

A predator to pest ratio for cotton IPM decisions

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By and large the Australian cotton industry now realises the major role that natural enemies of cotton pests, particularly predatory insects, play in cotton IPM.

But the potential value of these beneficial insects has not yet been fully exploited in cotton pest management. This is due to the lack of understanding of the efficacy of these beneficial insects, lack of techniques to maximise their abundance and effectiveness, and the continuous use of broad-spectrum insecticides on cotton crops against major pests.

In monocultural cotton fields pest populations can increase, minor pests can become major pests and non-pests can become pests. This is because the food, hosts, prey, and hibernating or overwintering sites of the natural enemies are reduced, which affects biological control.

Natural enemies of cotton pests usually have different food requirements in the larval and adult stages to develop and survive through the season. In contrast, adult pests — particularly *Helicoverpa* — can normally lay their eggs without any feeding, relying only on food reserves transferred from their larval stage. In addition *Helicoverpa* are highly migratory and can rapidly infest cotton crops and lay their eggs. Unless natural enemies are present and well established in high numbers before the pest arrive, they cannot respond rapidly enough to control these pests.

Insect sampling for pest management decisions

Knowing the numbers of pest and beneficial insect numbers in cotton crops allows growers or consultants to make appropriate pest management decisions. Sampling methods and the number of times per week to sample are given in the IPM guidelines in Entopak (by Robert Mensah and Lewis Wilson).

Within the cotton industry insects on cotton crops are sampled using D-vac (vacuum sampling), sweep net, beat cloth or visual counts. All these sampling techniques have their own limitations and none of them is 100 per cent accurate.

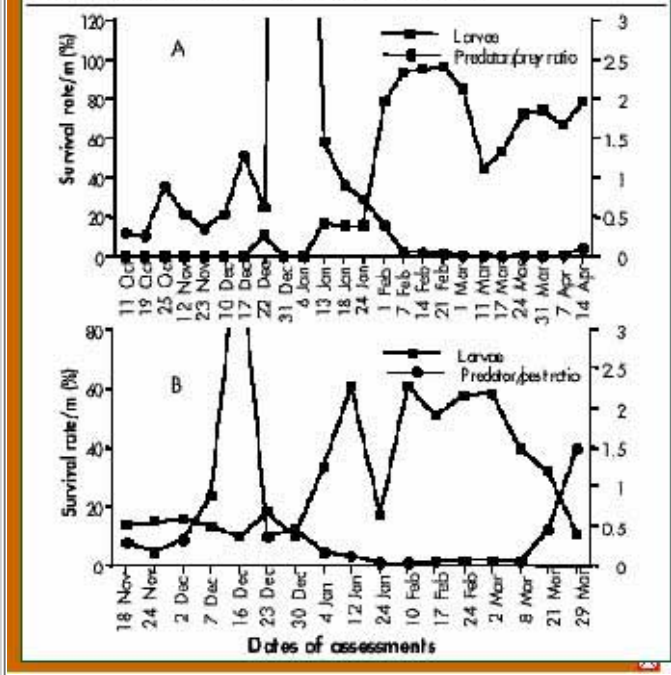
D-vac, sweep net and visual sampling give relative values of the proportion of insects on the particular crop at that point in time. The beat cloth technique may give insect numbers closer to the real value.

Nevertheless appropriate pest management decisions can be made using either of these methods.

TABLE 1: Predators of cotton pests identified in study plots (1992-98)

Order	Family	Species	Group
Coleoptera	Coccinellidae	<i>Coccinella transversalis</i> (Fabricius)	Predatory beetles
		<i>Adalia bipunctata</i> (Linnaeus)	
	Melyridae	<i>Dicranolais bellulus</i> (Guerin-Meneville)	
Hemiptera	Nabidae	<i>Nabis capsiformis</i> (Germar)	Predatory bugs
	Lygaeidae	<i>Geocoris lubra</i> (Kirkaldy)	
	Pentatomidae	<i>Cermatulus nasalis</i> (Westwood)	
		<i>Ochelia schellenbergii</i> (Guerin-Meneville)	
	Reduviidae	<i>Coranus triabeatus</i> (Harvath)	
Neuroptera	Chrysopidae	<i>Chrysopa</i> spp.	Predatory lacewings
	Hemerobiidae	<i>Micromus tasmaniae</i> (Walker)	
Araneida	Lycosidae	<i>Lycosa</i> spp.	Spiders
	Oxyopidae	<i>Oxyopes</i> spp.	
	Salticidae	<i>Salticidae</i> spp.	
	Araneidae	<i>Araneus</i> spp.	

FIGURE 1: Predator to pest ratio and survival rates of *Helicoverpa* larvae in cotton at A) Norwood (1993-94) and B) Bellevue (1994-95)



All insect thresholds currently used in the cotton industry are based on visual or D-vac sampling methods. With the introduction of the beat cloth technique, care needs to be taken to avoid 'panic spraying'.

For example, what should a grower do if visual or D-vac sampling gives a result of 0.4 mirids per metre but sampling with a beat cloth gives four mirids per metre?

A decision based on visual counts or D-vac will recommend no action taken provided fruit retention is not lower than 50 per cent. With the higher numbers sampled using a beat cloth, the grower will be tempted to control the pest. Additionally, high numbers of predators obtained using a beat cloth may lead to false sense of security.

So we need a conversion rate between the beat cloth technique and visual, D-vac or sweep nets to avoid over or under spraying, especially with sucking pests.

One of the biggest limitations of the beat cloth is this technique cannot be used after irrigation or rain, even if the foliage is dry. In this situation a 'beat bucket' may be more useful than a beat cloth because the bucket method can be used when the ground is wet. Either way, sampling beneficial insects should be happening at the same time as visual checks for *Helicoverpa*. But before either 'beat' method becomes an industry recommendation, the sampling results obtained need to be converted to come in line with those from visual, D-vac or sweep net techniques.

Predator to pest ratio

The decision to control *Helicoverpa* should be based on a pest threshold and the ratio of predators to pests in the crop as indicated by your visual counts (see IPM guidelines for more details).

How was the predator to pest ratio determined?

Irrigated cotton fields in the Gwydir Valley (Norwood) and Macquarie Valley (Bellevue) were treated with food sprays (Envirofeast) and biological insecticides, Gemstar (NPV) and foliar Bt, from October until the first week in January. This was to avoid disruption to the activity of predatory insects.

After this fields were treated with synthetic insecticides when *Helicoverpa* numbers exceeded two (first to third stage) larvae per metre of row of cotton (the recommended pest threshold).

Foliar application of Envirofeast started when the cotton crop was at the four true leaf stage and then at 14 day intervals until the end of the experiments.

Visual counts of *Helicoverpa* eggs, different instar larvae and predatory insects were made on cotton plants in 10 randomly-selected, one metre lengths of row (that is, 10 metres per field).

Survival rates of *Helicoverpa* eggs, very small,



The accepted predator to pest threshold is 0.5 or higher.
(Photo by N. Schellhorn)

small, medium and large larvae per metre were calculated from the field data. Predatory insects were separated into predatory beetles, bugs, lacewings and spiders. When calculating the predator to pest ratio, all the predators were grouped as one unit (total predators).

The predator to pest ratio per metre was calculated for each sample date by dividing the total number of predators per metre by the number of *Helicoverpa* eggs plus very small plus small larvae per metre.

Numbers of medium and large larvae were not included in the calculation as at that stage they were too big for the predators to effectively capture as food.

The minimum pest to predator ratio at which *Helicoverpa* larvae can survive to reach, exceed or remain under the threshold of two larvae per metre in the study sites was determined.

Results

Predator to pest ratio required to manage *Helicoverpa*

A predator to pest ratio of 0.5 or higher reduced the survival rate of *Helicoverpa* larvae (see Figure 1). A ratio lower than 0.5 resulted in surviving larvae exceeding the pest threshold, particularly at Norwood study site (Figure 1).

At Norwood, a predator to pest ratio of 0.5 and higher was recorded from December 10 until January 10. This maintained egg and larval numbers below the threshold (Figure 1a). The predator to pest ratio fell from 0.5 to 0.4 on February 1 and crashed on February 7 (Figure 1a). This resulted in a drastic increase in the survival rate and densities of *Helicoverpa* eggs and larvae to a peak of 12 per metre and required an insecticide treatment on February 21 to clean it up (Figure 1a).

The reduction of predator numbers and their subsequent crash coincided with the application of a synthetic pyrethroid spray against *Helicoverpa* by neighbouring growers.

At Bellevue, the increase in *Helicoverpa* survival rate started on January 4 when the predator to pest ratio fell below 0.5 (Figure 1b) indicating that control of *Helicoverpa* should commence when the predator to pest ratio falls below 0.5. The predator to pest ratio crashed at Bellevue on January 24 and did not recover until March 21 (Figure 1b). The recovery of the predator to pest ratio at Bellevue to 0.5 or higher from March 21, resulted in the subsequent reduction in the populations of *Helicoverpa* to as low as 0.35 per metre on March 29.

Decision making for conventional cotton

The accepted predator to pest threshold is 0.5 or higher (see IPM guidelines, CottonLogic, EntoPak)

When the ratio is 0.5 or higher and *Helicoverpa* numbers are below threshold it means the IPM system is functioning well.

When the ratio falls below 0.5 but is higher than 0.4 and at the same time *Helicoverpa* numbers are below threshold — with the population comprising mostly of eggs — a predator food attractant should be applied to the crop.

If the predator ratio falls below 0.5 but it is higher than 0.4, and *Helicoverpa* numbers are below threshold — but the population is predominantly larvae — a sugar-based or yeast-based food spray or UV-protected petroleum spray oil mixed with biopesticides should be applied to restore the predator to pest ratio to 0.5 or higher.

If *Helicoverpa* larvae levels are above threshold in your next check following the food spray/biopesticide or UV-protected petroleum oil/biopesticide mixture sprays and the predator to pest ratio is 0.4 or lower, use one of the soft option insecticides to correct the insect pressure situation. After this, return to predatory insect management strategies (see IPM guidelines for more details and also Decision making protocol for transgenic cotton).

Discussion

Pest management programs usually have decision support tools on which decisions to control pests are based. Most pest control decisions are made on the basis of pest numbers rather than the ratio of natural enemies to the pests. With the increasing adoption of IPM worldwide, the use of both pests and natural enemies — especially predator to pest ratios — as thresholds in pest management programs is becoming increasingly important.

The question of how many predators to pests are required to maintain pests, such as *Helicoverpa*, below thresholds is frequently asked.

This study indicated that the most acceptable predator to pest ratio for *Helicoverpa* in cotton is 0.5 or higher per sample date. A ratio lower than 0.5 could result in the number of *Helicoverpa* larvae surviving which would exceed the recommended pest threshold of two larvae per metre.

Calculation of the predator to pest ratio was based on visual counts of the total predators per metre divided by *Helicoverpa* eggs and early stage larvae. The calculation of the ratio excluded *Helicoverpa* medium and large larvae since at this stage in the life cycle of the pest they were too large for the predators to capture as food.

The predator population needs to include a mixture of predators (beetles, bugs, lacewings etc) and not be dominated by one type of predator (for example, spiders). At least three insects of the most common predators within the families Coccinellidae, Melyridae, Hemerobiidae and Pentatomidae should be present in your checks.

The application of supplementary food on commercial cotton crops can change the predator to pest ratio by attracting predatory insects to the area, keeping predatory insects in

the area, increasing consumption rate of pests by predators and reducing egg-laying activity by *Helicoverpa* due to the physical presence of the food attractant.

Any or all of the above changes can alter the pest to predator ratio in favour of predators. So it is important that growers and consultants practising IPM sample their cotton fields regularly. In this way the predator to pest ratio can be monitored closely so appropriate measures can be taken to maximise the abundance and effectiveness of predatory insects.

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