Trichogramma
Moth egg parasites

Biocontrol organism

- ***Trichogramma* spp.**

Trichogramma wasps are minute, being less than 0.5 mm long. The adult female wasp lays its own eggs into the moth eggs. The wasp eggs then hatch and the larvae begin to devour the developing caterpillar inside the egg.

The trichogramma larvae pupate and develop into fully formed wasps inside the moth eggs. The moth eggs gradually go black as the wasps develop inside.

Plate 72: Trichogramma wasps inspecting and parasitising a heliothis egg

Emerging wasps chew a hole in the moth egg, and they are then ready to parasitise other moth eggs. This process takes 7–20 days, depending on temperature.

A female wasp can parasitise over 50 moth eggs during its life of 5–14 days. Adult wasps feed on nectar, so it is important to have some kind of flowers present as a food source.

Mated female wasps will produce both male and female offspring. Unmated females can parasitise eggs but will produce only male offspring.

Target pests

- Heliothis *Helicoverpa armigera* and *H. punctigera*
- Fruit stem borer (pecan stem girdler) *Maroga melanostigma*
- Codling moth *Cydia pomonella*
- Oriental fruit moth *Cydia molesta*
- Lightbrown apple moth *Epiphyas postvittana*
- Cabbage moth *Plutella xylostella*
- Loopers *Chrysodeixis* spp.

Trichogramma wasps are commercially reared in many countries to control a range of moth and butterfly pests. There are many species and strains of trichogramma. Some have a wide host range, while others have a strong preference for the eggs of a particular moth species.

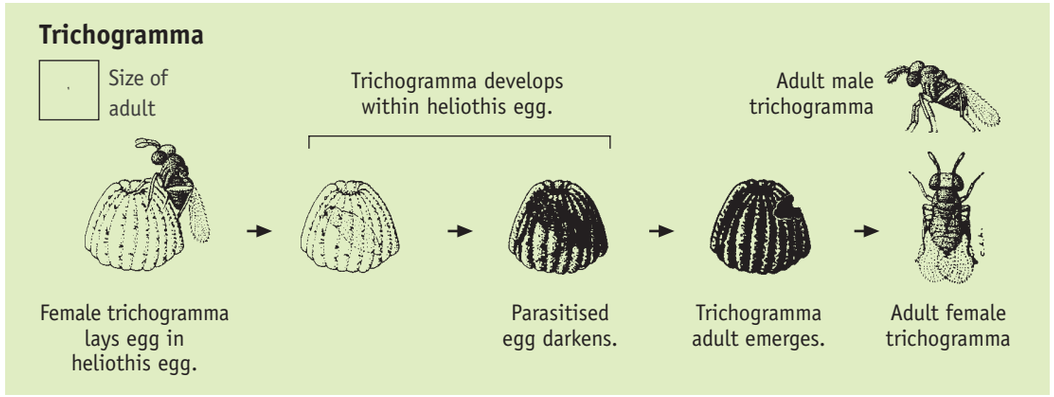

Figure 15: Life cycle of trichogramma

Suitable crops/environments

Trichogramma wasps are very sensitive to insecticides, and are especially suited to crops that are organically grown or on which there is minimal use of insecticides, or to periods during crop development when insecticides are not required. Trichogramma is best seen as an important component within a wider IPM program.

Various trichogramma species and strains are available to target different pests in a wide range of crops. They are currently being released into tomatoes, sweet corn, capsicum, french beans, cut flowers, lettuce, cotton, grapes, and such tree crops as pecans, apples, pears, citrus and stone fruit. The wasp can also be used in field crops such as soybean, navy bean, sorghum and cotton.

Before release

Select an appropriate species of trichogramma for the target pest; a number of species are commercially available. Be ready to release at the optimum time for your crop, and decide on the most appropriate method well before release.

Make sure there are no harmful chemical residues in the crop before releasing trichogramma. Some chemicals may be toxic for 4 weeks after they are applied. (See the chemical toxicity table for more information.)

At release

Trichogramma wasps are usually dispatched in the form of parasitised moth eggs, at over 50 000 parasitised eggs per gram. They can be distributed as loose eggs, either by hand or by various mechanical devices. Alternatively, the eggs are dispatched in capsules, each yielding approximately 1000 wasps, which are placed into the foliage. The capsule method provides some protection from predators and the elements, and the timing of placement in the field is not as critical as for the loose-egg methods.

Trichogramma can be used inoculatively or inundatively. The preferred method for your crop and area will depend on a number of factors, and suppliers will have up-to-date recommendations for your crop and district. In some districts, inoculative releases to speed up the natural build-up of egg parasitoids may be all that is required. In other districts, where the environment does not favour the maintenance of high levels of parasitoids, releases into each planting or moth flight are advised. Regular releases are recommended for indoor crops, and crops that do not harbour the large numbers of moth eggs necessary to maintain a useful population of trichogramma.

To quickly establish a continuous trichogramma population in the field, it is necessary to make two releases 5–7 days apart. The wasps live only 5–8 days in the field, and it takes 9–12 days for any parasitised eggs to produce a wasp. Thus, 7 days after the original release, most of the original wasps will have died. It will take a further 2–7 days before their offspring emerge. Thus a second release 5–7 days after the initial release will ensure that there are still adults present while the first generation completes its development.

Monitoring regularly for moth eggs is essential, in order to determine the best time for release and the release rate. Pheromone traps can be used to monitor the presence of some moth species.

The package containing parasitised eggs will be accompanied by details of the contents: for example the trichogramma species, numbers of parasitised eggs, the sex ratio, and the date at which they were originally parasitised, as well as the estimated time of wasp emergence.

Plate 73: Heliothis egg development: fresh white egg (*left*); brown ring stage (*centre*); and just before hatching (*right*), with dark head capsule visible

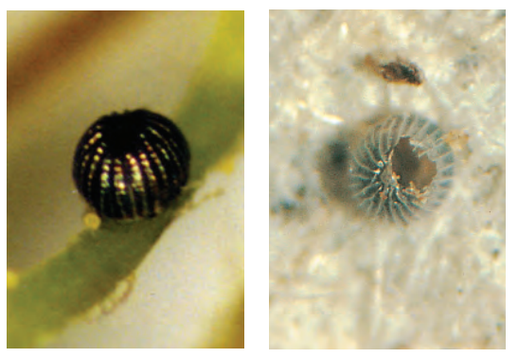

Plate 74: Black, parasitised heliothis egg (*left*), and parasitised egg showing escape hole of trichogramma (*right*)

Wait until close to emergence before distributing in the field. This reduces the chances of predation, and of loss due to rain or heat.

If weather conditions are unfavourable for release, parasitised eggs can be stored at 5–10°C for up to a week, depending on previous storage and how close they are to emergence.

Recommended release rates

Release rates will range from 25 000 parasitised eggs per hectare for low pest levels and inoculative releases, to 200 000+ per hectare for high pest levels and quick establishment.

Release rates for tree and vine crops will depend on whether bacterial and pheromone (mating disruption) products are in use. Releases should be made when moths are active and laying eggs. This can be determined by monitoring for eggs, using pheromone traps or making predictions using degree–day models.

Tree and vine crops: For crops treated with pheromones, a release of 60 000–120 000 per hectare is suggested. Any tree crops not treated with pheromones will require higher and more frequent releases.

Tomato and capsicum: For tomatoes or capsicum, where the target pest is heliothis, weekly releases are recommended, starting as soon as

Plate 75: Heliothis moth (actual length 18 mm)

Plate 76: Lightbrown apple moth, female on left, male on right

moths or moth eggs appear. Release at 50 000–150 000 per hectare.

Sweet corn: Begin releases 2–3 weeks before tasselling at 60 000–180 000 per hectare.

Cotton: Various release strategies are being investigated. Releases into adjacent crops such as sorghum or maize can create in-field insectaries. Apply 50 000–200 000 per hectare.

Enclosed areas: Release at 10 000–20 000 per 1000 m^2.

After release

The hatched female wasps will seek out suitable host eggs, preferably freshly laid ones, in which to lay their own eggs. It may take a number of releases and generations before parasitism increases to high levels.

The level of parasitism required for 'control' will vary with the crop, with the level of pest pressure, and with the impact of other beneficials and of any biological insecticides if applied.

Percentage of parasitism is a useful indicator of trichogramma activity, but the numbers of unparasitised and parasitised eggs per plant will provide a more accurate indicator of present and future control levels.

Percentage parasitism is determined by collecting the target host eggs, putting them singly into cells of a multi-cell tray and observing them to see whether a grub or wasp emerges:

- Collect at least twenty, and preferably fifty, eggs from across each block.
- Select 'brown ring stage' eggs. Pure white eggs may have just been laid and may not have had time to be parasitised. Wasps may parasitise eggs up to 3 days after they are laid.
- A small paintbrush can be used to lift the eggs off the plant and into a small vial. Alternatively, leaf sections containing eggs can be collected.
- Label the sample with date, site, etc. Keep in a warm place (20–25°C), but out of direct sun.
- Eggs that are not parasitised will darken and produce a small caterpillar in 3–6 days.
- Eggs that have been parasitised turn coal-black in about 5 days.
- By 6 days after collection, all grubs will have emerged. At this stage, the proportion of eggs that are parasitised or unviable can be calculated.

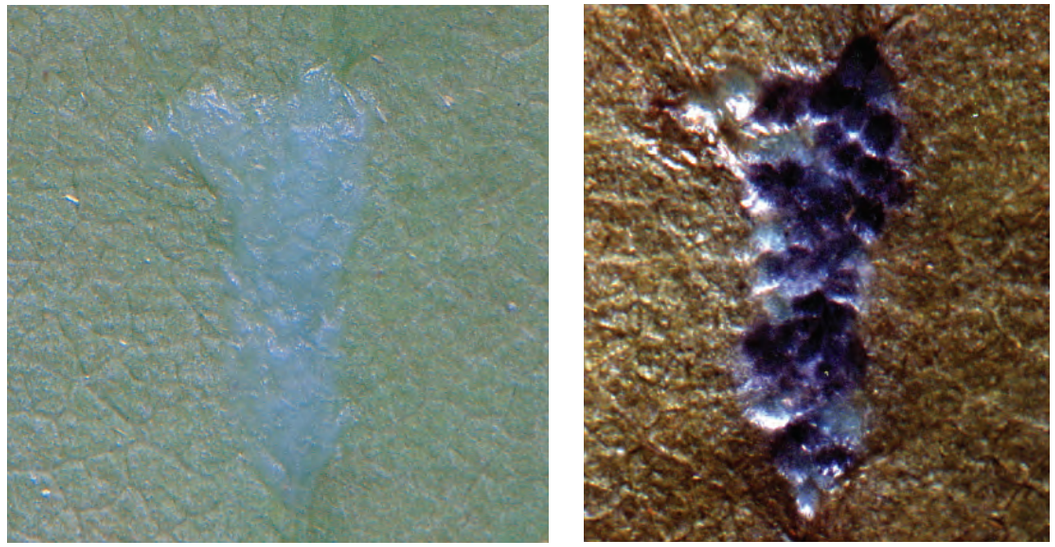

Plate 77: Unparasitised lightbrown apple moth egg mass (*left*) and black, parasitised eggs (*right*)

Plate 78: Trichogramma release capsule in sweet corn

Cultural practices to aid trichogramma establishment

The persistence of trichogramma from one season to the next will be influenced by the presence of other crops in the area that can host moth pests. Winter and summer legumes, lucerne, grain and forage sorghum and maize provide good refuges for moths and trichogramma. Strip cropping is more likely than large areas of fallow to favour a carryover of trichogramma.

Chemical use

Trichogramma wasps are extremely susceptible to most chemical insecticides and their residues. Under field conditions, dense foliage protects trichogramma to some degree from chemical sprays, and populations of trichogramma may therefore be able to recover from occasional insecticide applications. However, the repeated spraying of insecticides within a short time is likely to reduce trichogramma populations severely. *Bacillus thuringiensis* (Bt) and nucleopolyhedrosis virus (NPV) products have negligible effects on trichogramma. Some insect growth regulator products are safe to use with trichogramma.

Fungicides are generally safe to use with trichogramma, but there are a number of important exceptions. See chemical toxicity table for details.

Other natural enemies of moth eggs

Other egg parasitoids, e.g. *Telenomus* spp. and other trichogrammatids

Green and brown lacewings

Ladybirds, e.g. transverse, common spotted, three-banded and variable ladybirds

Predatory bugs, e.g. minute pirate bugs, black mirids, big-eyed bugs, damsel bugs

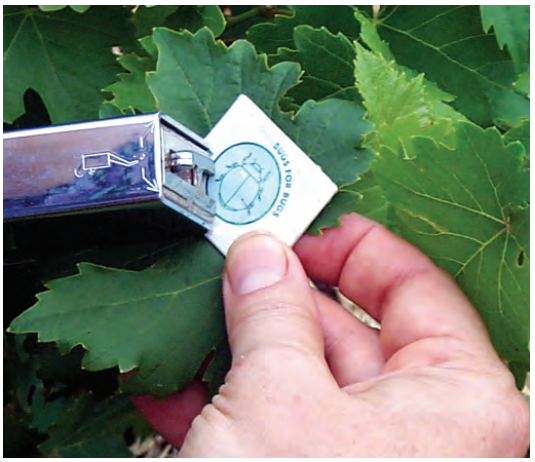

Plate 79: Stapling a release capsule in grapes