Agriculture Notes

Codling moth

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General information

Codling moth* Cydia pomonella *is the principal insect pest of pome fruit in Victoria and can damage almost the entire crop if not controlled.

Control of codling moth is the key to almost all other pest programs in pome fruit orchards since the chemicals commonly used to control codling moth have adverse effects on beneficial insect species, which contribute to biological control of other pests. As a result, regular seasonal chemical control programs are often required for control of minor pests.

Injury

Newly-hatched larvae (caterpillars) chew through the fruit skin and bore their way to the core. The presence in fruit of one or more holes plugged with frass (excrement) is characteristic of attack by codling moth. The larvae enter the fruit through the sides, stem end, or calyx end, and a syrupy substance may exude from the holes as the fruit matures. Similar damage can be caused by oriental fruit moth where pome fruit is grown near stone fruit.

Shallow entries called "stings" result when larvae penetrate a short distance and then die from insecticide poisoning or natural causes.

Description of life stages

The adult codling moth has a wing span of about 12 to 18 mm and is about 10 mm long when at rest with the wings folded. Males are smaller than females. The forewings are brownish grey with several grey cross-lines. An iridescent coppery-brown spot is present near the tip of each forewing. The hind wings are pale grey with fringed borders.

The female moth lays eggs singly on leaves and fruit. The egg is flat, oval, 1 mm long, opaquely white when first laid and develops a red ring towards maturity. Just before hatching the black head of the larva becomes visible in the egg.

A newly-hatched larva is white with a black head. There are generally five larval stages, which can be identified by the width of the head. Average widths of larval head for the five stages are approximately 0.3, 0.5, 0.8, 1.2 and 1.7 mm respectively.

Fully mature larvae are about 15 mm long and creamy pink with a dark brown head.

They leave the fruit and form cocoons under loose bark on the tree or in litter on the ground beneath the tree. Depending on the time of year, the larva in the cocoon either diapauses (becomes dormant) until the following spring or forms a pupa from which the moth emerges about two weeks later.

Seasonal development

Over-wintering larvae pupate early in spring and this over-wintered population begins to emerge as moths about the time of bloom. The moths emerge usually in one or more periods of peak activity, each period referred to as a "flight". Eggs laid during these flights give rise to the first generation of the new season. Adults of the first generation produce the second generation. Up to three generations per season may occur in Victoria, depending on prevailing weather conditions.

A varying proportion of mature larvae from the second generation enter diapause instead of emerging as adults during the current season. What proportion of larvae enters diapause depends on the temperature conditions during the season. Most of the larvae in the third generation enter diapause. Larvae that enter diapause spin cocoons within which they survive the winter.

Effect of temperature on codling moth

The body temperature of insects is closely related to the temperature of the surrounding environment. The growth of an insect increases as temperature increases until the optimum temperature for the particular type of insect is exceeded; at this point the growth rate rapidly declines (Figure 1). The temperature below which the growth of a given type of insect is assumed to be zero is called the lower developmental threshold for that insect and is estimated from the growth curve (Figure 1).

The lower developmental threshold for codling moth is 10 degrees Celsius. When temperature is traced through a series of days and compared to an insect's lower

developmental threshold the amount of its growth on any given day can be estimated. In Figure 2 the shaded area represents an estimation of insect growth in physiological time units called degree-days. A degree-day is essentially each degree of temperature by which the average temperature on a day exceeds the lower developmental threshold.

It is important to note that physiological time varies from day to day but chronological time is constant. The eggs, larvae and pupae of codling moth each have specific physiological time requirements to complete development before they transform to the next stage. Temperature also affects the flight, mating and egg laying activities of the adults. Although the minimum threshold for emergence of moths is 10 degrees C, male moths do not fly until temperatures exceed 13 degrees C and codling moths do not mate until temperatures exceed 16 degrees C. Table 1 lists the minimum thresholds and the physiological time requirements of codling moth during its various stages of development and activities.

Pheromone traps

Adult female codling moths release a sex-attractant chemical (pheromone) to attract male codling moths. Synthetic pheromones are used in traps to indicate the presence of male codling moths in orchards. Pheromone-trap catches and temperature records can be used to predict when the eggs resulting from a particular moth flight will be hatching. Such predictions, if accurate, should allow better timing of spraying. Further advice on the use of pheromones can be obtained from the author.

Table 1. Physiological time requirements and minimum thresholds for various stages and activities of codling moth

Stage	Activity	Minimum threshold (°C)	Physiological time required (DD°)	
			Average	Range
Adult	Male flight	13		
	Mating	16		
	Egg laying	16		
Egg	Hatch	10	89	69 - 111
Larva	Hatch to maturity	10	264	200 - 345
Pupa	Pupation to emergence	10	222	133 - 325

Biological control

Codling moth eggs are preyed on by earwigs and mirid bugs but neither give significant control. Wasps such as *Trichogramma* parasitise codling moth eggs and have been used with some success in Russia. Under Australian conditions, the rate of parasitism was too low for commercial use.

Removal of over-wintering sites by scraping loose bark from trees and maintenance of general orchard hygiene may help to reduce the survival of over-wintering populations. Similarly, provision of artificial cocooning sites such as bands of cloth or corrugated cardboard wrapped around the trunks allows over-wintering larvae to be trapped and destroyed. These methods are generally too time consuming and expensive for adoption by commercial growers.

Mating disruption is a technique in which the orchard air is saturated with pheromone emitted from slow-release dispensers. This prevents male moths from using pheromone, emitted from female moths, to locate and mate with the females. Mating disruption products are now available commercially for large scale orchards.

Codling moth larvae are susceptible to infection by a virus that can devastate localised populations. The virus has been developed into a commercial product overseas but local trials in Australia have had disappointing results. A parasitic nematode has shown promise for control of over-wintering larvae.

Chemical control

For recommendations on chemical control of codling moth refer to the current edition of the Orchard Pest and Disease Handbook available from district offices of DPI.

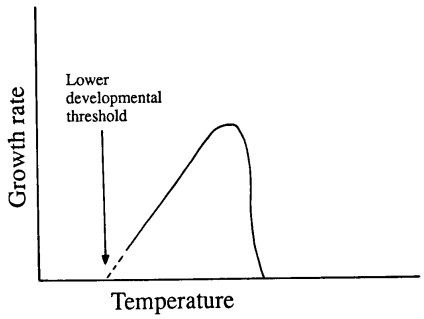

Fig 1. Effect of temperature on the growth rate of insects.

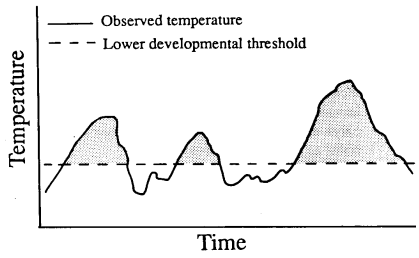

Fig 2. Effect of temperature on amount of insect growth