A new biocontrol agent and mass trapping of codling moth

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Introduction

Changes to the types of pesticides available for use in fruit production, and the progress of research into biological control of major insect pests, is providing fruit growers with safer, cost-effective and environmentally friendly options to incorporate into their pest management systems.

Codling moth (Figure 1) is the most serious pest of pome fruit worldwide and the most damaging pest of commercial apple, pear, quince and nashi orchards in Australia. It is widely distributed in all Australian states except Western Australia and Northern Territory. In the past, codling moth was controlled by multiple applications of organophosphate insecticides until the pest developed resistance to those pesticides. Newer pesticides with lower human toxicity are more specific and more expensive than the organophosphate pesticides they replaced, but also require more attention to timing of spray applications and adherence to resistance management strategies.

Figure 1. Codling moth. Photo: Gyorgy Csoka, Hungary Forest Research Institute, Bugwood.org.

Codling moth overwinters on pome fruit trees as hibernating mature caterpillars in cocoons in sheltered areas such as under bark scales on the trunk. In spring, as day length and temperature increase, the caterpillars emerge from hibernation, enter pupation and eventually emerge as adult moths ready to mate and lay eggs. Mating disruption is designed to reduce or delay mating so that fewer eggs are laid. Although application of sex pheromone mediated mating disruption (MD) can be an effective alternative to the use of pesticides for control of low to moderate population levels of codling moth, control of moderate to high population densities is more problematic. Several consecutive seasons of area-wide MD treatments are needed to control higher pest population levels. The aim of MD is to prevent, or at least significantly reduce, mating between the moths. However, if there are enough female moths present then mating can still occur. It is therefore important that fruit growers have access to a number of tools that can help reduce the number of female moths in their orchards.

A new biocontrol agent

A wasp called *Mastrus ridens* (Figure 2), that targets codling moth has been introduced into Australia. The wasps were confined in quarantine until, after 5 years of host-specificity testing, approval was granted to release them into orchards (Figure 3). The first release was into an organic orchard in the Goulburn Valley in 2014 to establish a nursery site and to provide a field site in which establishment issues such as dispersal, predation and hyper-parasitism could be studied. Since then the research team has been releasing *Mastrus* into sites in Queensland, New South Wales, South Australia, Tasmania and Southern Victoria. The team has also been investigating the effects on wasp survival of commonly used orchard pesticides.

Mastrus ridens seeks out hibernating codling moth caterpillars and lays eggs in the cocoon. When the wasp eggs hatch, the wasp larvae feed on the codling moth caterpillars. Codling moth larvae consumed by *Mastrus* are easily distinguished from those that have been consumed by predators because in the latter case there are generally only scattered remains. The research team confirmed parasitism by *Mastrus*, but there was also considerable predation by earwigs and ants. An added bonus was detection of another wasp, suspected to be *Gotra pomonellae,* which was also attacking codling moth pupae.

Figure 2. An adult *Mastrus ridens* wasp.

To release *Mastrus* in orchards, parasitised codling moth larvae in corrugated cardboard bands are chilled, transported in eskies, transferred into modified fruit fly traps which are suspended from lower limbs of fruit trees (Figure 4), and then left until the adult wasps emerge and disperse. The location of these release sites were recorded for future reference (Figure 5). Between 8,000 and 20,000 *Mastrus* were released at each site and *Mastrus* adults were seen searching the trees for codling moth larvae for about 7 days after release.

Until recently it has been difficult to catch female codling moths in traps. A chemical ester isolated from pears and added to pheromone traps changed that situation in apple orchards, but did not perform so well in pear orchards, probably because of competition from the pears themselves. Addition of an extra plant volatile to the pheromone pear-ester mixture increased the capture of male and female codling moths in pear orchards treated with mating disruption. Mass trapping using the enhanced lure in pear orchards under mating disruption gave excellent control of codling moths. By enhancing the potential for pheromone-mediated mating disruption to maintain codling moth populations and resultant fruit damage at low levels, mass trapping will complement biological control of codling moth. It also reduces the risk of exposure to pesticides that may be toxic to the *Mastrus ridens* wasp. Table 3 indicates the risk of some common pesticides and of their direct and indirect effects, such as fertility of surviving adults and their offspring.

Figure 3. *Mastrus ridens* project leader David Williams (Agriculture Victoria) explains the release process with Batlow orchardist, Greg Mouat.

Figure 4. A modified Lindfield trap used to deploy *Mastrus ridens* in commercial orchards across Australia.

Figure 5. *Mastrus ridens* release sites are GPS located and monitored.

Conclusion

The release of the codling moth parasitoid, *Mastrus ridens*, combined with mass trapping of codling moth females and the use of mating disruption, will potentially avoid the over use of insecticide cover sprays and provide effective biocontrol of codling moth in pome fruit.

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Table 3. The risk of some common pesticides and of their direct and indirect effects, such as fertility of surviving adults and their offspring.

Pesticides		Direct toxicity	Fertility of survivors	Fertility of offspring from survivours
Fungicides	Cyprodinil			
	Fenarimol			
	Mancozeb			
	Ziram			
Miticide	Abamectin			
Insecticides	Acetamiprid + novaluron			
	Clorantraniliprole			
	Clothianidin		No survivors	No survivors
	Indoxacarb		No survivors	No survivors

Low	
Moderate	
High	