5.2 CLIMATE EFFECT ON INSECT FLIGHT

Fact Sheet Objectives

- Describe the effect of temperature, wind and rainfall on the flight activity of key fruit pests in New Zealand
- Examine the implications of these factors on the performance of pheromone traps
- Explain the impact of wind on the dispersal and movement of scale insects
- Describe the effect of rainfall on the development of Apple Leafcurling Midge populations

Flight activity of key pests

Codling Moth flight

Codling Moth

Codling Moth is a small (8-10mm) silvery moth with copper brown wing tips that attacks apples, pears and walnuts.

- There are 1-2 generations of each season with flight commencing in early October in northerly regions and late October in Otago.
- Male moths emerge 7-10 days earlier in spring than females with flight activity peaking in mid-summer and continuing until late March.
- Codling Moth activity is strongly influenced by temperature and there is little moth flight activity when twilight temperatures are below 15^{o}C.
- Egg-laying only takes place on fruit and adjacent leaves once twilight temperatures are above 15^{o}C. Egg-laying activity increases significantly in response to high evening temperatures.
- Codling Moth movement is relatively limited and only a small proportion of female moths have the capacity to move between orchards but this movement can be assisted by wind and exceed 250m.

Leafroller flight

Light Brown Apple Moth

Lightbrown Apple Moth (LBAM) is small (8-12mm), is light tan and brown in colour and is an important pest of many fruit crops and ornamental plant species in New Zealand.

- There are typically three generations of moths each season with peaks in moth activity in spring, mid-summer and autumn but can occur year-round.
- LBAM is usually a nocturnal flier with greatest activity between 8-12pm.
- The lower temperature threshold for flight is 8^{o}C and the upper threshold for flight varies with each generation; in spring 20-21^{o}C, summer 24-25^{o}C and in autumn 27-28^{o}C

- Activity is also markedly affected by wind speed with no flight occurring above at wind speeds greater than 10km/hr.
- Most female moths move only short distances (<50m) while male moths are general more dispersive (>150m) and some move up to 1.5 km.
- Low rainfall conditions appear to favour adult flight activity and no adult flight occurs once daily rainfall exceeds 30-40mm.

Oriental Fruit Moth flight

Oriental Fruit Moth is a small (6-7mm) dull charcoal-gray non-descript moth that has 3 - 4 generations in northern locations.

Oriental Fruit Moth

- While initially it appears to attack only summerfruit crops, it can also be an important pest of apples, pears, quince and some ornamental species e.g. *Photinea*
- The moths normally fly in the evening just after sunset and occasionally between daybreak and sunrise. There is little moth flight activity when twilight temperatures are below the flight threshold of 15-16^{o}FC.
- Wet weather following a dry spell can kill many of the larvae in twigs when they are drowned by increases in sap flow.
- They disperse readily from adjacent host plants into orchard blocks and male moths have the potential to move 800m within 7 days.

Implications of climatic factors on pheromone trapping

Estimating pest levels within the orchard is an essential part of an effective pest management programme. Pheromone traps are a key pest monitoring tool of the key pests Codling Moth, Oriental Fruit Moth and Leafroller.

Pheromone trap

Temperature

Low evening temperatures (15^{o}C or below) depresses the flight activity of Codling Moth and Oriental Fruit Moth and therefore reduces trap catch particularly in October and November when evening temperatures are still highly variable.

- *Codling Moth*: the reduced reliability of trap information with low spring temperatures is overcome by highly recommended 'petal-fall' or first cover insecticide treatment. For specific regional timings refer to the Factsheet series "Effect of temperature on fruit pests".
- *Oriental Fruit Moth*: although moth activity is influenced by evening temperature in October and November, specific insecticides are not usually applied for control of the first generation.
- *Leafroller:* LBAM has a lower temperature flight threshold (8°C) suggesting that trap catches of these moths provide more reliable estimates (c.f. Codling Moth) of population density and are less affected by low and variable evening temperatures in October and November.

Wind

- Windy conditions reduce the flight of these three important moth pests so in October and November when equinoxial winds prevail, flight activity is reduced and the number of moth in traps will be depressed.
- Evening winds above 10km/hour reduce the ability of moths to locate pheromone traps. Windy conditions disturb the pheromone plume and air flow that would normally develop around the pheromone cap and trap which in turn reduces the moth catch.

Rainfall

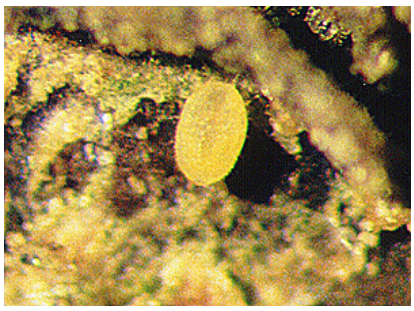
- Little, if any Codling Moth or Leafroller activity is likely to occur on days when rainfall exceeds 30mm.
- Wet weather not only reduces trap catch but also erodes pesticide residues protecting the fruit crop. This is particularly important in early summer as rainfall may inhibit trap catch.

Effect of wind on insect movement

Scale insects

- Armoured scale insects ability to disperse is greatly assisted by the transfer of infested plant material but aerial transportation of newly emerged crawler stages suggests that wind is a significant climatic factor.
- Newly emerging crawlers wander on the host for some time before they settle and activity is greatest when the temperature is above 15^{o}C. Crawling behavior is inhibited by winds above 28km/hr but they do move passively by wind currents.
- Some species of scale insects have been found to travel over 300m downwind and in some instances long-distance aerial transport of over 80km has been reported.
- Many shelter plants are significant hosts of scale species infesting fruit crops (e.g. San José scale) and these include Elm, Poplar, Walnut, Matsudana Willow, Birches, Alder and Plum.
- Movement within orchards appears to be more localised and distribution from infested shelter is probably a function of shelter height and location.
- San José scale has been shown to infest trees up to five rows (~30m) from adjacent infested shelter while Oystershell shell has been shown to infest fruit at 60-70m from a heavily infested source.

San José scale



Newly-hatched crawler (magnified)

Implications of rainfall on insect activity

Some insect pests are cued to rainfall events and these are usually an adaptation to survival under low rainfall conditions.

Apple Leafcurling Midge adult

Apple Leafcurling Midge

Apple Leafcurling midge is a significant pest of apples in some regions and the greatest control difficulties are in regions with high summer rainfall.

- Seasonal development of midge populations is continuous in Waikato and Nelson because there is regular summer rainfall and this results in 5 - 6 generations per year.
- In drier regions and/or seasons midge development can be arrested from mid-November when lack of rain delays the exit of fully-grown larvae from hardened leaf rolls.
- This can limit the number of generations to 3 - 4 year in Hawke's Bay and reduces total midge activity, leaf and fruit infestation in mid and late summer.

Apple Leafcurling Midge damage

Summary

- Codling Moth and Oriental Fruit Moth are active at dusk and have similar flight threshold temperatures (15^{o}C) whereas moths of the major Leafroller pest (LBAM) are active at temperatures down to 8^{o}C.
- Pheromone trap catch for Codling Moth is reduced by cool evening temperatures in early summer and results in under-estimates of the potential moth activity. This is risk is managed by use of a phenology-based insecticide treatment.
- Flight activity of the major Leafroller species (LBAM) is relatively unaffected by spring temperatures.
- Wind speeds above 8km/hr reduce the moth flight activity but wind transport facilitates the spread of scale insects (>60m) into adjacent orchard blocks.
- Extended rainfall (>30mm) reduces moth activity and trap catch but is a factor in increasing

Further information

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