MECHANISM OF RESISTANCE TO ORGANOPHOSPHATE INSECTICIDES IN *HELICOVERPA ARMIGERA*

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Abstract

Organophosphate insecticides are valuable insecticides used to control *Helicoverpa armigera* on cotton in Australia. Organophosphates most commonly used for *Helicoverpa* spp. control, are profenofos, methyl parathion and chlorpyrifos. However, there is an emerging organophophate resistance threat in Australian *H. armigera* ,which is compounded by cross resistance between profenofos and methyl parathion. An insensitive acetylcholinesterase has been identified as the common resistance mechanism. No resistance to chlorpyrifos has been detected and acetylcholinesterase remains fully sensitive to chlorpyrifos and its oxon.

Introduction

Insecticide resistance in *Helicoverpa armigera* is an enduring threat to the economic production of cotton in Australia. Chemical insecticides are currently essential for the control of *H. armigera* on cotton and are likely to remain an important component of control strategies for the foreseeable future. The development of resistance had been delayed by an insecticide resistance management strategy for *H. armigera* , but levels of resistance have gradually increased . Organophosphates have long been used for *H. armigera* control and are effective larvicides but they were not routinely used on cotton since more cost effective insecticides were available. However, as resistance to pyrethroids, endosulfan and carbamates has increased, so has the use of alternative chemicals such as the organophosphates, particularly late in the cotton growing season.

Results

While resistance to profenofos was detectable from time to time by bioassay, organophosphate resistance did not give control problems in the field. More recently, however, increasing resistance of *H. armigera* to alternative control chemicals such as endosulfan, pyrethroids and carbamates has resulted in an expanded use of the organophosphates (methyl parathion, profenfos and chlorpyrifos) on cotton and other crops and, as a consequence, there is an emerging and serious field resistance problem in Australia. This situation has been compounded by bioassay studies which indicate cross

resistance between profenofos and methyl parathion in H. armigera. Selection of field collected *H. armigera* by profenofos resulted in a high level of resistance in third instar larvae, to both profenofos (92 fold) and methyl parathion (52 fold). *H. armigera* larvae remain susceptible to chlorpyrifos.

Biochemical studies have identified an insensitive acetylcholinesterase (AChE) as the resistance mechanism causing resistance to methyl parathion and which presumably causes cross resistance between the methyl parathion and profenofos in Australian *H. armigera*. AChE from the profenofos resistant *H. armigera* was approximately 8 times less sensitive to inhibition by methyl paraoxon, and was also less sensitive to inhibition by profenofos, compared to the AChE from susceptible *H. armigera*. Acetylcholinesterase remains fully sensitive to chlorpyrifos. It is not yet clear how this is associated with insensitiv AChE responsible for methomyl and thiodicarb resistance, recently reported in this species.

Conclusions

While organophosphate resistance has been known for some time in Australian *H. armigera*, there has recently been an expanded use on cotton, of profenofos, methyl parathion and chlorpyrifos, (due to poor control with other insecticides and the variable performance of transgenic cotton). As a consequence, the frequency of profenofos resistant *H. armigera* has increased but fortunately, *H. armigera* remain susceptible to chlorpyrifos. Management strategies have proposed to limit the use of organophosphates. Studies also indicate that this resistance is associated with a real fitness deficit, resulting in slower larval growth which, combined with the judicious use of chlorpyrifos as an alternative insecticide may further retard the development of further field resistance problems.

A resistance mechanism, detectable by colorimetic analysis gives the opportunity for rapid field-based biochemical resistance detection. Such methods are already in use for the rapid diagnosis of pyrethroid and carbamate resistance in *H. armigera* . Since studies indicate that frequencies of profenofos resistant *H. armigera*, as detected by discriminating dose bioassay or by biochemical assay for AChE insensitive to methyl paraoxon are identical the detection of this resistance mechanism may lead to a rapid field based detection of OP resistance in *H. armigera*.

Figure 1
Inhibition by methyl paraoxon of Acetylcholinesterase from organophosphoros susceptible and resistant strains of H. armigera.

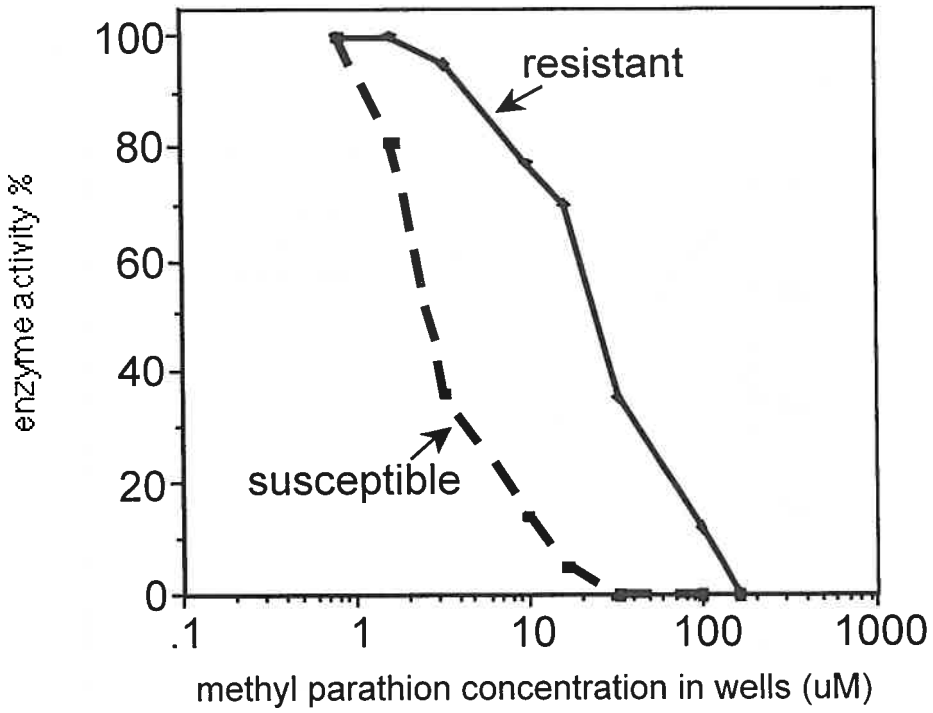

Figure 2
Inhibition by chlorpyrifos-oxon of Acetylcholinesterase from organophosphorous susceptible and resistant strains of H. armigera.