for Windows (Gillespie, 1995). Newly parasitised larvae were then exposed to the same doses and examined until pupation, death or the internal parasitoid emerged.

Lethal effects

The lethal effects were examined as above except that the criterion for determining survival was a coordinated response when prodded 8 days after exposure to the insecticide. A discriminating dose (LD99) was determined from the dose response curve. The effects of parasitisation by *M. demolitor* were examined by exposing groups of parasitised larvae (0-7 days after parasitisation) to the LD99. Survival was scored after 8 days.

Direct effects on adult *M. demolitor*

Adult parasitoids were topically dosed (0.5 µL) to the pronotum with the desired concentrations of acetone-diluted technical grade chlorfluazuron. Survival was assessed after 3 days.

Results

Toxicity data (i.e. LD50, LD90, upper fiducial limits, lower fiducial limits and slopes of the dosage- mortality lines) for the sub-lethal and lethal doses are listed in Table 1. The lethal dose is approximately 4 times higher than the sub-lethal dose. Other sub-lethal effects included delayed pupation and deformed wings of many of the surviving adults.

Table 1. Toxicity data for sub-lethal and lethal doses of Helix to *H. armigera.*

Dose	LD50*	UFL*	LFL*	LD99*	UFL*	LFL*	Slope
Sub-lethal	.000215	.000223	.000207	.000461	.000565	.000425	5.816
Lethal	.000861	.000940	.000788	.00174	.00219	.00139	6.230

*** Values are in grams of active ingredient/ Litre (g ai/L).**
UFL= Upper fiducial limits.
LFL= Lower fiducial limits

Parasitised larvae exposed to the range of sub-lethal doses were not killed by the insecticide, but produced a parasitoid. Larvae which were parasitised 0-3 days before exposure to the lethal LD99 were killed by the insecticide. However, larvae which were parasitised 4 days or more before exposure to the LD99 survived and produced a parasitoid.

Adult parasitoids survived 0.5 µL topical doses of 100 g ai/L. This was the highest concentration before the technical grade product became insoluble in acetone.

Discussion

This study indicates that Helix is likely to have only a minor effect on *M. demolitor* populations. Parasitised larvae exposed to a sub-lethal dose will successfully produce a parasitoid, larvae parasitised 4 days or more before exposure to a lethal dose will produce a parasitoid and adult parasitoids could not be killed by topical dosing with Helix. Although it is difficult and unwise to extrapolate laboratory results into the field, these data indicate that after a field has been sprayed with Helix, large numbers of parasitised larvae, as well as the adult parasitoids present in the field, will survive and parasitise more *H. armigera* larvae.

H. armigera larvae which receive a sub-lethal dose of Helix are most probably producing a parasitoid because the host is surviving subsequent moults, allowing the developing internal parasitoid, which is also unaffected by Helix, enough time to complete development. Parasitised larvae given 4 days or more development time before exposure to lethal doses of Helix produce a parasitoid. These results agree with the study of Murray *et. al.* (1995), who found that parasitised larvae exposed to lethal doses of nuclear polyhedrosis virus produced a parasitoid if given at least 3 days development time before the host was exposed to the virus. An explanation as to why this is happening may be that feeding by larvae 4 or more days after parasitisation has slowed or stopped. This means that the larva and the developing internal parasitoid receive a smaller or no dose. It is unclear whether this explanation is correct or whether host larvae are becoming more tolerant due to effects of the larval parasitoid on the host's metabolism. This aspect is being investigated by topical application of Helix to parasitised larvae.

Although parasitoids survive to pupation, there may be adverse effects on adult behaviour, fecundity, vigour or longevity that have not been determined.

The efficacy of Helix against *H. armigera* has been established during field usage up to the 1993/1994 season. The data generated by our study suggest that Helix offers the additional benefit of conserving populations of *M. demolitor* at a time when their contribution to larval mortality is often considerable. Thus, Helix has an important place in integrated pest management programs (IPM) along with *M. demolitor* which, due to it's late season activity, may become crucial to Helicoverpa control with the introduction of Bt cotton.

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