The use of sex pheromone lures to compare pear and apple leafcurling midge phenology

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Abstract Pear leafcurling midge (*Dasineura pyri*, PLCM) is a gall midge in the family Cecidomyiidae and is a persistent pest in New Zealand.Whilst mature trees can withstand considerable damage, feeding by larvae can cause severe distortion (galling) of developing leaves on younger trees. Apart from obvious leaf damage, PLCM activity is difficult to detect so the recent development of the synthetic sex pheromone provides a useful monitoring tool for this pest. Pear leafcurling midge pheromone traps were set up in four commercial pear blocks across the Nelson district, which is the main commercial pear-growing area in New Zealand, to assess the ability of the pheromone lure to monitor seasonal activity of the pest. Trapping results are compared and discussed in relation to apple leafcurling midge activity in five apple blocks in the same region.

Keywords pear leafcurling midge, *Dasineura pyri,* apple leafcurling midge, *Dasineura mali*, sex pheromone, phenology monitoring.

INTRODUCTION

Pear leafcurling midge, (*Dasineura pyri,* Bouché, PLCM) is of European origin and was first recorded in New Zealand in 1916 at Avondale, Auckland, and by 1925 had spread throughout pear-growing regions (Miller 1925). Apple leafcurling midge, *(Dasineura mali* Kieffer, ALCM) was first recorded in Auckland, New Zealand, in 1950, probably from infested apple stocks from the Netherlands (Morrison 1953) and is now wide spread throughout the country in apple-growing regions (Penman 1984). Apple and pear leafcurling midge are closely related but morphologically distinct (Gagne & Harris 1998). They are short-lived gall midges of the family Cecidomyiidae that are highly specific to their host crop and have four life stages: egg, larvae, pupa and adult. Their seasonal life cycle starts in spring around the time their host trees are flowering, with adults emerging from pupae that have spent winter in the ground. The development from egg to adult is completed in 25-30 days in New Zealand, and six generations of PLCM a year have been reported (Miller 1971). In Germany only four generations were reported by Kolb (1982). Virgin female PLCM produce a highly potent sex pheromone to attract males (Hall et al. 2012). Mated female midges then lay their eggs concealed inside unfurling leaves on growing shoot tips in a similar manner to ALCM. PLCM eggs are pale and are harder to see than the bright orange and more easily visible ALCM eggs. Young larvae hatch and feed on the tender new leaves causing the leaf to curl up tightly parallel to the midrib with the larvae protected inside the curled leaf. After feeding for about 2 weeks, larvae leave the rolls and drop to the ground where they pupate in the top 5 cm of soil. Because adult midges target young vigorously growing shoots to lay their eggs, feeding larvae generally cause only minor damage to mature trees, but on young newly planted or grafted trees, and in nurseries, they can cause severe damage and stunt new growth. Components of the sex pheromone for PLCM were identified by Amarawardana (2009). The pheromone chemistry was detected by linked GC-EAG and identified as a novel 17-carbon unsaturated diester. Four isomers were identified, one of which was found to be attractive to male PLCM. The purpose of this work was to evaluate the performance of the newly derived PLCM sex pheromone lure as a monitoring tool and to compare seasonal activity of PLCM with ALCM.

MATERIALS AND METHODS

Sites

Four orchards with mature 'Beurre Bosc' pear blocks and five orchards with mature 'Braeburn' apple blocks, both run under Integrated Fruit Production (IFP) standards, were selected from the Nelson pipfruit-growing region to monitor activity of pear and apple leafcurling midge.

Trapping

The delta trap design, colour, height of deployment and the type of pheromone dispenser used were all based upon ALCM research to develop lure and trap recommendations (Suckling et al. 2007; Cross & Hall 2009). Two red delta-type traps were set up in each block with sticky bases (190 × 180 mm) inside the traps loaded with rubber septa as the dispenser for the appropriate pheromone (either PLCM or ALCM depending on the property). Rubber septa were loaded with an experimental dose of 5 µg of pheromone for PLCM and the standard dose of 3 µg for ALCM. One pheromone trap was placed within the tree at a height of approximately 0.5 m, 20 m into the block, and this placement was repeated four rows over within the same block for the second pheromone trap. All pipfruit blocks were visited weekly from 6 September 2010 until 25 April 2011 and the pheromone trap bases were changed at these times. The bases were examined in the laboratory with a binocular microscope and counts of the captured midges recorded.

RESULTS

The PLCM pheromone lure was effective and male PLCM were caught in sufficient numbers throughout the 2010-2011 growing season to enable a comparison of the seasonal pattern of activity of the respective midge species, both of which had a total of four generations for the season. The main differences between male PLCM and ALCM trapped throughout the season appeared to be the period of time the midges were active, the timing of peak trap catches throughout the season and when the highest peak trap catch occurred. The PLCM traps also recorded a large variation between sites in mean total number of midge caught over the trapping period (237 to 2731).

Comparing the first and last catches of PLCM and ALCM for all four pear blocks and all five apple blocks, the PLCM catch started later and finished earlier, with an overall difference of 49 days indicating a shorter period of activity (Table 1). The dates that the trap catches peaked for these two midges also varied with the first or overwintering generation peak for PLCM occurring after ALCM but all other peaks occurring earlier than the ALCM (Table1). PLCM generations peaked in size with the second generation with diminishing peaks thereafter. The generation peaks for ALCM grew in size from the first peak with the third much later in the season (Figure 1).

DISCUSSION

Currently the main monitoring method for pear growers to determine if control of PLCM is necessary is to count the incidence of egg-infested shoot tips (Harris et al. 1996) and apply a suitable insecticide if required. This is easy for ALCM eggs that are bright orange, but because PLCM eggs are pale and very hard to see, monitoring is difficult. For both midge species egg monitoring is cumbersome and time-consuming. The synthetically produced PLCM pheromone lures containing the isomer attractive to male midges provide a simple,

Table 1 First and last catches and generation peak dates for pear leafcurling midge (PLCM) and apple leafcurling midge (ALCM) with variation between the two in days for the monitoring period between 6 September 2010 and 25 April 2011 on Nelson orchards.

	Generation peak	PLCM	ALCM	Variation
First catch		27 Sep	6 Sep	21
	1	11 Oct	27 Sep	14
	2	22 Nov-7 Dec	20 Dec	14-28
	3	10 Jan	7 Feb	28
	4	7 Feb	21-28 Mar	42-49
Last catch		21 Mar	18 Apr	28

accurate and more practical monitoring tool for this pest particularly to distinguish seasonal peak activity of males and associated peak egg-laying periods of females soon after. This monitoring tool can help identify the timing of life stages following peak adult flight, such as eggs and young larvae, both of which are more susceptible to control by pesticides than the mature larvae concealed in rolled leaves, as has been shown for ALCM (Burnip et al. 1998). Differences in the male flight phenology of PLCM and ALCM were identified and while four generations were recorded for both midges for the season studied, it has been shown that the period of activity for PLCM is compressed compared with ALCM with second and subsequent generation peaks, all occurring earlier than generation peaks for ALCM. The main (second generation) peak for PLCM occurred much earlier in the growing season compared with ALCM where the main generation was the third. The subsequent PLCM generation peaks reduced as the season progressed.

This pattern of an early large PLCM population is probably linked to pear tree physiology and an observed shorter period of active shoot growth

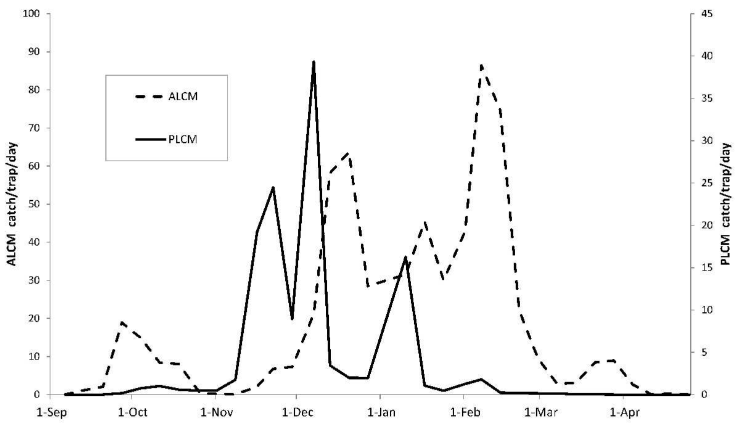

Figure 1 The mean number of pear leafcurling midge (PLCM) from four sites and apple leafcurling midge (ALCM) from five sites on Nelson orchards, trapped between 6 September 2010 and 25 April 2011.

that results in a lack of suitable oviposition sites later in the season. The four generations recorded for PLCM is the same number as reported by Kolb (1982) in Germany but quite different from the six reported by Miller (1971) in New Zealand. This is probably due to the use of the synthetic sex pheromone, which allowed the present research to distinguish between generations with more accuracy. The total number of PLCM trapped varied by site and was consistent with the observed number of shoots damaged at each site, demonstrating that pheromone traps can give an indication of midge population size at individual orchards. As pear and apple crops can be grown together in commercial pipfruit orchards, particularly in the Nelson region, it should now be possible to monitor each midge species separately. This is useful because the timing of generation peaks for the respective species are different and pheromone monitoring will provide more accurate timing of insecticide interventions if necessary. This is especially important in young newly-planted or newly-grafted pear blocks and nurseries where most damage can occur to vegetative growth.

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