WHOLE-FARM APPLE ARTHROPOD MANAGEMENT USING REDUCED-RISK TACTICS AND IPM SAMPLING AND MONITORING

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Abstract

A demonstration project was conducted in NY as part of a multi-state USDA-RAMP grant to evaluate IPM strategies and control technologies that are effective and economically viable options for reduced-risk (RR) pest management programs in apples, using provisional action thresholds for specific major pests based on previous studies involving reduced-risk tactics. Our primary objective was to determine the effectiveness of whole-farm approaches for managing the arthropod pests of apple orchards that rely on RR and OP-replacement insecticides for pest control. Five growers participated in a full-season RR management program, committing a total of 194 acres (155 acres of which constituted the entire farms of three of the growers). The full-season RR program resulted in clean fruit levels ranging from 93.5-98.7%, with late-season obliquebanded leafroller (OBLR) accounting for the largest category of insect damage (1.1–1.8%), and smaller amounts of damage being caused by tarnished plant bug (0.8–1.4%). Where available, fruit grown on the same farms using conventional practices ranged from 94.4–98.2% clean, with other damage being caused by tarnished plant bug (2.8% max), apple maggot (1.4% max), and obliquebanded leafroller (0.6% max).

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Five growers participated in a full-season RR management program, committing a total of 194 acres (155 acres of which constituted the entire farms at three sites, Oakes, Endres and Knight). The specifics of each grower's site are:

- Oakes, 42A (Cortland, Jonagold, Crispin) – entire farm
- Hance, 27.5A (Gala, R. Del., Cameo, Ginger Gold, Empire, Jonagold, Pioneer Mac, Idared, 20-oz)
- Endres, 67.5A (Crispin, Jonagold, Empire, Idared, R. Del. McIntosh) – entire farm
- Burnap, 11.6A (Empire, Gala, Cortland)
- Knight, 45A (R. Del., G. Del., Empire, Jonagold, Macoun, Gala, Honeycrisp, Cortland, N. Spy) – entire farm

Each research site received a seasonal program of reduced-risk (RR) selective insecticides, including insect growth regulators, antibiotics, microbials, nicotinoids, and oxadiazines. Where available (Oakes, Hance, Burnap), a comparison block, which had the same varieties and tree training, was also monitored at each site. These blocks all contained at least one fresh fruit variety such as 'Empire' that might be selected for marketing in Europe or some other market outlet that may eventually demand IPM protocols for market access.

Private crop consultants (J. Misiti, J. Eve) played a leading role in the interactions with most growers, being responsible for general communication with cooperating growers, and in ensuring that recommended insecticide sprays were applied to the plots. Materials used in the blocks receiving a RR pesticide program included: Dormant oil for mites and San Jose scale; Actara, Avaunt, Assail, and Calypso, Delegate for pink and post-petal fall pests such as plum curculio, internal Lepidoptera and apple maggot, plus Intrepid, Dipel, Proclaim and SpinTor for leafrollers, and Beleaf and Provado for aphids. All sprays were applied by the grower. In an effort to reduce the intrinsic cost of implementing the RR program in commercial orchards, we used sampling and monitoring-based decisions to implement some of the following recommended tactics: border sprays for some plum curculio and apple maggot treatments, omitting pink bud sprays where no threat of rosy apple aphid, spotted tentiform leafminer, or tarnished plant bug existed, and monitoring OBLR and apple maggot populations during the summer as a basis for making treatment decisions.

Procedures

From 22–29 April, Trécé Pherocon VI pheromone traps were hung in all plots at each RR orchard site as follows: one codling moth (CM) trap was hung in the top of the tree canopy using a bamboo pole, and one oriental fruit moth (OFM) and lesser appleworm (LAW) trap was placed at head height in separate trees in each of six interior orchard locations regularly spaced throughout the research site. All traps were checked and cleaned weekly until late August; all lures were changed at the beginning of July, and CM lures were additionally changed again at the beginning of August. Six volatile-baited apple maggot sphere traps were deployed along the most likely borders of each orchard site for AM immigration during late June and early July; these were also checked weekly until late August.

All plots were sampled for representative arthropod pests throughout the season. Overwintered obliquebanded leafroller populations were assessed by sampling 25 blossom clusters and shoots on each of 40 trees during the bloom period; 1st brood spotted tentiform leafminer (STLM) mines were counted on 10 fruit cluster leaves on each of 30–40 trees in mid-June; green aphid infestations were assessed three separate times, on 10 foliar terminals per each of 30 trees in mid-June, mid-July and early August; OBLR terminal infestations were evaluated on 300–600 terminals per plot during the first and second weeks of July; and internal Lepidoptera feeding damage was assessed by inspecting 10 fruits on each of 30 trees in late June and followed up weekly for up to 7 weeks by inspecting 10 fruits on each of 10 trees in 2–3 sites per farm.

An additional assay was conducted to validate a sampling protocol for determining feeding damage caused by internal lep species during the season, to be used as a basis for deciding on the need for additional, directed applications of selective insecticides to control these species (CM, OFM, and LAW).

Mite populations were assessed 3 times during the summer at each farm by collecting four 25-leaf samples from two sites in each block and brushing them in the lab to count motile forms of phytophagous and predacious mites. Shortly before the respective harvest date in each orchard, 5 batches of 200 fruits (in 25 fruit/tree-subsamples) were picked from each plot: 600 from trees in the interior of the plot, and 100 from trees on each of the 4 outside edges. All fruits were inspected for damage caused by diseases and insects, including the three internal Lepidoptera species.

Results

Pheromone trap catches from around the state revealed population patterns similar to those seen during previous seasons for the different species, but relative numbers were somewhat higher than in 2007. As seen in Fig. 1, codling moth levels were fairly low in all sites except for Hance (located in western NY), where catches exceeded 40 moths per trap during the first brood flight period. Catches at Endres and Knight exceeded 10 moths per trap during this same period; thereafter, numbers settled below this peak for the remainder of the season. Levels of the remaining two moth species also exhibited some sharp peaks, depending on location, with LAW reaching nearly 80 per trap at Knight, but showing peak numbers of less than 20 moths per trap at the remaining sites. Apple maggot numbers were lower than typical levels, with 4 sites catching less than 2 flies per trap on a weekly basis during the entire summer; at the remaining farm (Burnap), numbers peaked at nearly 12 flies per trap at the very end of August.

Data on European red mites and phytoseiid predators were averaged to determine the mean density of each for the dates when samples were collected from each plot. There were no cases in which mean European red mite numbers surpassed the designated treatment threshold levels during the season (June, 2.5; July, 5.0; August, 7.5 motiles/leaf); therefore, no miticides were recommended or applied in any of the blocks. Overall farmwide maximum counts of ERM averaged 0.10–2.44 motiles per leaf during the season (Table 1). Phytoseiid predator mites were generally low as well in all sites, with farmwide maximum levels ranging from 0.12–1.30 motiles per leaf. Most phytoseiids identified were *Typhlodromus pyri* (67-100%).

Most in-season insect sampling sessions showed low levels of incipient pest species, both fruit- and foliar-feeding. As a summary of sampling results:

Internal leps (Codling moth/Oriental fruit moth), fruit damage range, on-tree fruit inspections (June-Aug): Oakes, 0%; Hance, 0.5-1.5%; Endres, 0.5% max; Burnap, 0.5% max.

Obliquebanded Leafroller, Bloom/Summer – infested clusters/terminals. Oakes, 1.9% / 0%; Knight, 0.0% / 1.2%; Endres, 1.0% / 2.5%; Burnap, 0.1% / 0%; Hance, 1.3% / 0%.

Spotted Tentiform Leafminer, June – leaves with 1st gen mines. Oakes, 0%; Knight, 0.3% / 1.8% (2nd brood, July); Hance, 0%; Endres, 0%; Burnap, 0%

Aphids, Summer – % infested terminals, June/July/August. Oakes, 0% / 8% / 0%; Hance, 0.8% / 44% / 0.3%; Endres, 2% / 7% / 0%; Burnap, 1.3% / 53% / 0%.

Spray records from the RR sites were able to be compared with those from conventional (STD) blocks at three of the five grower farms. Spray program costs were generally comparable between the two treatments at these three sites, with combined insecticides in these three RR sites averaging $214.10 per acre, nearly the same as the STD programs ($214.96/A); numbers of spray applications made during the season averaged between 7–8 for both programs. (Refer to Appendix 1 for all spray records.) Only one grower (Knight) substituted border-row or selective planting applications for full-block or farmwide sprays for specific treatment decisions; i.e., at first cover for plum curculio. Interestingly, although the STD programs differed by the inclusion of organophosphate and pyrethroid products, both programs relied to a similar extent on certain products with microbial (Proclaim), and nicotinoid (Actara, Assail, Calypso, and Provado) active ingredients, indicating the level of adoption of these "newer" types of materials across our production area (Appendix 1).

The full-season RR program implemented on the five growers' farms resulted in clean fruit levels at harvest ranging from 93.5-98.7%, with late-season obliquebanded leafroller (OBLR) accounting for the largest category of insect damage (1.1–1.8%), and smaller amounts of damage being caused by tarnished plant bug (0.8–1.4%) (Table 2). Where available, fruit grown on the same farms using conventional practices ranged from 94.4–98.2% clean, with other damage being caused by tarnished plant bug (2.8% max), apple maggot (1.4% max), and obliquebanded leafroller (0.6% max).

Acknowledgments

We are grateful to the following growers for allowing us to conduct this research on their farms: D. Oakes, Lyn-Oaken Farms, Lyndonville; C. Hance, Pultneyville; R. Endres, Fruition Farm, Sodus; M. Maloney, Burnap Fruit Farm, Sodus; J. Knight, Knight Orchard, Burnt Hills. We also acknowledge J. Eve Consulting, Naples, and J. Misiti, Lyndonville, for assistance in coordinating with grower program schedules, and for the following technical assistants' efforts in plot setup, maintenance, and sample collection and processing: Ashley Blackburn, Dave Combs, Justin Eveland, Kate Fello, Leslie Mitchell, Nicole Gottschall, and James Watt. Contributions of crop protectants and trapping supplies were made by: Dow AgroSciences (B. Olson); Syngenta (J. Zelna); and Trécé (W. Lingren). This work was partly supported by a grant from the USDA RAMP Program (Project No. 2006-51101-03604).

Fig. 1. Trap catches of major pest species in five NY RAMP orchards, 2008.

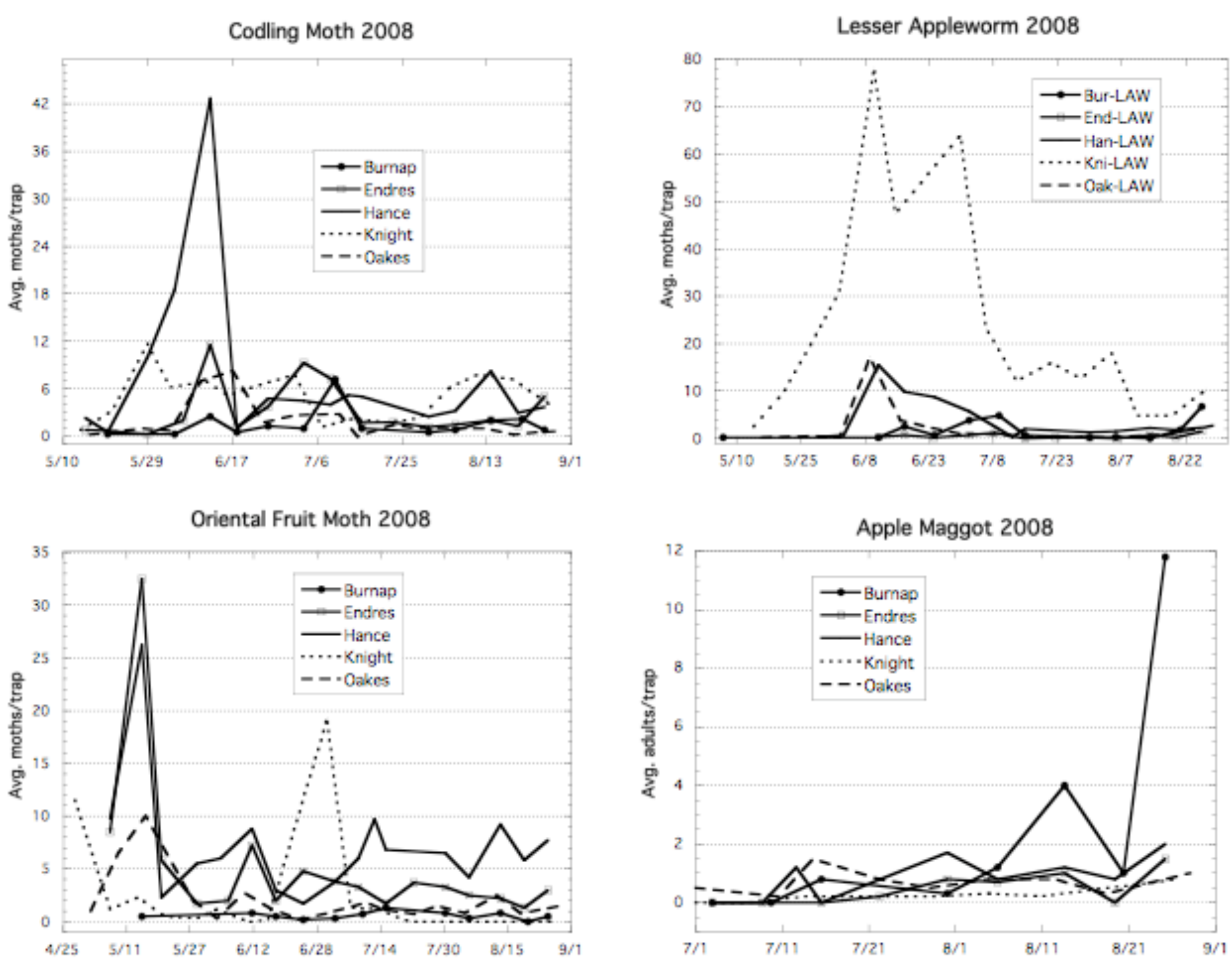

Table 1. Summary of European red mite (ERM) and predatory phytoseiid mite numbers in foliar samples taken in Reduced-Risk orchards, 2008.

Farm	Date Sampled	# sites sampled	Avg. # motiles per leaf ERM	Avg. # motiles per leaf Phytoseiids	Percent *T. pyri*
Oakes	24-Jun	2	0.01	0.06	100.0
	15-Jul	2	0.10	0.22	66.7
	13-Aug	2	0.01	0.56	70.8
Hance	25-Jun	2	0.01	0.12	100.0
	16-Jul	2	0.03	0.08	100.0
	14-Aug	2	0.56	0.17	93.8
Burnap	25-Jun	2	0.02	0.08	100.0
	16-Jul	2	0.52	0.12	90.9
	18-Aug	2	2.44	0.38	80.0
Endres	25-Jun	2	0.10	0.03	100.0
	16-Jul	2	0.00	0.28	97.3
	18-Aug	2	0.00	0.32	100.0
Knight	14-Jul	6	0.10	1.30	–

Table 2. Summary of mean % fruit damage at harvest in NY RAMP sites 2008.

Percent Fruit in each damage category

Treatment/Block, Site	AM	Int. Lep	TPB	Sting	SB/FS	OBLR	Clean	Add'l X-Fancy	USDA Grade X-Fancy	USDA Grade Utility	USDA Grade Cull
Burnap RAMP	0.2	0.2	0.3	0.5	0.2	0.1	98.7	0.9	99.6	0.0	0.4

	Int. Lep	Sting	OBLR Early	OBLR Late	AM	PC	TPB	RAA	SJS	SB/FS	Clean	Add'l X-Fancy	USDA Grade X-Fancy	USDA Grade Utility	USDA Grade Cull
Endres RAMP	0.4	0.3	0.0	1.4	0.2	0.1	0.8	0.1	0.0	3.4	93.5	4.1	97.6	1.7	0.7

	Int. Lep	Sting	OBLR Early	OBLR Late	AM	PC	TPB	RAA	SJS	SB/FS	Clean	Add'l X-Fancy	USDA Grade X-Fancy	USDA Grade Utility	USDA Grade Cull
Hance RAMP	0.8	0.8	0.0	1.1	0.1	0.0	1.4	0.0	0.1	0.0	95.7	1.7	97.4	1.6	1.0
Hance Std	0.2	0.6	0.0	0.6	1.4	0.0	2.8	0.0	0.0	0.0	94.4	2.4	96.8	1.6	1.6

	Int. Lep	Sting	OBLR	AM	PC	TPB	RAA	SJS	SB/FS	Scab	Clean Insects only	Add'l X-Fancy	USDA Grade X-Fancy	USDA Grade Utility	USDA Grade Cull
Knight RAMP	0.0	0.1	1.8	0.0	0.5	1.2	0.1	0.1	66.3	0.1	96.5	43.3	74.9	24.0	0.6

	Int. Lep	Sting	OBLR Early	OBLR Late	AM	PC	TPB	RAA	SJS	SB/FS	Scab	Clean	Add'l X-Fancy	USDA Grade X-Fancy	USDA Grade Utility	USDA Grade Cull
Oakes RAMP	0.0	0.0	0.0	0.1	0.0	0.0	0.8	0.0	0.0	3.1	0.2	95.8	3.5	99.3	0.6	0.1
Oakes Std	0.0	0.2	0.0	0.2	0.0	0.0	0.8	0.0	0.3	0.2	0.2	98.2	1.7	99.8	0.2	0.0

AM, apple maggot; Int. Lep, internal Lepidoptera (codling moth, oriental fruit moth, lesser appleworm); TPB, tarnished plant bug; SB/FS, sooty blotch/ flyspeck; OBLR, obliquebanded leafroller; PC, plum curculio; RAA, rosy apple aphid; SJS, San Jose scale.

APPENDIX 1. SPRAY STATISTICS 2008 - Obj. 2, Whole Farm Mgt Using RR Materials

Grower	Crop	Treatment	# Sprays	# Pheromone Tie Applic.	Chemical Cost (Insecticides + Miticides $/A	OP lb ai/A	Cyclodiene (endosulfan) lb ai/A	Pyrethroid lb ai/A	Antibiotic (Spinet-oram) lb ai/A	Microbial (Dipel, Proclaim) lb ai/A	Miticide (incl. Agrimek) lb ai/A	IGR (Intrepid, Esteem) lb ai/A	Oxadiazine (Avaunt) lb ai/A	Nicotinoid (Actara, Assail, Calypso & Provado) lb ai/A	Pyridine-carbox-amide (Beleaf) lb ai/A	Pheromone Ties #/A	Oil gal/A	Total lb ai/A	Difference (STD vs RR) lb ai/A
Oakes	APPLE	RR	6	0	$158.75	0	0	0	0.08	0.01	0	0	0	0.398	0.053	0	0	0.54	
		STD	7	0	$174.46	3.01	0	0.031	0	0.021	0	0.248	0	0.153	0.053	0	0	3.52	2.975
Hance	APPLE	RR	9	0	$286.56	0	0	0	0.081	0.008	0	0	0.188	0.713	0	0	0	0.99	
		STD	8	0	$261.31	3.36	0	0	0.081	0.008	0	0	0	0.7	0	0	0	4.15	3.159
Burnap	APPLE	RR	6	0	$196.99	0	0	0	0.07	0.225	0	0	0.073	0.57	0	0	0	0.94	
		STD	7	0	$209.10	7.963	0	0	0	0.225	0	0	0	0.378	0	0	0	8.57	7.628
Endres	APPLE	RR	12	0	$367.59	0	0.36	0	0.063	0.748	0	0.16	0	0.997	0	0	0	2.33	
Knight	APPLE	RR	6	0	$195.61	0	0	0	0.09	0.01	0	0	0.23	0.07	0	0	5	0.40	
	Means	**RR**	**7.8**	**0**	**$241.10**	**0.00**	**0.07**	**0.00**	**0.08**	**0.20**	**0.00**	**0.03**	**0.10**	**0.55**	**0.01**	**0.00**	**1.00**	**1.04**	
		STD	**7.3**	**0**	**$214.96**	**4.78**	**0.00**	**0.01**	**0.03**	**0.08**	**0.00**	**0.08**	**0.00**	**0.41**	**0.02**	**0.00**	**0.00**	**5.41**	**4.59**