Improved monitoring of oriental fruit moth (Lepidoptera: Tortricidae) with terpinyl acetate plus acetic acid membrane lures in Uruguayan orchards

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INTRODUCTION

The use of sex pheromones for the management of oriental fruit moth, *Grapholita molesta* (Busck), has been broadly adopted throughout its worldwide distribution in both stone *(Prunus* spp.) and pome *(Malus domestica* Borkhausen, and *Pyrus* spp.) fruits and now includes the use of hand-applied dispensers, aerosols, sprayables and attract and kill formulations. One limitation with sex pheromone-based management programs is the difficulty in monitoring pest populations with sex pheromone-baited traps. A series of studies have recently reported on the use of terpinyl acetate in a sticky trap (2; 3) and the use of a new pheromone lure that uses the combination for the three-component sex pheromone of *G. molesta* plus the sex pheromone of *Cydia pomonella* (L.) (4; 6). Recent studies with other important tortricids, such as *C. pomonella* (5), and several tortricid leafrollers (7; 1) have shown catches can be significantly increased when kairomones are combined with acetic acid.

MATERIALS AND METHODS

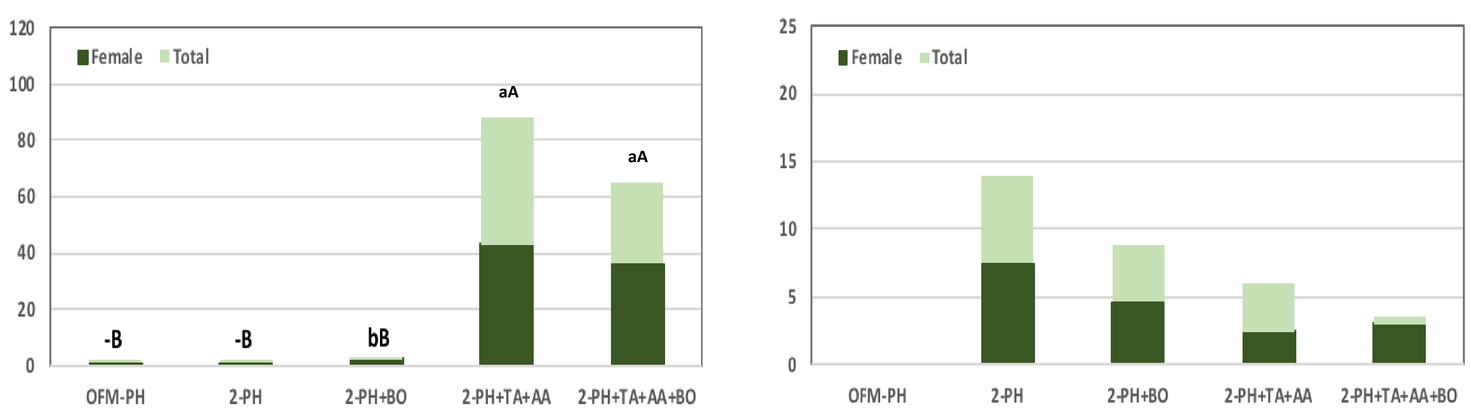
Male and female moth catches of *G. molesta* in traps baited with various septa and membrane lures were evaluated in stone and pome fruit orchards treated with sex pheromones for mating disruption from 2015 to 2017. Membrane lures were loaded with terpinyl acetate (TA), acetic acid (AA) and (*Z*)-3-hexenyl acetate alone or in combinations. Two septa lures were loaded with either the three-component sex pheromone blend for *G. molesta* alone or in combination with codlemone (2-PH), the sex pheromone of *C. pomonella*. A third septum lure included the combination sex pheromone blend plus pear ester, (*E,Z*)-2,4-ethyl decadienoate (2-PH/PE), and a fourth septum was loaded with only β-ocimene. The first study was conducted from 15 December to 18 January (2015 – 2016) in a peach orchard treated with Isomate OFM dispensers (Pacific Biocontrol) at 250/ha and was adjacent to commercial apple orchards. This study compared five lures, including OFM-PH, 2-PH, 2-PH + BO, 2-PH + TA + AA and 2-PH + TA + AA + BO. The second study was conducted during 2016-2017 and consisted of three trials. Trial 1 was conducted from 25 January to 10 February in a "Fuji" apple block treated with OFM/CM puffers (Suterra) at 2.5 units/ha. The second trial was conducted from 26 January to 16 February in peaches treated with Checkmate OFM (Suterra) at 250 dispensers per ha. The third study was conducted from 26 January to 16 February in peaches treated with the paste formulation, SPLAT OFM (ISCA Technologies) at 3.7 kg/ha.

RESULTS

- The addition of β-ocimene or (*Z*)-3- hexenyl acetate did not increase moth catches.
- The addition of pear ester to the sex pheromone lure only marginally increased moth catches.
- The use of TA and AA together significantly increased moth catches compared with the use of only one of the two components.
- The addition of TA/AA significantly increased moth catches when combined with the 2-PH lure.
- The TA/AA lure also allowed traps to catch both sexes.
- Catch of *C. pomonella* with the 2-PH lure was comparable to the use of codlemone.

Optimization of these complex lures can likely further improve managers ability to monitor *G. molesta* and help to develop multispecies tortricid lures for use in individual traps. The complexity of combining sex pheromones with host plant, and microbial volatiles for a suite of species may be too great to create one optimized lure. Instead, the use of suboptimal lures with some sufficient attractiveness across all species might be sufficient to establish action thresholds and to reduce monitoring costs.

Grapholita molesta *Cydia pomonella*



Comparison of female and total moth catches of *Grapholita molesta* (a) and *Cydia pomonella* (b) in traps baited with individual and combinations of the sex pheromone (OFM-PH), the combination sex pheromone (2-PH), β-ocimene (BO), terpinyl acetate (TA) and acetic acid (AA) lures, Uruguay 2015–2016. No female *G. molesta* were caught in traps baited with the two pheromone-only lures, and these data were not included in the analysis, denoted "−". Treatment histograms with different lower case and upper case letters were significantly different in female and total moth catches, $p < 0.05$. Catches of *C. pomonella* did not differ among lure treatments, $p > 0.05$

Comparison of lures with various blends in a series of three trials conducted in Uruguay testing septa lures loaded with the sex pheromone of *Grapholita molesta* (OFM-PH), the combination sex pheromone of *G. molesta* and *Cydia pomonella* (2-PH), the combination sex pheromone plus pear ester (2-PH/ PE) and/or β-ocimene (BO), and a membrane cup lures loaded with terpinyl acetate (TA) and acetic acid (AA) together (TA/AA) and with (Z)-3- hexenyl acetate (TA/AA/Z3), 2016

Mean (SE) moth catches [a]					
Trial No.	Lures Septa	Membranes		Total	Females
1	OFM-PH	– –	– –	6.6 (1.6)	0.2 (0.2)
	2-PH	– –	– –	17.6 (4.7)	0.0 (0.0)
	2-PH/PE	– –	– –	18.0 (5.9)	0.0 (0.0)
	2-PH	BO	– –	13.8 (3.3)	0.0 (0.0)
	2-PH/PE	BO	– –	18.0 (5.7)	0.0 (0.0)
Stats				$F_{4,20} = 1.37$ $p = 0.28$	--
2	OFM PH	--	--	0.2 (0.2)	0.0 (0.0)
	2-PH	--	--	0.2 (0.2)	0.0 (0.0)
	2-PH	--	TA/AA	2.6 (0.7)ab	1.6 (0.9)
	2-PH/PE	--	TA/AA	2.4 (0.9)ab	1.6 (0.6)
	2-PH	BO	TA/AA	2.8 (1.2)a	2.4 (1.3)
	2-PH/PE	BO	TA/AA	1.6 (0.4)ab	1.2 (0.4)
Stats				$F_{3,16} = 0.31$ $p = 0.82$	$F_{3,16} = 0.05$ $p = 0.99$
3	OFM PH	--	--	20.0 (7.8)	0.0 (0.0)
	2-PH	--	--	45.6 (7.5)	0.0 (0.0)
	2-PH	--	TA/AA/Z3	33.6 (5.1)	1.0 (0.4)
	2-PH/PE	--	TA/AA/Z3	31.6 (5.4)	0.4 (0.2)
	2-PH	BO	TA/AA/Z3	35.0 (4.4)	0.2 (0.2)
	2-PH/PE	BO	TA/AA/Z3	33.6 (4.6)	0.6 (0.4)
Stats				$F_{5,24} = 2.21$ $p = 0.09$	--

Note. Column means followed by a different letter were significantly different, $p < 0.05$.
[a]Data were excluded from the analyses if the mean was ≤0.6 moths per trap.

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