Trichogramma: Small wasps that pack a big punch

By Brad Scholz and Nat Parker*

There are many species of beneficial insects and spiders that inhabit cotton crops. Some beneficials, such as ladybird beetles, are easily recognised, while others are often overlooked.

One species that is easily overlooked is the tiny Trichogramma wasp. This incredible little wasp is smaller than a pin head, but can single-handedly prevent heliothis *(Helicoverpa spp.)* from causing serious damage to crops.

Trichogramma only attack the egg stage of hosts and are known as egg parasitoids. They are very important biological control agents because they kill heliothis before they hatch and start feeding on your crop.

This means that even if you see heliothis eggs in your crop, they may not hatch if there are lots of Trichogramma wasps present. Spraying with insecticides may not be necessary when the levels of egg parasitism are high. If you are serious about IPM and avoiding unnecessary sprays, then you should try to learn more about Trichogramma.

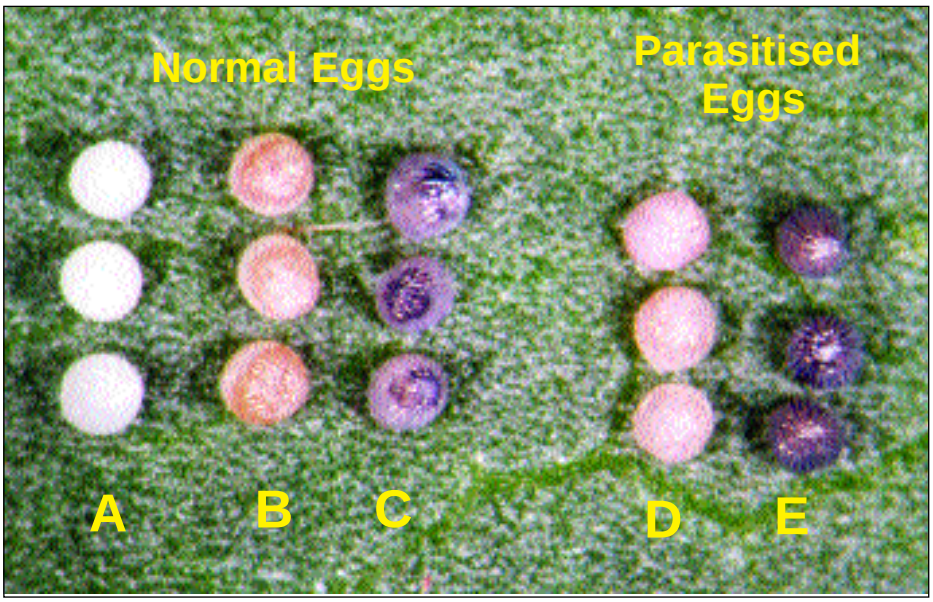
Recognising egg parasitism

Eggs that have been attacked by Trichogramma are described as being 'parasitised'. It is important to be able to distinguish parasitised eggs from unparasitised eggs because there may be a mixture of both types in your crop.

Parasitised eggs turn a distinctive black colour three to four days after they have been attacked. These eggs must not be confused with 'black-head' eggs. Black-head eggs are eggs where the black head capsule of the developing caterpillar is visible through the clear egg shell. This gives the egg a black appearance to the naked eye.

By contrast, black parasitised eggs have a jet black shell that is not transparent. Black parasitised eggs will not produce caterpillars, but will eventually produce one or more wasps. Adult Trichogramma wasps emerge from parasitised heliothis eggs after eight to 10 days development during summer.

Trichogramma are brown or yellow wasps that have red eyes, and are related to another small wasp called Trichogrammatoidea. Typically two to four of these wasps will emerge from a parasitised heliothis egg. Another egg parasitoid called Telenomus also attacks heliothis eggs.



Normal and parasitised heliothis eggs.
A Normal one day old eggs are pearly white in colour.
B Normal two day old eggs are called brown, coloured or 'red'ring'
C Normal three day old eggs. This is the black-head stage of egg development. The black head capsule of the developing caterpillar is visible through the clear egg shell.
D Three day old parasitised eggs are typically tan or brown
E Four day old parasitised eggs have a jet black egg shell.

Telenomus is a black wasp with black eyes, and only one wasp normally emerges from a parasitised heliothis egg. Egg parasitoids are active during daylight hours, and prefer fine days to rainy days. The levels of egg parasitism can drop to low levels when it is raining.

Collecting eggs

The best way to determine the levels of egg parasitism in your crop is to collect eggs and wait to see how many hatch and how many turn jet black. It is important to only collect brown eggs (eggs that are about two days old) when assessing parasitism. White eggs may have just been laid and Trichogramma may not have had sufficient time to find them. If you collect white eggs you will generally underestimate the levels of egg parasitism.

In cotton you should randomly collect at least 20 eggs on leaves or squares from different plants in a field. In vegetative sorghum and maize you can also collect eggs on leaves.

For heading sorghum it is best to sample pre-flowering heads just after they have fully emerged from the boot — that is before the first yellow flowers appear on the top of the head. To collect the eggs from sorghum you remove the head using secateurs and spin it into a plastic bucket.

The eggs will fall into the bucket and can be stored in a container to be sorted later. Try to collect at least 50 eggs from a minimum of 10 heads. It is also important to keep the eggs cool in an esky after you have collected them because exposure to high temperatures, for example in a car glovebox or on a dash board, may kill them.

Storing eggs

Heliothis larvae are cannibalistic, and caterpillars that hatch from unparasitised eggs will eat nearby eggs if they are free to roam. To prevent this, the eggs must be isolated individually in a multi-celled egg tray.

The basic tools required to store eggs

are an egg tray, a fine paint brush and some sticky tape. We use plastic egg trays that can hold 96 eggs. Please contact us if you would like to know more about these trays. Alternatively you can make you own egg tray using three mm thick craftwood. Simply drill a series of six mm diameter holes in one piece of craftwood and glue this to a solid piece of craftwood. You will then have a multi-celled egg tray.

To transfer the brown eggs to the egg tray use a fine paint brush, or a tooth pick, dipped in water. Only one egg should be placed in each cell.

Be careful when you are removing the eggs from leaves as they are fragile and can be easily damaged. When all of the eggs are in the egg tray, cover the tray securely with sticky tape. This prevents the larvae that hatch from unparasitised eggs moving into nearby cells and eating eggs.

Attach a label to the egg tray and record the date, locality and crop. Store the egg trays at room temperature, for example in your office or kitchen, but don't leave them in the shed as it may get too hot during summer.

Calculating the levels of egg parasitism

The levels of parasitism can be estimated two to three days after you have collected the eggs. This is when all of the unparasitised eggs should have hatched, and you will see a small caterpillar in the cell of your egg tray. The number of eggs that don't hatch can be used to estimate parasitism, that is:

% Est. egg parasitism = (UHE/TE) x 100

UHE = Unhatched eggs
TE = Total eggs in the egg tray

The actual level of egg parasitism can be calculated four to five days after you have collected the eggs. This is when the parasitised eggs should have turned jet black.

% Actual egg parasitism = BE/(BE + HE) x 100

BE = No. of jet black parasitised eggs
HE = Hatched eggs (caterpillars) in tray

Sometimes brown eggs collapse or don't hatch for other reasons and these unviable eggs should be excluded when you calculate the actual levels of egg parasitism — that is, only use viable eggs. If you collect 60 brown eggs and you find that 45 turn jet black, five hatch and 10 collapse, then the actual level of egg parasitism is:

% Actual egg parasitism

= (45/(45 + 5)) x 100
= 90% egg parasitism

What can Trichogramma do?

Trichogramma wasps are very common in cotton on the Darling Downs, and they have caused 80–100 per cent mortality of heliothis eggs from mid-January to April for the past six years. A new species of wasp, called *Trichogramma pretiosum*, has become widespread during this time. The same species has also been recorded in other cotton growing districts.

The high levels of egg parasitism that we now find can successfully manage heliothis in cotton, particularly from January onwards. We have recorded 96 per cent egg parasitism at 90 eggs per metre in Ingard cotton (Figure 1), and we have seen a leading Downs consultant not spray conventional cotton at 60 eggs per metre because of high levels of egg parasitism.

Trichogramma can save you sprays, but you need to be aware of them and monitor levels of egg parasitism. If you find high levels of egg parasitism then you may choose not to spray, or you may decide to use a 'softer' insecticide to manage the

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hatchling heliothis caterpillars. In this way you have incorporated an assessment of parasitism into your spray decision.

If you cannot collect eggs to assess Trichogramma activity, then you should look very carefully at the heliothis counts provided by your consultant. In particular you should look at the ratio of small caterpillars to eggs.

If Trichogramma are active you will find eggs, but few small caterpillars. This indicates high egg and/or young caterpillar mortality. But if you find as many small caterpillars as eggs, then you know that egg hatch and young caterpillar survival is high, and you may need to intervene with an insecticide.

It is important not to spray heliothis based on egg counts alone. Egg counts may be misleading, particularly when Trichogramma are active and egg mortality is high. You need only be interested in the viable eggs — those that hatch and produce caterpillars.

How to use Trichogramma

The easiest way to use Trichogramma is to conserve and enhance natural populations. There are some simple practices that can be employed to do this on your farm, including:

- Not spraying insecticides of any kind unless it is necessary. This is best achieved by adhering to the general integrated pest management (IPM) guidelines and following the recommended thresholds for spraying — that is avoid spraying below threshold populations of pests.
- Choosing insecticides carefully when you have to spray. Some insecticides, such as Dipel, Gemstar, Vivus, Steward and Prodigy have very little impact on Trichogramma. Broad spectrum chemical insecticides, including the synthetic pyrethroids, are usually very toxic to Trichogramma and should be avoided whenever possible. You will not find Trichogramma on farms where regular spraying with broad-spectrum insecticides is practiced. Check your IPM guidelines for the best products to use to conserve Trichogramma and other beneficials.
- Maintaining habitat diversity on-farm. This can be achieved by growing a mixture of crops and avoiding cotton monocultures. Sorghum and maize are particularly good nursery crops for Trichogramma because they often contain high numbers of eggs. The capacity of these crops to act as nurseries can be extended by growing staggered plantings — that is by sowing on two or more occasions. Although chickpea can have high numbers of heliothis eggs, it is not a good nursery crop for Trichogramma because the acidic chickpea leaves are toxic to the adult wasps. It is important to manage pests carefully in your nursery crops so that you don't kill the wasps. For example, if you have to spray sorghum to manage heliothis try to use Gemstar, Vivus, or another selective insecticide, so that you don't kill the Trichogramma.

Bollgard II cotton will act as a nursery for Trichogramma because it will receive few insecticide sprays. If you find high levels of egg parasitism in your Bollgard II then

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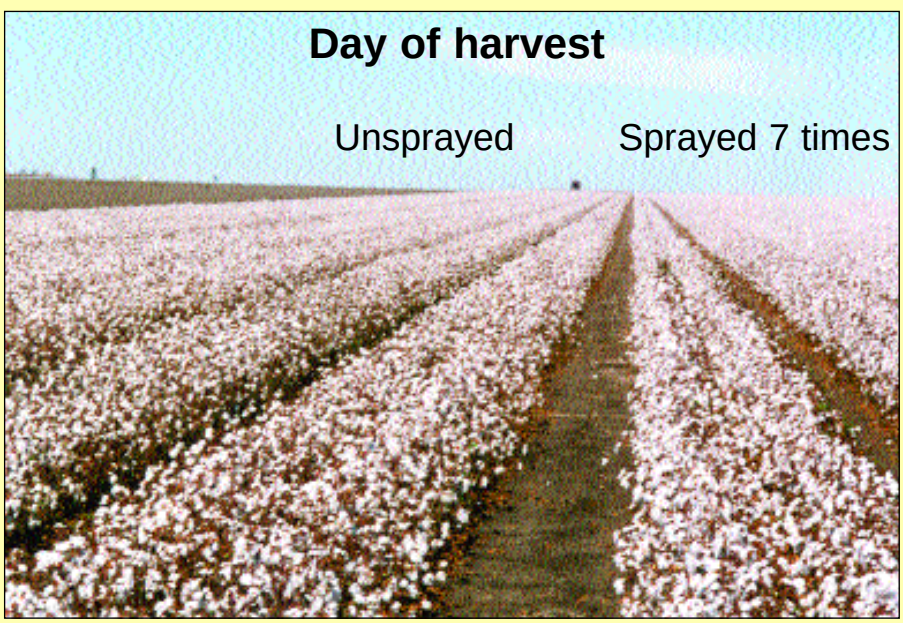


During the 2001–02 season parts of two dryland Ingard cotton fields at Jimbour on the Darling Downs were left unsprayed for the whole season. Trichogramma provided excellent control of heliothis in the unsprayed crop, even at high egg densities (see Figure 1). The unsprayed crop set slightly later fruit than the adjacent sprayed crop. At harvest the unsprayed crop yielded slightly less than the crop sprayed seven times, but was $90 per hectare more profitable.

The top photo shows the unsprayed and sprayed crop 10 days before harvest, and there is a noticeable difference in the number of open bolls. The bottom photo shows the same field on the day of harvest when there was very little difference between the unsprayed and sprayed crop.

manage your non-heliothis pests carefully. If you conserve your Trichogramma they may move into adjacent, or nearby, conventional cotton and other crops.

Releasing Trichogramma

Trichogramma can also be purchased and released into crops to kill heliothis eggs. They are available from 'Bugs for Bugs', Mundubbera Queensland, and the company should be contacted for details of costs and release methods.

One release method that is suitable for small acreages is the use of small cardboard capsules. Each capsule contains about 1,000 wasps, and they can be stapled to cotton leaves to prevent them from falling on the ground. This prevents the possible exposure of the wasps to potentially deadly high soil temperatures.

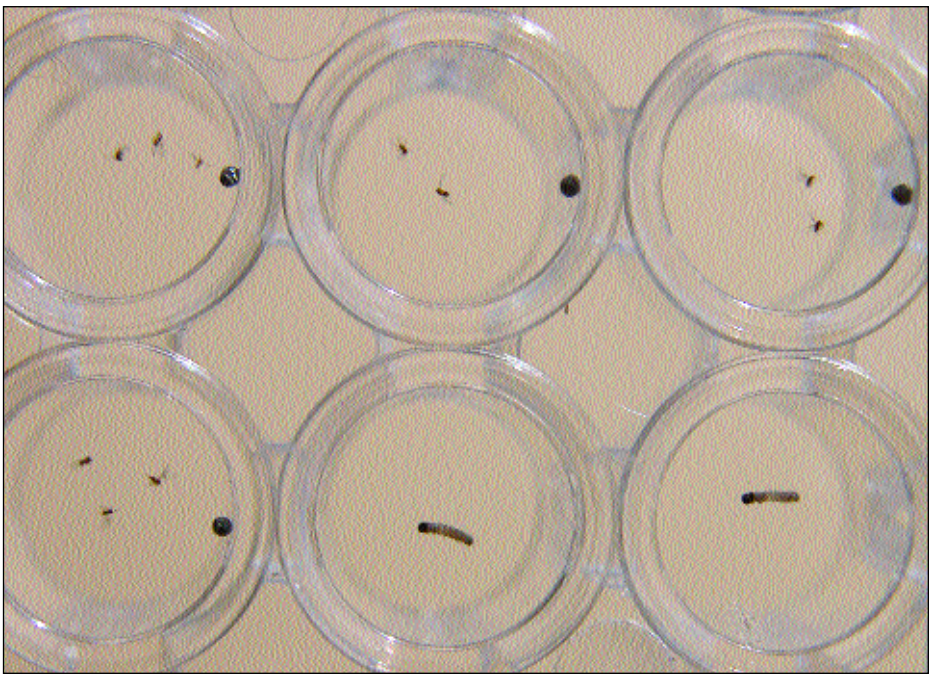
It is important not to think of Trichogramma releases as a substitute for an insecticide spray. They will give inconsistent results if they are used in this fashion. This is primarily because heliothis eggs hatch in two to three days during summer, and many may hatch before you can order Trichogramma and release them into your crop.

It is best to think of Trichogramma as part of an IPM program, where the careful selection of 'soft' insecticides can be used in conjunction with the wasps to manage heliothis. In recent years some cotton growers have released wasps to 'kick-start' Trichogramma populations — that is to establish populations before they would naturally appear.

This approach, called inoculative release, normally involves completing two releases of 30 capsules per hectare about a week apart. This process can be completed in cotton, or in adjacent crops such as sorghum or maize. Avoid spraying the release crops with broad spectrum insecticides so that you don't kill the Trichogramma. You may not notice an immediate impact from the inoculative releases, but you should notice an impact after the wasps have completed one generation in the field — that is about 10 days after a release.

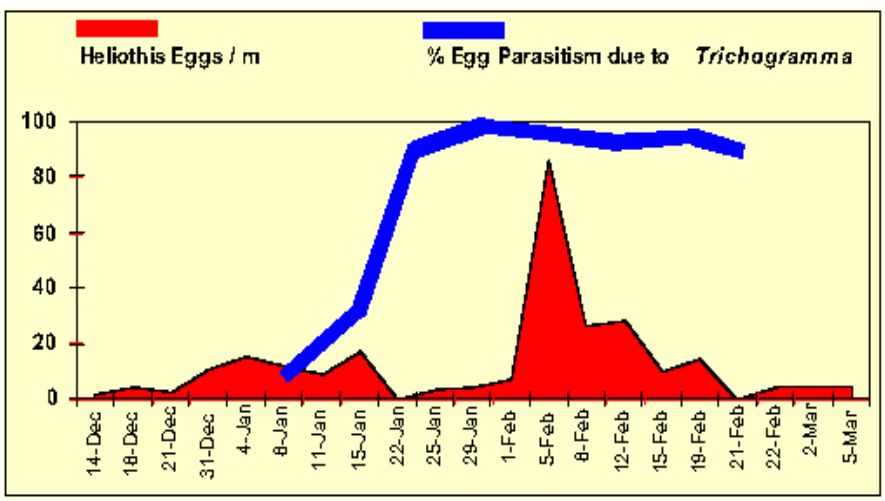
A key difference between predators and Trichogramma is the nature of their impact. An egg that is eaten is removed from the crop and isn't counted by consultants. But an egg that is parasitised remains in the crop and can be accidentally counted by consultants, unless it has turned jet black and is recognised as being parasitised. So you really need to assess egg parasitism if you want to avoid unnecessary sprays, and get the most out of your Trichogramma.

We are part of an exciting time in cotton pest management because the introduction of Bollgard II cotton and the availability of selective insecticides means that we can conserve and utilise Trichogramma more than we ever have before. So make the effort to learn more about Trichogramma wasps — they may be in your crop and you just don't know it.



Collect brown eggs and transfer each egg to a separate cell in an egg tray using a fine paint brush dipped in water. Handle the eggs carefully so that you don't damage them. Cover the tray securely with sticky tape to prevent hatchling caterpillars from roaming and eating eggs in adjacent cells.

FIGURE 1: Levels of heliothis egg parasitism in unsprayed Ingard cotton at Jimbour, on the Darling Downs, during the 2001–02 season



High levels of egg parasitism were found from January onwards, even at egg densities of 90 eggs per metre

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If you would like to know more about Trichogramma please contact Brad Scholz on email (brad.scholz@dpi.qld.gov.au) or phone 07 4688 1312. If you would like to purchase Trichogramma please contact Richard Llewellyn, BioResources Pty. Ltd., on email (richard@bioresources.com) or phone 07 3289 4919.