PYRETHROID RESISTANCE IN *HELIOTHIS ARMIGER*

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Introduction

Insecticides have provided spectacular control of cotton pests and have enabled the production of a high yielding quality product. However, the intense selection pressure has led to the development of insecticide resistance i.e. insects with the ability to survive treatments which were initially lethal. Since the factors which confer resistance are inherited, sustained use of the same insecticide may increase the frequency of resistance genes amongst the survivors and ultimately cause spray failures. There is now an increasing awareness that insecticide resistance poses a threat to the long-term viability of the cotton industry.

Resistance Mechanisms

Insecticide resistance can arise from many factors including:

- reduced insecticide penetration
- changes in the rate of insecticide activation or detoxification (metabolism)
- alteration in target site sensitivity.

Reduced penetration and metabolic factors appeared to be implicated in the development of insecticide resistance to DDT in 1972/73 (Sucksoong 1979). Thus, structurally unrelated synthetic pyrethroids initially provided excellent control of DDT resistant *H. armiger*, despite the fact that both insecticides acted on the same target site (nerve permeability). On the other hand, the recent spray failures at Emerald in 1983 were caused by target site insensitivity, so called kdr. As a consequence pyrethroid resistant larvae were cross resistant to all insecticides affecting nerve permeability, including DDT and endosulfan.

In addition to kdr, a penetration factor was identified in pyrethroid resistant *H. armiger*, presumably due to some change in the insect integument. Using radiocarbon labelled cypermethrin it was possible to differentiate between susceptible and resistant *H. armiger* on the basis of the rate of insecticide penetration through the integument and its concentration in the haemolymph (Figure 1). Similar results were obtained with another widely used pyrethroid. fenvalerate. These data indicate resistance may involve two or more factors acting in concert.

Implications for Future Control Strategies

DDT resistance in *H. armiger* persisted for many years after cessation of its use (Wolfenbager *et al.* 1981). It is likely therefore that a sustained effort on behalf of cotton growers will be needed if the synthetic pyrethroids are to be conserved. To date the only practical means to secure control of *H. armiger* with the kdr factor has been to change to an insecticide with a different mode of action. Unfortunately, the high cost associated with the development of new insecticides has severely limited the number of alternatives to the pyrethroid/endosulfan group. Currently there are the organophosphate and carbamate insecticides which inhibit the enzyme acetylcholinesterase and chlordimeform which is believed to inhibit amine metabolism. Rotation of these groups in conjunction with limitations on pyrethroids form the basis of the present pyrethroid strategy.

With increased use, resistance may develop to the acetylcholinesterase inhibitors. To deal with this, monitoring of acetylcholinesterase sensitivity and metabolism of acetylcholinesterase inhibitors is being initiated. However, in view of the potential problem facing the cotton industry, all available means should be employed to prevent a deterioration in the present situation. Steps should be taken to:

- continue surveillance and identification of resistance mechanisms.
- support the current pyrethroid strategy
- comply with regulations governing the use of chlordimeform
- adopt the SIRATAC integrated pest management programme and adhere to pest threshholds.
- use shorter season cotton varieties, preferably those with some tolerance to *H. armiger*
- develop more effective microbial toxins derived from *Bacillus thuringiensis* (BT) or pathogenic agents like the Polyhedrosis virus.

It is likely that growers will be faced with the prospect of living with insecticide resistance. Nevertheless, if the appropriate remedial actions are adopted on an industry wide basis, economic injury to crops may be prevented.

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References

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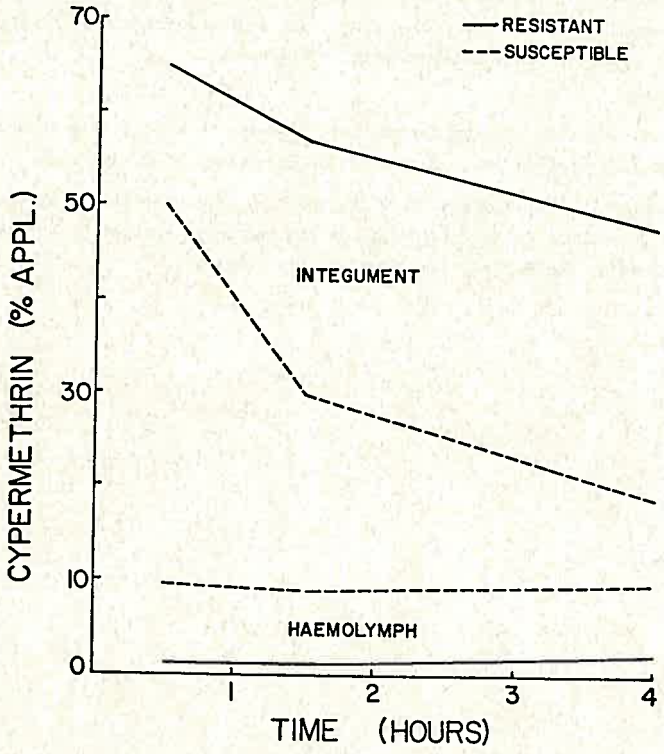

Figure 1. Penetration and accumulation of ^{14}C-cypermethrin in *H. armiger*. Pyrethroid susceptible Ex Narrabri
resistant Ex Emerald