USING PREDATORS AND PARASITES TO CONTROL COTTON PESTS

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Introduction

Production of cotton in Australia is very dependent on insecticides for the control of the major pests, *Helicoverpa* spp., mites and sucking insects. This approach has resulted in even greater reliance on insecticides because of pest resurgence and the need to control secondary pest outbreaks. For many years now some researchers have been espousing a view that beneficial insects - predators and parasites - are important in the management of some of these pests. However, disruption by insecticide sprays has often negated any effect beneficials might have in managing pest populations. Despite intensive research over many years to quantify the importance of beneficial insects, it seems we are still a long way from understanding just how effective they are. In fact there are some mixed messages emerging from recent research (Stanley and Gregg 1994).

According to Robert Mensah, NSW Agriculture, these mixed messages have come about because most researchers have evaluated the performance of beneficial insects only on the number of prey individuals can eat, grouping them as important or non-important. However the significance of predation to prey populations depends upon (1) the total number of predators present and (2) the predators ability to find and consume prey. For example, individual predators may consume only small numbers of prey; however, if predator density is high relative to prey density then predators may cause significant mortality in prey populations. Conversely, individual predators may consume large numbers of prey, but if predator density is low relative to prey density the overall effect on prey populations may be slight. The concerted action of these beneficial insects to control prey is more important. Researchers must therefore understand how whole communities of generalist and specialist natural enemies act to suppress pests e.g. *Helicoverpa* spp., not just the individual species which we introduce or augment.

How effective have beneficials been?

Various trials have been conducted over the last 4 years to investigate what role predators and parasites have in pest management in cotton and how insecticide sprays interfere with this approach. A major difficulty with these trials is having as reference an unsprayed area which is not subject to insecticide drift from nearby

conventionally-treated areas. Also, growers are reluctant to leave a large area of cotton unsprayed. Envirofeast® IPM studies showed that as predator numbers decline, the majority of heliothis larvae survive to medium and large and cause significant damage (Mensah *et al.* 1996). The decline in predator numbers usually coincides with the first use of pyrethroid sprays, indicating that it is insecticide drift from these 'hard' chemicals that is the major culprit in the decline of predator numbers. Some parasites tolerate insecticides better than predators and are relatively abundant in crops despite intensive spray programs. Unfortunately, parasitised eggs and larvae are not easily recognised in the field. A rapid assessment method that provides this information would be very useful.

Unsprayed, irrigated areas generally have not been performing well in terms of cotton yield or predator numbers (Mensah and Harris 1995), but the same is not true of raingrown cotton crops (Murray *et al.* 1996). Studies have shown that Envirofeast®-sprayed cotton has more predators than unsprayed cotton (Mensah and Harris 1996) but there should not be an expectation of season long benefits from predators. Early to mid season contributions by predators have greatly reduced insecticide inputs in these trials.

What thresholds apply?

The predator to prey ratio is the critical component when using predator numbers to determine what action to take. When IPM in raingrown cotton trials were first discussed during 1992, we were guided by a rule that if heliothis densities were close to threshold (2 larvae per metre) and 3 - 4 predators per metre or more were present, take no action and recheck in 1 - 2 days if practical (CRCTPM 1992). Since then the predator-prey ratio has been refined for use with Envirofeast® sprays.

This ratio is defined as the total number of predators per metre (as determined by suction sample) divided by the total number of eggs plus neonates (Mensah unpublished). The medium and large larvae are not included because when heliothis larvae reach that stage they become too big to be used as food for most of the key predators (Mensah unpublished). This predator-prey ratio has been used to manage Envirofeast® IPM cotton for the past three years to achieve yields similar to conventional insecticide-managed cotton (Mensah *et al.* 1996). The predator-prey ratio will be incorporated into entomoLOGIC so that growers have access to it.

The most important aspect when using thresholds is having an accurate and reliable sampling method. Relative estimates of predator densities have been determined using visual assessments, shake sheets, sweep nets and suction

machines. Each method has its own advantages and disadvantages. Many researchers are now using suction sampling, and predator counts are confined to 20 - 25 key species. "*The cotton pest and beneficial guide*" by Pyke and Brown (1996) and Bug Match™ in cotton (Rhone-Poulenc Rural (Aust.) Pty. Ltd. are useful references for predator identification.

What factors affect predator abundance?

Our knowledge of factors that affect beneficial populations in Australian cotton fields is scant. Predators respond positively to the availability of food (prey). If no prey are available predators will either starve or move away. The impact of insecticides are discussed below, but the effect of other factors on predator numbers has not been the subject of detailed investigations. High relative humidity, rainfall and low temperature can affect predators. When crops are irrigated and water is flowing through the crop, an artificially high relative humidity is created within the cotton crop, especially those whose canopies have closed. This results in mortality and some movement of predators from the crop. However, numbers build up quickly as soon as the irrigation water dries up and humidity returns to normal.

The effect of cultivation is minimal but predators are disturbed and forced to fly. If there are refugia such as lucerne strips nearby, most insects will seek shelter there and return to the crop after cultivation. We are not aware of data comparing predator populations in skip-row versus solid-plant cotton.

What is the effect of insecticides on beneficials?

There are only two products that have beneficial-neutral status - *Bacillus thuringiensis* (Bt) and *Helicoverpa* nuclear polyhedrosis virus (NPV). Virtually all other cotton insecticides affect beneficial populations to some extent, ranging from slightly hazardous e.g. Bt plus low rate endosulfan, to highly hazardous e.g. organophosphates and synthetic pyrethroids (L. Wilson, pers. comm.).

Rebuilding predators after sprays?

Under conventional insecticide programs beneficial insects are seldom given an opportunity to rebuild between successive sprays. The adoption of Ingard™ cotton will remove most of the regular sprays directed against heliothis, so there will be opportunities to conserve beneficials if no early-season sprays are applied. However, sprays against green mirids and aphids pose the greatest threat to the stability of beneficial populations in Ingard™ cotton.

The success of rebuilding predators after spraying depends on whether there is a refugia inside or outside the cotton system, the type of insecticide used, the frequency of application, and the method and timing of the application. In Envirofeast® IPM, predator numbers can partially be rebuilt after insecticide sprays (Mensah and Harris 1994).

Can predators be managed in lucerne and other refugia?

For the past four years, lucerne and other alternate crops have been evaluated as refuges for predators and trap crops for green mirids within the Envirofeast® IPM program (Mensah and Harris 1995, Mensah *et al.* 1996). It has been found that movement of predators from lucerne into cotton is unlikely to occur without the assistance of a mechanism to move them about (Mensah and Harris 1996). The same may hold true for other refuge crops e.g. sorghum, adzuki beans. It is here that Envirofeast® product can be used to facilitate predator movement (Mensah and Harris 1994, 1996). Slashing or mowing of lucerne strips though will force both predators and green mirids into cotton, creating a potential mirid problem.

Do beneficials control overwintering pupae?

The most important beneficials acting against heliothis pupal populations are the various parasitic wasps and flies. Many of these survive the winter in a dormant phase within their overwintering hosts and emerge in the spring with the return of warmer conditions. Levels of pupal parasitism are usually quite low under conventionally-managed cotton crops relative to other summer crop options e.g. sorghum, in which beneficials are usually not disrupted by multiple insecticide sprays.

Predation of overwintering pupae may become more important if insecticides are less frequently used in cotton. Carab beetles, ants, earwigs, true wireworm larvae and mice have been recorded eating pupae. With the current pest management strategy which relies solely on insecticides, pupal predation has been low and therefore tillage to reduce survival of overwintering pupae assumes greater importance at this stage.

Progress with food sprays and latest developments

An IPM program based on Envirofeast® sprays during the 1994/95 and 1995/96 seasons has achieved yields similar to those of conventional insecticide-managed cotton. NPV was also successfully evaluated in Envirofeast® IPM programs (Mensah *et al.* 1996). The only problem is that Envirofeast® in non-rainfast. Rhone-Poulenc Rural (Aust.) Pty. Ltd. are collaborating with their

counterparts in the USA, France, and a company in Australia to reformulate Envirofeast® product. Work in this area is said to be progressing well.

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