Pest Management Efficacy and Economics in the New York Risk Avoidance and Mitigation Program

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A four-year research project was initiated during the 2002 growing season to evaluate, on a regional scale, apple and peach pest management systems based on reduced-risk (RR) tactics that previous research and experience had indicated would be effective, sustainable, economically viable, and lead to enhanced biological control. The participating states were: Michigan, New Jersey, New York, North Carolina, Pennsylvania, Virginia and West Virginia. The goal of this project was to design pest management systems that greatly reduced residues and worker exposure to organophosphorous (OP), carbamate, and pyrethroid insecticides.

Using a uniform protocol across all states, side-by-side comparisons were made of RR and conventionally managed orchards (5- to 10-acre plots) with 65 cooperating growers across seven states. Pesticide programs in conventional blocks were determined by individual growers or their consultants and relied extensively on OP insecticides; OPs accounted for 84% and 83% of insecticide active ingredient applied to apples and peaches, respectively. Pest management decisions in RR blocks were made by the PIs in each state, and relied on RR or OP-replacement insecticides and pheromone-mediated mating disruption. Within each state, some apple RR blocks used hand-applied pheromone ties (Isomate) for mating disruption of both codling moth (CM) and oriental fruit moth (OFM) (referred to as RR + PT) and others were managed with only RR insecticides and, in many instances, one or more sprayable OFM pheromone applications. All peach blocks relied on RR or OP-replacement insecticides plus mating disruption for OFM and peachtree borer. Data were collected on the abundance of pest and beneficial arthropods and fruit quality, and a partial budget analysis was conducted to assess the impact of these new programs on net profit.

General Methods

The following pest control tactics were used in programs designed for apples and peaches throughout the region: (1) selective insecticides and acaricides (insect growth regulators, antibiotics, microbials, nicotinoids, oxadiazines, kaolin, horticultural mineral oil, tetrazines, hexythiazox); (2) mating disruption; (3) conservation of natural enemies; (4) cultural practices. These tactics were integrated into specific pest management programs designed to be most appropriate for each state and major production region within each state. The range of potential tactics that were tested and the development of specific IPM programs were based on site-specific sampling protocols, local pest complexes and market destination of the crop. Reduced-risk management programs in apples and peaches were tested in plots of 5A or larger. A block with similar tree training systems, cultivars, ages of trees, and planting spacing was also selected adjacent to, or nearby each reduced-risk block. This block was treated with the grower's standard pest management practices so that pest levels, fruit quality, harvest damage, and pest management inputs in the two blocks could be compared.

Apple and peach pest management systems have traditionally been based on organophosphates, carbamate and pyrethroid insecticides. This project compared pest management systems based on reduced-risk tactics to greatly reduce residues and worker exposure to organophosphate, carbamate, and pyrethroid insecticides. By using sampling, monitoring-based spray decisions and reduced-risk materials, fruit damage from direct pests such as plum curculio, codling moth, oriental fruit moth, and apple maggot was as low as when organophosphates were used, and at a generally comparable per-acre cost when mating disruption is not used.

At least three reduced-risk blocks and standard comparison blocks were set up in each major growing region of each participating state during the 2002 growing season. Research sites were selected that represented typical horticultural production systems and levels of potential damage from the insect and mite pest complex in each growing region in each state. Research was conducted during each of the four years of the project in the same research and comparison plots at each site in order to compare results among different seasons and to monitor the pest and damage levels over multiple seasons. All control sprays in both the reduced-risk and standard comparison plots were applied by growers. Both the reduced-risk research plots and the standard comparison blocks were sampled throughout the season so that population levels of selected natural enemies and the infestation levels and damage could be compared.

The reduced-risk research plots were monitored according to pest management protocols established by the various states to determine the need and timing for control tactics against insect and mite pests throughout the season. The growers and private pest management consultants determined which pest management practices were used in the standard comparison blocks, but these practices included use of organophosphate, pyrethroid, and carbamate insecticides. An economic assessment was conducted to compare the costs of insecticides and acaricides, pesticide application costs, and percent fruit damage in the reduced-risk vs. grower standard comparison blocks. In order to eliminate variability between yields among blocks not related to pest management practices, the profitability of the research plots and standard blocks was compared by estimating the returns to growers using the average state yield and market value for fresh and processed fruit for each state.

New York Results

Results from the 17 New York sites in which this study was conducted are summarized for each of the four years of the project.

2002 – Moth catch trends from the non-disrupted blocks showed codling moth (CM) levels to be fairly moderate throughout the season throughout the state; in the most western sites, lesser appleworm (LAW) levels tended to be modest, but oriental fruit moth (OFM) pressure was sometimes severe. In the eastern orchards, the opposite trend was observed, with OFM scarcely present, particularly during the latter half of the season, and LAW at reasonably high levels in most of these blocks, particularly towards the end of the season and beyond harvest. Phytophagous mite populations were relatively low throughout the season: RR, an average of 1.6 motiles per leaf, 6% of samples indicating over-threshold populations; grower standards, 1.1 motiles per leaf, 4% of samples over threshold. Fruit damage at harvest caused by insect feeding or infestation was uniformly low in the RR blocks with (91.5% clean) or without (92.0% clean) pheromones, and the grower standards (93.6% clean). Average per-acre insecticide costs were $216 (plus an additional $148 for pheromones) in the RR and $149 in the grower standard blocks. Some localized damage from internal Lepidoptera was noted in two cases. Other fruit-feeding insects caused nominal damage in a few cases, including rosy apple aphid, leafrollers, San Jose scale and tarnished plant bug.

2003 – Again, pheromone ties suppressed trap catches of the target species at levels near zero. European red mite (ERM) populations surpassed economic threshold levels in three each of the RR and grower standard plots during the summer; average foliar numbers were 3.4 and 1.0 motiles per leaf, respectively. Predator mite numbers were low (~0.14 per leaf) throughout. Fruit insect damage at harvest was again uniformly low across all blocks and treatments, with no statistically significant differences between the RR blocks with (95.5% clean) or without (95.7% clean) pheromones, and the grower standards (96.0% clean). Overall damage was somewhat reduced from 2002, however, with only six farms exhibiting any internal Lepidoptera feeding damage, compared with eight farms in 2002. Insecticide costs averaged $262 and $202 per acre for RR (8.2 total applications) and grower standard (8.7 total applications) programs, plus a $141 per acre pheromone cost in the RR sites. Other fruit-feeding insects causing nominal damage in isolated cases included leafrollers, tarnished plant bug, and plum curculio.

2004 – The pheromone ties continued to suppress trap catches of all three species at levels near zero. ERM populations surpassed economic threshold levels in two RR plots during the summer. Fruit insect damage at harvest showed no significant differences between the RR blocks with (95.5% clean) or without (94.7% clean) pheromones, and the grower standards (94.6% clean), similar to the previous two years. Overall damage from internal Lepidoptera was considerably reduced from

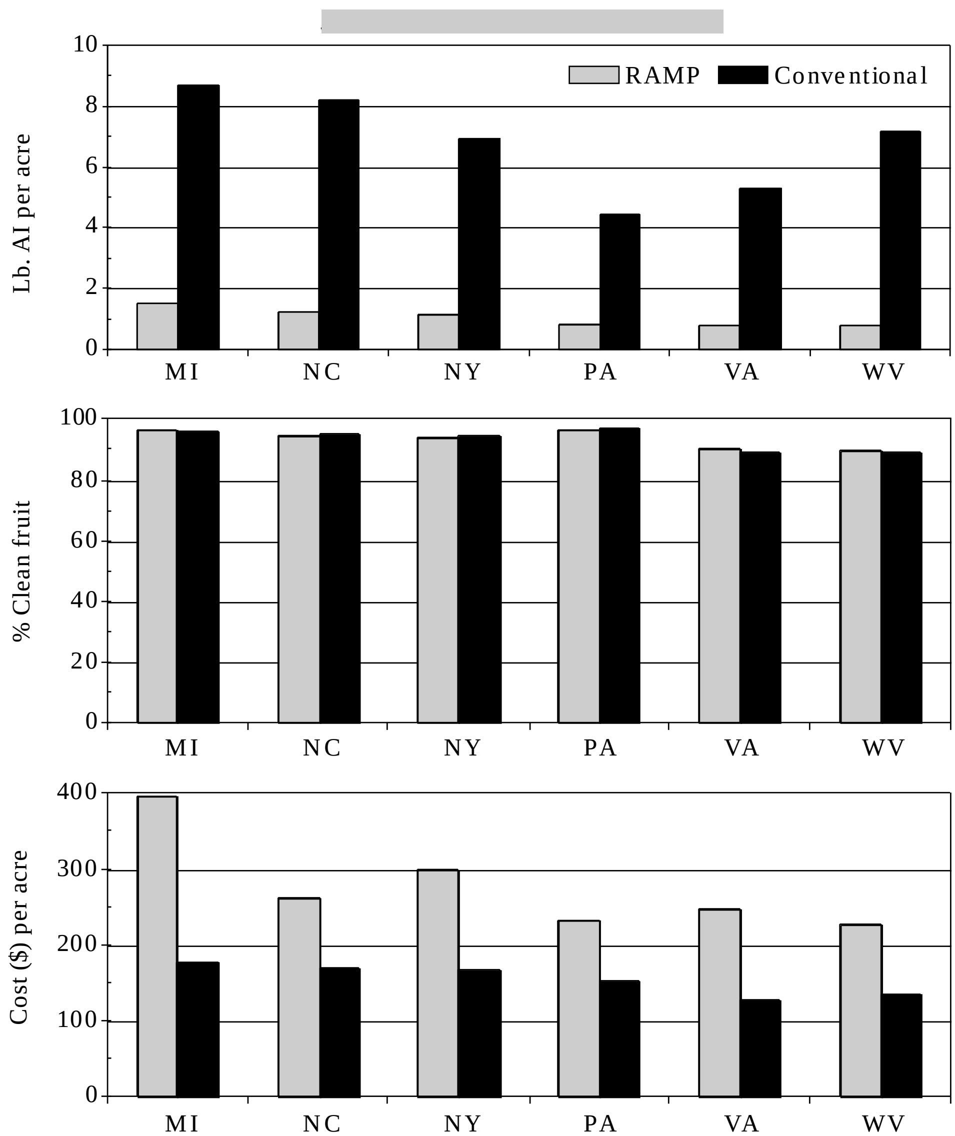

Figure 1. Mean insecticide use, fruit quality and insect management costs in RR and conventionally managed apples, over four years in each state.

2003, with only seven farms exhibiting any internal worm damage, and a maximum value of 1.1%. Insecticide costs averaged $225 and $156 per acre for RR (7.1 total applications) and grower standard (7.9 total applications) programs, plus a $136 per acre pheromone cost in the RR sites. Other fruit-feeding insects causing damage in isolated cases included tarnished plant bug, plum curculio, and apple maggot.

2005 – Because of uniformly low internal Lepidoptera pest populations in most sites during previous years, pheromone mating disruption in combination with the RR pesticides was implemented at only 2 of the 17 farms; these successfully suppressed most moth catches all season. Levels of ERM surpassed threshold only once in an RR block and three times in grower standard blocks, with maximum predator mite numbers averaging 1.1 per leaf (range, 0.02–2.6) and 0.96 per leaf (range, 0–3.13) in RR and grower plots, respectively. Fruit insect damage at harvest again showed no significant differences between the RR blocks (94.4% clean) and the grower standards (93.8% clean). Internal worm damage was minimal overall, occurring in only one plot for each treatment (RR: 0.07%, Std: 0.28%). Insecticide costs and use patterns for 2005 were lower than in previous years because of our recommendations to implement some of the following 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 exists, omitting petal fall leafroller materials in low-pressure blocks. Costs averaged $161 per acre (5.5 total applications) in the RR blocks without pheromones ($321 per acre in the two sites with pheromone disruption), compared with $147 per acre (7.5 total applications) in the grower standards.

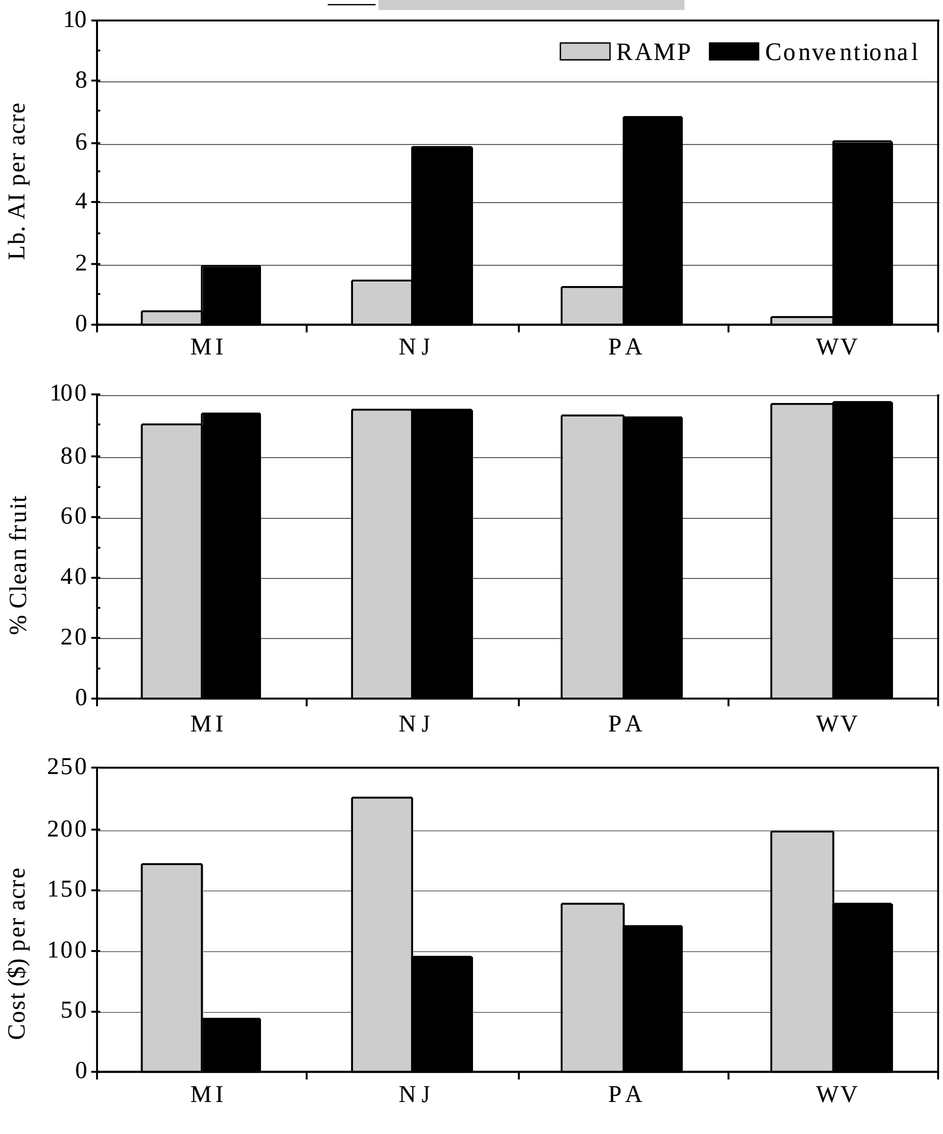

Figure 2. Mean insecticide use, fruit quality and insect management costs in RR and conventionally managed peaches, over four years in each state.

Multi-State Results

Overall results of this project for both apples and peaches are summarized in Figs. 1 and 2, respectively, which depict means across four years for each state. Most impressive was the dramatic reduction in pounds of insecticide applied in RR compared with conventional orchards; averaged across all states there was a 81.7% and 77.7% reduction in pounds AI per acre in apples and peaches, respectively. To illustrate the potential of these programs to minimize adverse environmental impacts, the four-year average cumulative environmental impact quotient (EIQ) (Kovach et al. 1992) for pesticides applied in seven Pennsylvania apple orchards was 157.9 and 29.5 in conventional and RR orchards, respectively, or a 5.3-fold EIQ reduction in RR orchards. Similarly, in five peach orchards the EIQ load in RR orchards was 5.9-fold lower than conventional orchards (195.9 vs. 33.4). This level of reduction equates to approximately 381 tons AI annually of mostly OP and carbamate insecticides if RR IPM programs were used on all apple acreage in the 6 states represented in this proposal (73% of eastern apple production), or 513 tons for all 186,000 acres in the east. For peaches, such a reduction would lead to 37 tons less AI of mostly OP insecticides applied annually to the participating states, with the potential of 97 tons less on the 58,300 acres in the east.

The level of insect control in RR and conventional blocks was very similar; the overall percentage of clean fruit (non-insect damaged) in apple plots was 93.7 (RR) and 94.3 (conventional) and in peaches 94.1 (RR) and 94.8 (conventional). However, the cost to obtain this level of control was considerably higher in RR blocks, with the cost for insect control averaging almost 78.5 and 85.1% higher in apple and peach RR blocks, respectively. Although RR insecticides were considerably more expensive than older broad-spectrum insecticides used in conventional blocks, pheromone dispensers for mating disruption were a major component of this higher cost. Average costs in the RR blocks without pheromone ties varied from a low of $210.82 / A in 2005 to a high of $237.73 / A in 2002, and average costs for the RR + PT varied from a low of $327.63 / A in 2005 to a high of $374.74 / A in 2004.

For the partial budget analysis used to evaluate the impact on profit from changes in insect management costs and fruit quality when adopting RAMP systems, yields were held constant at five-year averages (1998-2002) for the individual states, so only quality issues and spray costs relating to insect management were captured in the analysis. In apples, a total of 263 profit comparisons were made between blocks with conventional and RR programs, and only 57 RR comparisons (22%) were more profitable than their conventional insecticide program comparisons. When the analysis was further broken down, RR treatments without pheromone ties were more profitable in 43 out of 150 comparisons (29%), but in only 14 out of 113 comparisons (12%) for RR with pheromone ties. Overall, the difference in income between the conventional and RR blocks had narrowed from a high of $162.90 / A in 2002 to only $38.04 / A in 2005. The difference between conventional and RR + PT had narrowed from a high of $285.69 / A in 2002 to $128.27 / A in 2005. In peaches, a total of 65 comparisons were made of conventional and RR programs. The RR treatments were more profitable in 15 out of 65 comparisons (23%). However, unlike apples, the difference in income between the standard and RAMP blocks had actually widened from a low of only $6.27 / A in 2002 to $122.15 / A in 2005.

Summary

Extensive evaluations of insect pest management programs that use organophosphate (OP) insecticides to control plum curculio, CM, OFM and apple maggot have shown the effectiveness of these insecticides. In addition, because some predaceous mites and aphid predators have become resistant to OPs, successful biological control of phytophagous mites and aphids has been possible. However, because OP insecticides are toxic to other natural enemies in orchards, it has been difficult to obtain biological control of foliar pests such as leafhoppers and leafminers. In addition, leafrollers, OFM and leafminers that were formerly of minor importance in orchards, have become resistant to OPs and now must be controlled with other classes of insecticides, many of which are toxic to mite predators. Results from these 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. By using sampling and monitoring-based spray decisions, we have been able to show fruit damage from such direct pests as plum curculio, CM, OFM, and apple maggot in plots treated with reduced-risk materials to be as low as that occurring in plots treated with organophosphates, and at a generally comparable per-acre cost when mating disruption is not used. This project has helped show that selective insecticides alone, and in some cases integrated with mating disruption, can provide adequate control of direct pests of fruit for which there is no allowable tolerance of damage.

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