DISRUPTION OF INTERNAL-FEEDING LEPIDOPTERA IN APPLES USING THE EXOSEX SYSTEM, 2006

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This trial was conducted in mixed plantings of processing apples on two commercial farms in Wayne Co., NY. A mating disruption system employing an electrostatically charged pheromone-containing powder was evaluated for efficacy in managing three internal-feeding Lepidoptera species, codling moth (CM), *Cydia pomonella*; oriental fruit moth (OFM), *Grapholita molesta*; and lesser appleworm (LAW), *Grapholita prunivora*, when applied against all seasonal generations of these pests. Apple varieties included Cortland, Ida Red, and Rhode Island Greening.

Materials & Methods

In 2006, an internal worm management program was tested in one "low-moderate risk" (DeBadts) and one "moderate-high risk" (Knapp) commercial orchard, using a novel pheromone dispensing technology directed against all generations of these species during the season. The treatments used were Exosex Advanced Mating Disruption System (Exosect Ltd., Southampton, UK), which employs a series of trap-like dispensers containing a pheromone lure plus a tray of fine natural wax powder that contains pheromone lure and is electrostatically attracted to the insect's body parts. This is intended to work using the following principle: When the male moth, attracted by the dispenser's pheromone lure, walks across or flies close to the powder-coated tray surface, the powder adheres to all its body parts, including the antennae, which become coated and saturated by the pheromone. This prevents the male from being able to detect the natural pheromone of calling females; additionally, a powder-coated male moth produces a "false" pheromone trail as it flies, which further disrupts the communication between other male and female moths and potentially promotes powder transfer to males attracted to this secondary "false" source. It is anticipated that any delay in a female's mating caused by this process will reduce her fertility and, therefore, also the viability of her eggs.

Separate dispensers were used for codling moth and oriental fruit moth; the OFM product was directed additionally against LAW, as these two species have similar pheromone blends. In addition to the Exosex treatments, the growers applied their current pesticide programs against these and all other arthropod pests on their farm. The Knapp orchard (Idared) is certified organic, and Debadts (R.I. Greening and Cortland) is managed conventionally. Both farms produce fruit for processing; plot size was 2 ha (5 acres) at each site. The specifics of the Exosex applications were:

Exosex OFM was applied between 26–27 April, and consisted of the following:

Trap-like dispensers with a tray of 60 small wells containing 2.5 g of OFM pheromone powder (0.0085% Z8-12:OAc, 0.0006% E8-12:OAc, and 0.0001% Z8-12:OH, remainder inert wax powder carrier), deployed in the top third of the trees' canopy at a rate of 25 per ha (10 per acre).

Exosex CM was applied on 2 May, and consisted of similar dispensers but instead containing 2.5 g of Codlemone (0.1% [(E,E)-8,10-12:OH], remainder inert wax powder carrier), deployed in the top third of the trees' canopy at a rate of 25 per ha (10 per acre).

Records were kept of the amount of time required for application and maintenance of the pheromone dispensers, and the following average times were determined: dispenser assembly, 0.3 person-hr/A; dispenser deployment, 1.15 person-hr/A (per species); dispenser tray change, 0.8 person-hr/A; dispenser lure change (OFM only), 0.8 person-hr/A. Total, 4.2 person-hr/A.

Pheromone treatment efficacy in depressing adult male trap catch was monitored by using 15 monitoring traps per site: 5 each of Exomonitor traps for OFM and CM (baited with Exosex lures), plus 5 Pherocon IIB traps (baited with standard Scentry rubber septum lures) for LAW per plot, in 3-species groupings located at relatively uniform spacings throughout the plots' interiors, and checked weekly from 1 May to 23 August. In addition, a group of 9 Pherocon IIB traps in a non-disrupted check plot nearby (approximately 100 m at DeBadts, and 300 m at Knapp) and another group of 9 traps in a conventional mating disruption plot on the same farm was monitored as well, to maintain information on background levels of each of these species and for purposes of fruit injury comparison at harvest. (This conventional mating disruption program at DeBadts was against OFM only, consisting of Isomate M-100 ties applied at 250/ha [100/A] on 15 June; at Knapp, Scentry OFM/CM spirals were applied at 500/ha [200/A] on 10 June.) The Exosex powder dispenser trays were replaced on 6 July for both species at DeBadts and for OFM at Knapp; because of a shipping error, the trays for CM could not be replaced at Knapp until 19 July. Lures in all the monitoring traps were changed on 7 July; lures in the OFM dispensers were replaced on 9 (Knapp) and 16 (DeBadts) August.

An on-tree non-destructive fruit sampling protocol was used to monitor the progress of any larval fruit infestations during the summer, and consisted of weekly on-tree fruit inspections conducted from mid-July through August, comprising 100 fruits per plot (10 on each of 10 trees). An evaluation of larval fruit-feeding damage at harvest was made by taking random samples of 1000 fruits from each plot (20 from each of 5 trees along each plot edge, and 20 from each of 30 trees distributed throughout the plot interior) and examining them for internal and surface injury. Pre-harvest samples were taken between 22 Sept–6 Oct. At the Knapp site, the conventional mating disruption block was picked out before we were able to evaluate harvest damage, so no conventional MD harvest fruit damage data are available for comparison with the other treatments.

Results

Trap catches of adults were generally suppressed to low levels in Exosex treatment plots during the mid- and late summer, although some breakthrough captures did occur, so trap shutdown was not absolute in all cases (Fig. 1). At both sites, oriental fruit moth pressure was moderate, and the highest numbers trapped in the Exosex plot were during the final 2 wk of the monitoring period, from 16-23 August; in neither case did levels exceed 10 moths/trap, which is generally presumed to be a provisional treatment threshold. The conventional mating disruption plots had catches at or near zero most weeks. For codling moth, adult pressure was much lower in both sites, and adult catches in the Exosex plots were very low or zero in all cases, and never exceeding 0.5 moths/trap. Lesser appleworm pressure was roughly comparable to OFM at each farm, and Exosex plot numbers sometimes peaked above those in the non-disrupted checks, but this is not considered to be as serious a pest as the other two species, so the significance of these occurrences is not known.

An anomaly arose regarding the efficacy of the Exomonitor traps' ability to accurately reflect actual moth population numbers in these orchards. Because OFM infestations in New York are often accompanied by concurrent populations of the congeneric lesser appleworm (*G. prunivora*), our evaluations of OFM mating disruption programs often include an examination of their effect on LAW populations. These two species share a similar pheromone blend (LAW - 98:2% of Z:E-8 12-OAc; OFM - 92:8% of Z:E-8 12-OAc), so they can be caught in each other's traps, and both are generally impacted by OFM pheromone disruption products. For this reason, we included LAW monitoring traps in all plots, using our standard Pherocon IIB model with a Scentry lure, as we did not have an Exomonitor LAW trap. In our weekly trap monitoring, there were many occasions when no (or few) OFM would be caught in the Exomonitor OFM traps, but considerable numbers would be found in the adjacent Scentry-baited LAW traps. This trend predominated throughout the season, such that of all the OFM specimens collected in traps deployed in the two Exosex plots, 85.4% of them were taken out of LAW traps; on seven different dates, the only OFM collected were from LAW traps, with the respective Exomonitor OFM traps having caught zero. For this reason, we feel that future assessments of this technology should include side-by-side comparisons of similar monitoring trap and lure combinations in order to provide the most reliable indication of pest population presence and activity in the treated blocks.

The fruit sampling procedure produced results generally consistent with the pest histories of these respective farms, showing a fairly problematic larval population at Knapp, and quite low infestation levels at DeBadts. At the former site, a number of damaged fruits were detected in the Exosex plot during 3 of the 5 weekly inspection sessions, although at levels considerably lower than in either the conventional mating disruption or untreated check plots (Table 1). At DeBadts, however, no damaged fruits were ever found.

Fruit damage at harvest caused by internal-feeding Lepidoptera was fairly low in all treatments, and never surpassed 2% in any treatment (Table 2). At both sites, there was no statistical difference between the Exosex and the Grower Standard (non-disrupted) plots. At the DeBadts site, the percent clean fruit in the conventional mating disruption plot was significantly higher than in the Exosex plot, and was the same as the Grower Standard. In all cases, fruit damage levels were well within acceptable limits.

Although the Exosex treatments tested could potentially be a useful component of the internal lepidopteran management programs in these orchards, the amount of labor and handling time as employed in this trial was greater than that required using other types of pheromone dispensers (e.g., ~30 min/person/A for Isomate ties). Also, because of the lack of difference in fruit damage between the Exosex and Grower Standard treatments, it would be useful to assess Exosex efficacy in orchards with higher pest pressure. Further work should focus on reducing the time input required to use this system, and its efficacy when used in place of preventive pesticide applications, rather than in addition to them.

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Table 1. Detection of larval-infested apples during summer fruit inspection dates in Exosex and pheromone-treated plots, 2006.

		Percent damaged fruits detected				
	No. fruit inspected	300	100	100	100	100
		7/20	**7/26**	**8/3**	**8/10**	**8/16**
Site	**Treatment**					
Knapp	Exosex	2.7	0	0	6	4
	Mating Disruption	3.3	4	2	7	19
	Grower Standard	29.0	1	6	17	55
DeBadts	Exosex	0	0	0	0	0
	Mating Disruption	0	0	0	0	7
	Grower Standard	0	0	0	0	9

Table 2. Percent deep (internal) and sting (surface) fruit injury[1] at harvest in Exosex and pheromone-treated plots, 2006.

Site	**Treatment**	**Sting**	**Deep**	**Clean**
Knapp	Exosex (OFM, CM)	0.2a	1.7a	98.1a
	Grower Standard (Organic program)	0.1a	1.7a	98.2a
DeBadts	Exosex (OFM, CM)	0.0a	0.4a	99.6a
	Mating Disruption (Isomate: OFM)	0.0a	0.0b	100.0b
	Grower Standard	0.0a	0.1ab	99.9ab

[1]Within a site, values in the same column followed by the same letter are not significantly different at *P*=0.05 level (Fisher's protected lsd test).

Fig. 1. Pheromone trap catches in two WNY orchards receiving Exosex and pheromone treatments against codling moth, oriental fruit moth and lesser appleworm, 2006.