Helicoverpa insecticide resistance: Management for the grain industry

By Louise Rossiter, NSW Department of Primary Industries

The development of insecticide resistance is a major limitation to successful pest control in crop production in Australia. Resistance at the field level results in reduced efficacy of insecticide applications, leading to increased spraying and reduced chemical options. Insecticide resistance represents a significant economic cost to growers particularly when more expensive chemistries and mixtures become necessary for control. Increased spraying also represents an environmental threat, and has social implications, particularly in areas close to towns.

The Australian cotton industry has been supporting insecticide resistance monitoring and associated research for over 25 years in an effort to manage insecticide use and maintain the efficacy of all available chemistries. Recently, the Grains Research and Development Corporation has increased their support of this research. With Helicoverpa a major pest of grain and pulse crops, insecticide resistance management, is as important for the grains industry as it is for cotton.

The registration of some key insecticides in grains, cotton and pulse crops means there is increased selection pressure for resistance with potential use extending from spring through to autumn, targeting successive generations of Helicoverpa.

Of particular interest in terms of monitoring for the development of resistance are Steward (indoxacarb) and Tracer (spinosad). Both these products are registered in cotton, and in several pulse crops including chickpeas, soybeans and mung beans.

Tracer is also registered for use in sorghum and both chemicals currently hold minor use permits in a small number of other grain crops in some states (for more details see the APVMA website). Large plantings of these pulse crops (chickpea plantings in 2004 were 200,000 hectares in northern NSW alone) can mean significant selection for resistance if insecticides are required for control.

What we do to monitor for resistance

The insecticide resistance monitoring program for *Helicoverpa armigera* (cotton bollworm, corn earworm) is based at the Australian Cotton Research Institute at Narrabri, and aims to measure resistance frequencies of field populations collected from Central Queensland through to the Riverina area of NSW.

Testing for Helicoverpa insecticide resistance at the ACRI, Narrabri.

Field collections of Helicoverpa eggs are reared in the laboratory and larvae are tested with doses of insecticide that are known to kill susceptible insects. Survivors are considered to be resistant.

The tested insecticides incorporate the key chemistries used within the cotton farming system, with a number of these also used in grains and pulse crops. Eggs are collected from all available hosts including sorghum, maize, chickpeas and other pulses, sunflowers and cotton. These data are used to determine regional resistance frequencies to identify any changes in resistance.

In the event of increasing resistance frequencies, we work with the industries involved to develop management strategies that will avoid widespread field failures of insecticides.

Both *H. armigera* and its native counterpart *H. punctigera* (native budworm) are tested for resistance – but the native budworm is yet to present a resistance problem. The absence of resistance in *H. punctigera* is generally attributed to its large annual spring immigration into agricultural areas from areas of central Australia where they are not exposed to insecticides.

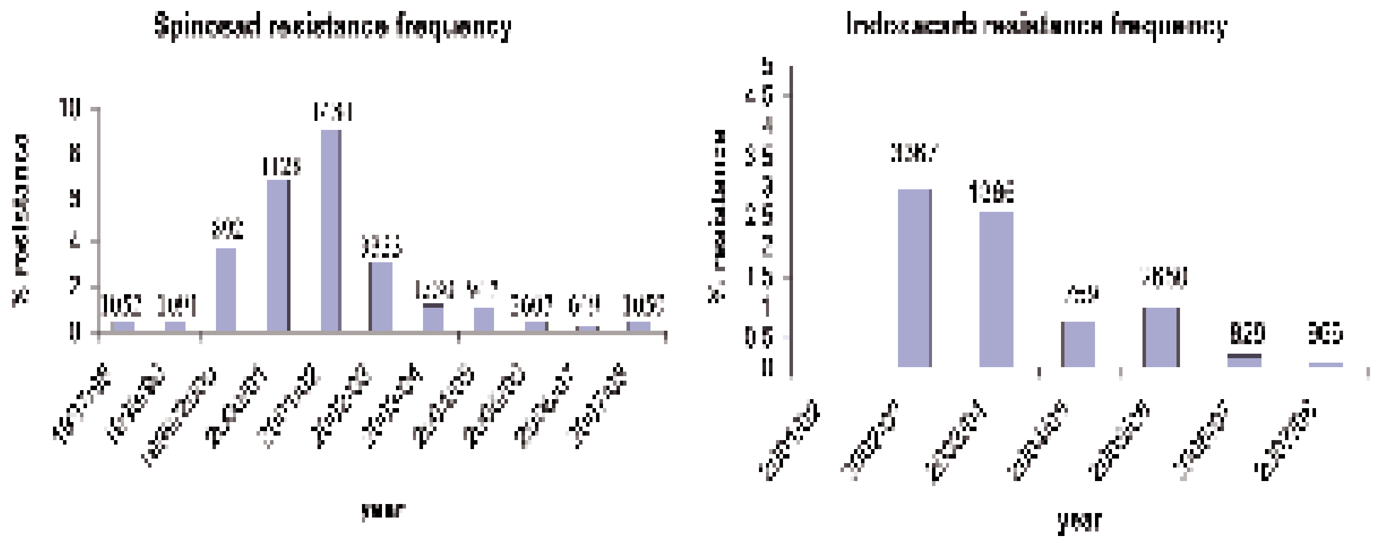
These large numbers of *H. punctigera* dilute any resistance that may be present in local populations from the previous season.

On the other hand, *H. armigera* is highly migratory locally, but remains within agricultural regions from one season to the next, surviving the colder temperatures of winter in a pupal diapause and emerges in spring.

The exception to this occurs in Central Queensland where the warmer winter allows *H. armigera* to continue its life cycle through winter without going into diapause.

Both scenarios allow for resistance carryover between seasons.

FIGURE 1: Spinosad (Tracer) and Indoxacarb (Steward) resistance frequency trends since registration in Australia



MONITORING RESULTS

Overall Helicoverpa pressure this season (spring 2007 to autumn 2008) was reasonable, with early season *H. punctigera* collected from various pulse crops in late August – early September.

Collections from maize and sorghum indicated *H. armigera* were present in November–December but collections from cotton in December indicated *H. punctigera* to be the dominant species (note: maize and sorghum only attract *H. armigera*).

Collections in January and February showed an increasing species dominance by *H. armigera*, although *H. punctigera* continued to be collected. Collections were primarily from the Gwydir and Namoi Valleys by staff located at Narrabri, with other areas relying on collections from CRDC supported collectors as well as industry contributions.

Overall, the monitoring results for 2007–08 suggest positive effects on the insecticide resistance status of *H. armigera*. Resistance frequencies for most of the tested chemistries were similar to or reduced from previous seasons.

This result may be due to various factors such as reduced and more strategic insecticide use, widespread uptake of Bollgard II (GM cotton with 'built-in' Helicoverpa resistance) within the cotton farming system (thereby reducing insecticide spraying), resistance management strategies and integrated pest management.

Tracer

Results for Tracer (spinosad) were encouraging with few survivors detected, which is a similar result to the past three seasons. As one of the first IPM compatible chemistries registered for use in cotton, it was used extensively in the late 1990s, which resulted in increases in resistance frequencies (Figure 1) and reports of control problems occurring in the field.

As a result of management tactics including restrictions within the cotton insecticide resistance management strategy (IRMS) and reduced use for various other reasons, the trend of increasing resistance has been reversed to the extent observed this season.

Steward

Resistance management for Steward (indoxacarb) has contributed to the low resistance frequencies that have been observed since its introduction into cotton (Figure 1). Like Tracer, few survivors were detected in the resistance monitoring program over 2007–08. Resistance development remains a major concern given its registration in a number of pulse crops, and is a threat that needs to continue to be managed.

Other insecticides, including various older chemistries within the organophosphate, carbamate and synthetic pyrethroid groups, are included in the monitoring program. But few of these specifically tested are registered for use in grains and pulse crops.

Resistance frequencies for these chemistries tend to vary according to use patterns, but results from 2007–08 indicate similar, and in some cases reduced frequencies to those found last season.

MANAGEMENT TACTICS

Resistance management for Helicoverpa is based on limiting the exposure to any insecticide group to one generation. The average time taken for Helicoverpa to complete its life cycle is 42 days. So ideally, to avoid selection across multiple generations an insecticide should only be applied across a 42 day period.

Within a mixed farming system involving various crops with different growing seasons (which can also vary geographically) such limitations are not practical.

To minimise the impact of the longer use period, the current IRMS for cotton allows insecticides to be used for longer than 42 days with a restriction on the maximum number of applications to encourage rotation with other insecticides.

For other crops, the restriction on the number of applications is included on the label of some insecticides, including Tracer and Steward. It is important to realise that these label restrictions are an important component of resistance management, designed to maintain the long term efficacy of the product.

To a limited extent, the cotton IRMS incorporates likely use of Tracer and Steward in non-cotton crops, and is therefore a useful tool for grain growers in a mixed cotton–grain system.

For example, the IRMS limits Steward and Tracer use on chickpeas to before October 15 (September 15 for Central Queensland) to allow for a period longer than 42 days between use on chickpeas and cotton. This gap in use allows time for other chemistry to be used to kill any resistant insects that may have been selected on chickpeas.

The opportunity exists to further integrate grain and cotton insecticide management strategies.

Knowing whether you are dealing with *H. punctigera*, *H. armigera*, or a mixed population is important in making deci-

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sions about insecticide use. *H. punctigera* has not presented the resistance problem of *H. armigera* and remains susceptible to the range of insecticides used against it, including those that have been used long term such as the synthetic pyrethroids.

Clues to the relative abundance of *H. armigera* and *H. punctigera* are:

- The size of the spring immigrations of *H. punctigera*, as recorded in local pheromone traps;
- The timing of the spring emergence of *H. armigera* from diapause – the new Helicoverpa Emergence Model can be used to predict when this will occur in your district; and,
- The crops – maize and sorghum are hosts only to *H. armigera*, so control in these must target this species.

Also, in Central Queensland, *H. armigera* populations are present all year round due to the absence of a diapause state.

As an end of season non-chemical management tool, pupae busting is effective at reducing carryover of resistant insects to the next season. It is equally important in grain, pulse and cotton crops that have had Helicoverpa pressure and been sprayed.

Growers should consider pupae busting fields that may potentially harbour insecticide resistant Helicoverpa pupae. The rule of thumb is that at risk crops are those which still have Helicoverpa larvae in them by mid March when the cooler weather initiates diapause in *H. armigera*.

This research is supported by the GRDC and CRDC. For more information contact Dr Louise Rossiter, NSW DPI, Narrabri ph 02 6799 2428 or louise.rossiter@dpi.nsw.gov.au ■

GRDC on the lookout for innovative research partners

The Grains Research and Development Corporation (GRDC) is seeking partners to help drive its research priorities and increase farm profitability and sustainability.

Farming systems groups and research organisations have been invited to tender for projects outlined in the GRDC's Investment Plan 2009–10 (open and multi-stage tender).

GRDC chairman Keith Perrett said the plan was an opportunity for prospective research partners to work with the GRDC to ensure that Australian grain producers were provided with technologies and practices enabling them to compete effectively in global grain markets.

"The GRDC will continue to focus investments on the development and adoption of technologies and practices that will meet our stakeholders' needs and enable the Australian grains industry to remain globally competitive," Keith said.

"Our investment plan addresses climate change, productivity growth, supply chains, markets, natural resource management, biosecurity, innovative skills and technology development."

Keith also flagged changes to the electronic application forms – known as 'e-forms' – research partners used to apply to the GRDC for funding.

KEY POINTS

- GRDC calls for applications from potential research partners
- Investment plan priorities include productivity, natural resource management and climate change
- Tenders close at 2pm AEST, October 2.

"The e-forms have been updated as part of the continual improvement of GRDC processes," he said. "The updated forms now capture information on environmental, social and economic risks and benefits, and include additional spatial and crop-type information that will assist us in reporting research outcomes. These changes will also apply to project specification, progress reports and final reports." ■

GRDC chairman Keith Perrett.