Comparison of Different Pheromone Release Systems for Mating Disruption of the Obliquebanded Leafroller Integrated With a Biorational Insecticide
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Abstract

The effectiveness of two different types of pheromone release systems in disrupting OBLR mating and subsequently preventing fruit damage were compared in 2.6–5.6-acre blocks in three commercial orchards in western NY: (1) Microsprayers (aerosol spray-burst devices, MSU), one application setup for the summer (Doyle and Oakes orchards); (2) Paraffin-based pheromone emulsions (Agrium), one application per summer generation (Mitchell orchard). Each of these treatments was combined with a 3-spray program of spinosad (SpinTor), an IPM-compatible insecticide that is naturally derived. Small sections of each block were left unsprayed to test the effectiveness of the pheromones alone. The different pheromone release treatments were evaluated by comparing male trap catches in pheromone traps with standard (Trécé) lures, and control was assessed by sampling growing terminals for OBLR larval infestations, and fruits for feeding damage, both in the summer and at harvest in the fall. All results were compared with similar samples taken from a comparable orchard on each farm managed under each grower's respective standard OBLR program.

Trap catch results indicated pheromone disruption at the Doyle and Mitchell orchards, but little effect was seen at the Oakes site. At Doyle's, the traps located in Check blocks caught many more moths, indicating that the pheromones in the disruption block disoriented the male moths. The catches at Oakes' were similar in the Check and Disruption blocks, showing that the presence of pheromones in the disruption blocks did not affect the male moths' ability to locate the females. However, the raw number of moths caught at Oakes was significantly lower than the number caught at Doyle's and Mitchell's. The highest catch at Oakes' was 13 (per trap per 3-day period), compared with Doyle's high of 69.5. It is possible that the pheromones were not as effective at the lower moth populations.

Results of terminal infestation samples were inconclusive. At Oakes' Orchard, the blocks with the pheromone-only treatment had the highest infestation (8%). At Doyle's and Mitchell's, however, the treatments exhibited statistically comparable infestations between 1–10%.

The fruit damage results from inspection in early August and again at harvest indicate that a combination of pheromones and insecticides could result in a lower percentage of damaged fruit, although these differences were not always statistically significant. At Doyle's Orchard, the percent damaged fruits was 2% lower using the combination of pheromones and insecticides, compared with using pheromones alone. Treatment differences were clearest at Oakes' Orchard, with 2.3% damage in the combination plots, and 10–11% using either method alone. Further commercialization of either of these dispensers will depend on their effectiveness against problem populations, as well as the economics of employing them either alone or in combination with selective insecticides.

Background

The obliquebanded leafroller (OBLR), *Choristoneura rosaceana*, is currently considered to be the most important arthropod pest in commercial apple orchards in Western N.Y. This pest overwinters as small larvae (overwintering generation) and completes one generation during the summer (summer generation). Although larvae from both generations feed upon fruit, damage from the summer generation is more serious than that from overwintering larvae. OBLR became a serious pest in commercial apple orchards in western N.Y. in the mid-1970's, apparently because it became resistant to commonly used organophosphates. Insecticide resistance has gradually proliferated throughout the years in OBLR populations in commercial apple orchards in western N.Y., and now the more recently introduced organophosphate insecticides such as Penncap-M and chlorpyrifos have become less effective than in the past. A few populations have also become resistant to esfenvalerate. Growers in areas severely infested with OBLR commonly apply 4–5 special sprays to control this pest throughout the season. Even in these orchards receiving multiple sprays, it is not uncommon for growers to suffer 5–10% fruit damage, which may result in revenue losses of several hundred dollars per acre.

Extensive research has been conducted in the past to evaluate pheromone disruption of mating of OBLR as an alternative control tactic in N.Y. apple orchards. Different pheromone blends, placement of dispensers, release rates, integration with insecticide sprays, and effectiveness of disruption in different plot sizes, have all been evaluated during the last 5 years in commercial apple orchards in western N.Y. The results of these studies have been variable. In some tests, fruit damage in blocks treated only with pheromone disruption has been comparable to that obtained by growers in standard insecticide treatments. In other trials, pheromone disruption has not provided satisfactory control compared with standard insecticide treatments.

During the last several years, different types of novel pheromone release systems have been used to successfully disrupt mating of various types of lepidopterous pests, including species such as the codling moth, *Cydia pomonella*, which is an important pest in apple orchards. A "microsprayer system" uses machines for releasing pheromones in puffs of atomized liquid from pressurized canisters spaced at relatively wide intervals from each other. The advantages of this system are that the microsprayers can be placed in the trees for optimum spatial release, the amount of pheromone released can be precisely controlled per unit of time, and pheromones are protected from environmental processes such as oxidation and ultraviolet light degradation. Paraffinic emulsions have also been used to release pheromones for mating disruption. These paraffinic emulsion systems are also capable of releasing high concentrations of pheromones from widely spaced point sources. These emulsions are convenient to apply and can be placed on trees by "tree-marking gun" type applicators. Work ws conducted in 1998 to test the effectiveness of these dispensing systems, as well as that of a sprayable formulation not tested in 1999. All pheromone dispnser treatments provided good trap shutdown throughout both of the summer flights, and in areas of relatively heavy OBLR pressure, a combination of pesticide sprays plus pheromone disruption appeared to provide an advantage over pesticides alone.

Spinosad (SpinTor) is a naturally derived selective insecticide compatible with N.Y. apple IPM recommendations that can provide control of OBLR comparable with that of standard insecticides, but it is more costly than using standard materials. In 1999, sprays of this selective insecticide were applied in blocks treated with pheromone using the microsprayer and paraffin emulsion dispensers, to investigate the possibility of obtaining improved control of this pest and determine the practicality of relying on a reduced spray program.

OBJECTIVES

1. To compare the effectiveness of different pheromone release systems (microsprayers and paraffinic emulsion) in disrupting mating and preventing fruit damage by OBLR.
2. To evaluate the effectiveness of integrating novel pheromone release systems and an IPM-compatible insecticide in preventing OBLR fruit damage.

METHODS

These tests were conducted in unreplicated blocks, 2.6–5.6A in size, of commercial orchards composed of medium to large size (10–20 ft tall) trees, which traditionally have been infested with moderate to high populations of OBLR (15–30% damage if untreated): Oakes, Delicious/ Jonamac/Idared; Mitchell, Cortland/Rome; and Doyle, Idared. Two pheromone release systems were tested for disrupting mating of the summer generations of OBLR:

(1) Microsprayers (developed at Michigan State Univ.) On 28 May–1June, these units were placed in the tops of the tree canopies in a regular grid pattern, 4 per acre, throughout the Doyle and Oakes blocks, and dispensed an 8.4% w/w mixture of pheromone in ethanol, using mostly Z11–14 OAc (~97%, with the balance being the "contaminant" E-isomer), at a rate of 0.4 g/hr/A.

(2) Paraffinic emulsion (Agrium Biologicals, Saskatoon, SK), a 5% formulation containing the "natural blend" mixture of: Z11–14OAc (90%), E11–14 OAc (5%), and Z11–14 OH (5%). Applications of 30g AI/A were made once per generation (3–5 June and 3 August) using Idico tree marking guns, by directing the sprayed material primarily into the upper 2/3 of the tree canopies using a uniform number of squirts per tree.

Each block was further divided into a "split plot" treatment, in which variable-sized plots (Doyle, 2 rows by 40 trees; Mitchell, 2 sections of 3 rows by 12 trees; Oakes, 4 sections of 4 rows by 8 trees) were left unsprayed by any OBLR insecticides. The remainder of the blocks were treated by the grower with spinosad (SpinTor). In addition, each orchard received the grower's conventional spray program against the overwintered generation. At each site, a Comparison orchard was designated, which received the grower's standard summer OBLR control program. The pesticide spray application dates were:

Oakes: SpinTor (5 oz/A) – 21 June, 10 and 28 July; (Grower Std), SpinTor (5 oz/A) – 25 June, 10 and 28 July.

Mitchell: SpinTor (10 oz/A) – 31 June and 13 July; (Grower Std), Lorsban (12 oz/A) – 30 June.

Doyle: SpinTor (5 oz/A) – 11, 20, and 29 July; (Grower Std), Lorsban (10.7 oz/A) + Lannate (5.3 lb/A) – 11 July; Lorsban (8 oz/A) – 20 and 29 July.

Disruption of adult male orientation to a pheromone source was assessed by hanging two widely spaced Pherocon wing traps baited with standard Trécé lures in the middle row of each plot. Catches of male moths were recorded 2–3 times each week, and compared with those obtained in similar traps hung in the non-pheromone Comparison blocks at each farm. OBLR larval populations and injury were evaluated in several different ways. Larval infestation levels were assessed on 16–19 July by inspecting 10 terminals randomly selected from around the canopy of each of 10 trees per plot. On 5–9 August, fruit damage was assessed on the tree by inspecting 100 random fruits from each of 4 trees in each plot. Fruit damage levels at harvest were determined by inspecting 100 fruits from each of 4 trees in each plot during each variety's harvest period — Mitchell, Cortland (17 Sept.); Oakes, Delicious/Jonamac/Idared (24 Sept.); Doyle, Idared (1 Oct.) — and grading them into USDA damage categories. These values were compared with damage in nearby trees at each respective orchard that had been treated only with the grower's standard insecticide programs.

RESULTS

The pheromone treatments provided variable trap shutdown throughout the two summer flights, compared with the trap catches in the non-disrupted orchard (Fig. 1). Aside from a spike near the end of June, moth catches in the paraffin-treated Mitchell block were very low throughout the season, particularly during the initial peak catch period at the beginning of June. The catches at Oakes' were similar in the Check and Disruption blocks, showing that the presence of pheromones in the disruption blocks did not affect the male moths' ability to locate the females. The microsprayers failed to prevent trap catches for the first 3 weeks of moth flight at the Oakes site, although catches were near zero thereafter until the end of July; traps in that orchard were not checked during August. At the Doyle site, where the moth population was especially high, the microsprayers held trap catches near zero for the entire season, after a week of moderate moth catches in mid-June, indicating that the pheromones in the disruption block disoriented the male moths. It is not known why this treatment did not have the same effectiveness in the Oakes orchard, although it should be noted that the adult OBLR population there was particularly low, so this may have influenced the overall efficacy of catch suppression. The raw number of moths caught at Oakes was significantly lower than the number caught at Doyle's and Mitchell's. The highest catch at Oakes' was 13 (per trap per 3-day period), compared with Doyle's high of 69.5. On an average trap catch-per-day basis, all the pheromone-disrupted sites had at least numerically lower catches than in the non-pheromone Checks, but these differed statistically only at the Doyle microsprayer site (Table 1).

Table 1. OBLR male moth catch, avg/trap/day (SEM), in pheromone-treated and untreated plots.

Pheromone Treatment	**Mitchell**	**Oakes**	**Doyle**
Microsprayer	—	0.64 a (0.41)	0.38 a (0.19)
Paraffin	0.40 a (0.18)	—	—
Check	0.74 a (0.32)	0.90 a (0.24)	3.22 b (1.34)

Numbers within a column followed by same letter not significantly different ($P = 0.05$, lsd test).

Larval terminal infestations on 16–19 July were relatively low in 1999, probably owing to below-normal terminal growth resulting from the very dry summer weather. Results of terminal infestation samples were somewhat inconclusive (Fig. 2). At Oakes' Orchard, the blocks with the pheromone-only treatment had the highest infestation (8%). At Doyle's, however, the treatments exhibited statistically comparable infestations between 4–10%. Significant differences among treatments were seen only at the Oakes site, where the levels in the grower comparison insecticide-only block were lower than in the pheromone-only trees (Table 2).

Table 2. OBLR terminal infestation and summer fruit damage in pheromone+pesticide plots

	% terminals infested 7/16–19			% fruit damaged 8/5–9		
Treatment	Mitchell	Oakes	Doyle	Mitchell	Oakes	Doyle
Pheromone	2.0 a	8.0 a	10.0 a	7.8 a	0.0 a	4.3 a
Pheromone+Insecticide	1.0 a	2.0 ab	3.0 a	3.0 b	1.0 a	2.5 a
Insecticide	1.0 a	1.0 b	4.0 a	7.5 a	0.0 a	5.8 a

Numbers within a column followed by same letter not significantly different (*P* = 0.05, lsd test).

Summer fruit damage was typical of that seen during most seasons (Fig. 2); damage levels at the Doyle and Mitchell locations were lowest in the pheromone+insecticide portions of the plots, but significant only for the Mitchell (paraffin) block. Fruit damage during this period was nearly absent at the Oakes site (Table 2).

The preharvest fruit damage evaluation showed a uniform trend in all of the blocks (Fig.2). The combination of pheromone disruption plus a pesticide program provided generally better control of OBLR fruit damage than did either method used alone, although there were significant differences at only two of the three sites. Control was best in the Oakes block, and similar at Doyle's, although in this latter case there was no statistical difference between the pheromone and the insecticide/pheromone combination. No significant differences were seen at the Mitchell site, although the combined treatment did have numerically less damage (Table 3). Direct comparison of the pesticide+pheromone treatments in this trial with the grower standard pesticide-only treatments is not straightforward in all the test blocks, because only at the Oakes site was the same pesticide (SpinTor) was used for both treatments. SpinTor was used in the pheromone+pesticide plots at the other two sites, but the grower standard trees received

Table 3. OBLR fruit damage at harvest in plots treated with pheromone and/or pesticide.

Pheromone/ Pesticide Treatment	**Mitchell** (Cortland, 9/17)				**Oakes** (Del./Jonamac/Idared, 9/24)				**Doyle** (Idared, 10/1)			
	Fancy	No.1	Cull	Total	Fancy	No.1	Cull	Total	Fancy	No.1	Cull	Total
Pesticide + Pheromone	7.8a	4.0a	2.8a	**14.5a**	0.8a	1.3a	0.3a	**2.3a**	2.5ab	0.0a	0.8a	**3.3a**
Pheromone only	7.5a	6.8b	5.3a	**19.5a**	3.5ab	3.0a	4.3a	**10.8b**	2.5a	1.8b	1.3a	**5.5a**
Pesticide only	6.8a	7.8b	5.5a	**20.0a**	5.8b	2.5a	1.8a	**10.0b**	7.3b	8.3c	9.8b	**25.3b**

Numbers within a column followed by same letter not significantly different (P = 0.05, lsd test).

Lorsban+Lannate at Doyle's and Lorsban alone (although only 2 applications) at Mitchell's. The levels of control provided by pheromones alone in these plots are comparable to the results observed in the past using this technique. Perhaps as a function of pest pressure, pheromone disruption appears to be variable in its effectiveness depending on the circumstances of its use. Although it generally does no worse than many insecticide programs in preventing OBLR fruit damage, it does a better job in only a relatively small proportion of cases, which is one reason it has been difficult to develop and market a commercially competitive pheromone product for this pest.

The ease of use of the two dispensing techniques tested here is a marked improvement over most of the previously available hand-applied dispensers, and it would not be difficult for a grower or orchard manager to incorporate these methodologies into a typical commercial production system. As with any prototype product of this type, the prospects of successful commercial development and marketing of these new pheromone dispensers will relate to how effectively they work in a variety of situations, whether alone or in combination with selective insecticides, and how economically they can be employed in relation to other available leafroller management alternatives.

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