Apple Arthropod Management Using Reduced-Risk Pesticide Programs

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Efforts to reduce the use of broad spectrum insecticides like organophosphates, carbamates and pyrethroids have begun and will continue as the Food Quality Protection Act of 1996 is fully implemented. Large scale evaluations of alternative insect control programs based on reduced-risk pesticides were begun in several states in 2002. The NY project is being conducted at 14 sites on growers' farms in the three major apple producing areas of the state.

Fresh and processed apple products constitute a major component in the diets of infants and children. Implementation of the Food Quality Protection Act of 1996 has begun and will continue to limit reliance on broad-spectrum insecticides, which have been the foundation of pest management programs for these crops in New York State for the past 40 years.

New York is a participant in a multistate USDA-RAMP (Risk Avoidance and Mitigation Program) project that is examining pest control programs that use only selective reduced-risk pest control tactics on multiple farms throughout the state over a four year period. The goal of this project is to design pest management systems that will greatly reduce residues and worker exposure to organophosphate, carbamate, and pyrethroid insecticides and to evaluate, on a regional scale, reduced-risk tactics that previous research and experience indicate will be effective, sustainable, economically viable, and compatible with biological control. Among the approaches being used in these programs, which are designed for fresh market apple production, are selective (reduced-risk) insecticides, mating disruption, conservation of natural enemies, and cultural practices. These tactics are being integrated into specific pest management programs designed to be most appropriate for each major production region within the state. This article reports the results after the second year of the study (2003).

The RAMP Project in NY

Research sites were set up in all the major apple growing areas of New York: Western NY (Appleton, Oak Orchard, Lyndonville, Waterport, Sodus, Phelps); Central NY (Lafayette); Hudson Valley (Milton, Stone Ridge, Gardiner); Capital District (Burnt Hills, Granville); and Champlain Valley (Chazy, Valcour). Each research site was a "split-plot design" in which the entire block received a program of reduced-risk insecticides, and a five-acre portion of the block was additionally treated with pheromones for mating disruption of the later summer generations of codling moth (CM), oriental fruit moth (OFM), and lesser appleworm (LAW). Pheromone traps for all species were hung in all plots, and pheromone ties were deployed for CM and OFM; traps were checked weekly. Fruits were inspected for disease and insect damage at harvest. A grower standard comparison block, which had the same varieties and planting style, 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 could eventually require IPM protocols for market access.

Private crop consultants played a leading role in the interactions with growers within a region, and were responsible for general communication with cooperating growers, and in ensuring that recommended insecticide sprays were applied to the plots in a timely manner. In growing areas where there were insufficient numbers of private crop consultants, the leading role for appropriate seasonal interactions was undertaken by Cornell faculty or field extension personnel. Materials used in the reduced-risk pesticide program included: Apollo or dormant oil plus Pyramite or Acramite (as needed in summer) for mites, Actara for early season pests (including rosy apple aphid, spotted tentiform leafminer, plum curculio and tarnished plant bug), Avaunt for post-petal fall pests such as plum curculio, internal Lepidoptera and apple maggot, plus Confirm and SpinTor for leafrollers. All sprays were applied by the grower.

From April 22–May 2, Trècè Pherocon IIB pheromone traps were hung in all three plots at each commercial orchard site as follows: one CM, OFM, and LAW trap group was placed at head height and arranged around the canopy of each of three trees in a middle row (one at each end and one in the center) of the Reduced-Risk Pesticides plot, Pheromone+Reduced-Risk Pesticides plot, and Grower Standard plots at each site. All traps were checked and cleaned weekly until late August; CM lures were changed every four weeks, and OFM and LAW lures were changed during the middle two weeks of July. From June 16–July 1, polyethylene pheromone tie dispensers were hung in the Pheromone+Reduced-Risk Pesticides plots at each site, using different products to disrupt three separate moth species: codling moth were disrupted by Isomate CTT ("twin-tube") at 200 ties/acre, and oriental fruit moth and lesser appleworm were disrupted by Isomate M-100 at 100 ties/acre. All OFM ties were hung at head height by hand; CM ties were hung in the upper 1/3 of the tree canopy by hand for dwarf trees, and using a pole+hoop applicator for trees taller than 7 ft. Average time requirements for deploying the pheromone ties were as follows:

Hand-applied: 1.27 hr/acre/person (or 0.79 acre/hr/person); 236 ties/hr/person

Pole+hoop: 1.24 hr/acre/person (or 0.81 acre/hr/person); 242 ties/hr/person

All plots were sampled for representative arthropod pests throughout the season. Ten blossom terminals from each of 10 trees were inspected during the bloom-to-petal fall period for obliquebanded leafroller infestations; 20 fruits on each of 30 trees were examined for plum curculio damage after petal fall; apple aphid infestations (and predator incidence) were assessed on 10 terminals per each of 10 trees several times during the summer months; and leafminer mines were counted on 10 terminal leaves from each of 10 trees in late summer. Mite populations were assessed three to four times during the summer by collecting four 25-leaf samples from each block and brushing them in the lab to count motile forms of phytophagous and predacious mites. Also, from July 21–31, fruit was examined for internal larval feeding damage in each plot by inspecting 20 random fruits on each of 30 trees along the edges and near hedgerows where pressure from immigrating moths was expected to be most severe. Shortly before the respective harvest date in each orchard, 20 fruits were picked from each of 35 trees in each plot: six trees grouped in the center of the plot, 12 trees from the mid-interior region (a few rows in from each of the four edges) and 12 trees from the outside edges + 5 extra along one edge designated as being at high risk for apple maggot injury (700 fruits total per plot). In cases where the Reduced-Risk Pesticides plot was separate from the Pheromones+Reduced-Risk Pesticides plot, a total of 16 trees along the 'apple maggot edge' were sampled in each plot (860 fruits total per plot). 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 codling moth levels were fairly low to moderate throughout the season in all the blocks, with catches rarely exceeding 10 moths per trap per week, and in many cases considerably fewer than five per trap. Abundance of the remaining two species was highly variable, depending on location. In the most western sites, lesser appleworm levels tended to be modest, but oriental fruit moth pressure was sometimes severe, with numbers exceeding 125 per trap per week in one instance. In the eastern orchards, the opposite trend was seen, with OFM scarcely present, particularly during the latter half of the season, and LAW at reasonably high levels (as much as 15–30 per trap per week) in most of these blocks, particularly towards the end of the season and beyond harvest. In all cases, the pheromone ties suppressed trap catches of not only the two target species (CM and OFM), but also LAW, at levels at or near zero. Interestingly, these low or zero-catch patterns were also seen in the pheromone-disrupted plots even during the first flight of these species; i.e., before the application of this season's pheromone tie dispensers. Because a normal number of moths were being caught in the adjacent non-disrupted plots, it must be assumed that either sufficient pheromone was still present from the previous year's ties to affect continued trap shutdown into the spring of this season, or else the previous year's pheromone treatment had a locally suppressive effect on populations within the plot and few moths were migrating in from other plantings. The suppression of LAW is presumed to be due to the similarity of its pheromone blend (98:2 of Z:E-8 12-OAc) to that of OFM (92:8 of Z:E-8 12-OAc).

Data on European red mite and phytoseiid predators were analyzed by first determining the average density of each for the four times samples were collected from each plot. Densities were compared among the reduced-risk strategies and the standard strategy using analysis of variance. There were significantly more phytoseiids in the Reduced-Risk plots (0.15 per leaf) compared with the Standard plots (0.9). There were no differences in European red mite densities between the two treatments. Most phytoseiids identified were *Typhlodromus pyri*; however, there was a difference in species composition between Reduced-Risk plots and the Standards, with *T. vulgaris* and *Amblyseius andersoni* being found at different levels in the two treatments at later sample dates.

Fruit damage at harvest caused by fruit-feeding insects was uniformly low across all blocks and treatments (Table 1), with no statistically significant differences between the Reduced-Risk pesticide blocks, with or without pheromones, and the Grower Standards, similar to the 2002 results. Overall damage by internal-feeding Lepidoptera was somewhat reduced from 2002, however, with only six farms exhibiting any internal worm damage in 2003, compared with eight farms in 2002 (Figure 1). Some distinct differences did occur among the stratified samples taken within respective blocks. For instance, localized damage of up to 13–16 percent was noted along a specific orchard edge in one case.

In no instance were fruit damage readings statistically correlated with the pest management strategy used. However, for damage caused by internal Lepidoptera, which were responsible for an average of 0.24% fruit damage, the data suggest that

TABLE 1

RAMP plots 2003, summary of mean % fruit damage at harvest, across all sites.

Treatment	Int. Lep stings	Int. Lep entries	Apple Maggot	Plum Curc	TarnPl. Bug	Rosy Apple Aphid
Pheromones + Red.-Risk Pstcs	0.15	0.20	0.02	0.29	0.85	0.00
Reduced-risk Pesticides	0.35	0.40	0.13	0.33	0.81	0.00
Grower Std	0.19	0.11	0.06	0.33	0.94	0.02

Treatment	EuroApple Sawfly	Early OBLR	Late OBLR	San Jose Scale	Fruit Scab	Summer Diseases	% Clean*
Pheromones + Red.-Risk Pstcs	0.04	0.13	2.28	0.19	5.28	3.71	95.85
Reduced-risk Pesticides	0.00	0.06	2.20	0.05	5.97	2.89	95.67
Grower Std	0.03	0.08	2.18	0.08	5.81	4.45	95.98

* Results not significantly different (P = 0.05, Fisher's Protected lsd test; disease incidence not considered.)

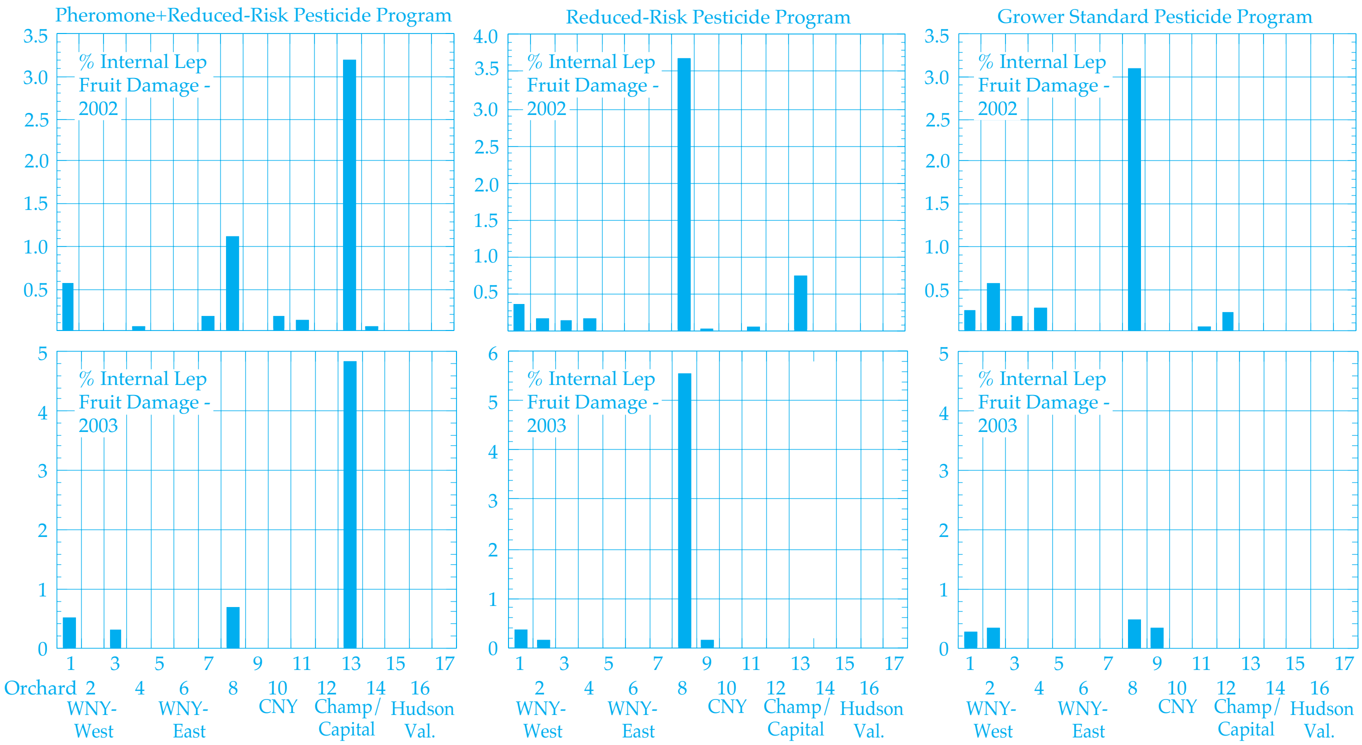

Figure 1. Percent fruit damage at harvest caused by internal-feeding Lepidoptera moth pests (oriental fruit moth, lesser appleworm, and codling moth) in plots receiving a program of pheromones plus reduced-risk pesticides, reduced-risk pesticides only, or under the grower's standard management program, 2002 and 2003 seasons. (WNY, western NY; CNY, central NY; Champ/Capital, Champlain Valley and Capital District)

this damage might be higher in the two reduced-risk programs. In these programs, the six highest incidences of fruit damaged occurred in either the Reduced-Risk or Rheromone+Reduced-Risk treatments. However, all of these six observations came from just three farms. Of the arthropod pests, the greatest experiment-wise incidence of fruit damage was due to the summer generations of OBLR (2.2 percent). The most consistent arthropod pests were plum curculio and tarnished plant bug, although the percent damaged fruit attributable to these pests was quite low. Location in the blocks influenced the proportion of fruit damaged by summer generations of OBLR, plum curculio, tarnished plant bug, and European apple sawfly. In all cases, the highest incidence of damage occurred in the exterior sections of the plots.

Conclusions

Extensive evaluations of insect pest management programs that use organophosphate (OP) insecticides to control plum curculio, CM, OFM and apple maggot have shown their effectiveness. In addition, because some mite and aphid predators have become resistant to OP's, successful biocontrol of pest mites and aphids has been possible. However, because OP insecticides are toxic to other natural enemies in orchards, it has been difficult to obtain biocontrol of foliar pests such as leafhoppers and leafminers. Also, leafrollers, OFM and leafminers that were formerly of minor importance in orchards, have become resistant to OP's and now must be controlled with other classes of insecticides, many of which are toxic to mite predators. Results from small-plot evaluations of the new more selective, reduced-risk insecticides have shown that these compounds are effective against secondary pests such as aphids, leafhoppers, leafminers, and leafrollers. However, fruit damage from CM, OFM, and apple maggot in plots treated with reduced-risk materials has often been slightly higher than that occurring in plots treated with organophosphates. This project will help determine if selective insecticides alone, or integrated with mating disruption, can provide adequate control of direct pests of fruit for which there is no allowable tolerance of damage. It will also help identify potential new pests, as well as natural enemies, that may occur in orchards treated with these new, selective tactics.

Acknowledgments

We wish to acknowledge the cooperation of all the growers (M. Biltonen, W. Blackler, M. Boylan, E. Brown, G. Burnap, S. Datthyn, R. Farrow, M. Fleckenstein, M. Forrence, T. Furber, T. Green, J. Knight, M. Maloney, D. Oakes, S. Reed, P. Russell, R. Schoonmaker, K. Trammel, and D. Wilson), consultants (P. Babcock, J. Eve, J. Misiti, and R. Paddock), and fruit extension agents (D. Breth and K. Iungerman) participating in this trial, without whom this study could not have taken place. We also thank our technical field assistants, Milo Bonacci, Emily Fitzgibbons, Scott Lakso, Rachel Mussack, Josh Burden, Jason Sheehe, Judy Staton, Peter Jentsch and the Hudson Valley crew. We are grateful for support and material received from CBC America Corp., Dow AgroSciences, Dupont, Makhteshim Agan, and Syngenta. This work was supported by a grant from the USDA Risk Avoidance and Mitigation Program.

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