Using Pheromone Trapping for Better Management of Worms in Fruit, 2003-2004

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The threat of lepidopteran pests to pome and stone fruits is increasing, and reduces the quality of these commodities. As chemicals fall under continued regulations, and as pesticide resistance is a topic of concern, pheromone trapping can play a significant role in determining the timing of insecticide applications and thus help protect crops from these pests.

The risk of lepidopteran pests infesting tree fruit has increased over the past five years. It began with peaches and Bosc pears in the late 90's, and shoot-tip infestation of apples. The problem in peach was addressed by incorporating pheromone traps into management schemes to determine first flight of oriental fruit moth (OFM). This was followed by the use of the Michigan State University degree-day model to time insecticide applications. Growers saw an improvement in control of OFM by using pheromone trapping, spraying according to degree-day models and implementing mating disruption technology. These solutions for oriental fruit moth management in peaches should serve as lessons in managing internal lepidopteran pests in apples. Monitoring insect activity with pheromone traps will be a key component of a decision-making model to schedule management practices for internal lep pests.

Observations made in apples and pears across the region in 2002 showed that internal lepidopteran larvae were infesting fruit at increased levels. The primary species were oriental fruit moth (*Grapholitha molesta*), codling moth (CM, *Cydia pomonella*), and lesser appleworm, (LAW, *Grapholitha prunivora*). The number of truckloads of processing apples rejected at processors due to presence of larvae increased from 30 loads from 12 growers in 2001 to 113 loads from 48 growers in 2002. This has been less of a problem over the last two cool, wet growing seasons with only 12 rejected loads from 11 growers in 2003, and 14 loads from 9 growers in 2004. A third of the loads rejected in 2004 were due to detection of dock sawfly, a pest related to weed control problems. Every truckload of apples rejected as canners is diverted to juice, which reduces its value by 40-50%. This is a drop in value from approximately 8 cents per pound for processing apples to less than 4 cents per pound for juice.

Our experience contrasts with what is happening in the Mid-Atlantic States, where the number of loads rejected due to internal worms has increased every year to more than 800 loads in 2004 (a potential value of over $1M loss). Scientists suggest the following possible reasons for the increased infestation by internal lepidoptera: 1) the reduction in the use of broad-spectrum insecticides such as organophosphates (OPs), 2) the development of resistance to those insecticides, and 3) the reliance on more selective insecticides to control other pests in the complex that are not effective against OFM and/or CM. For the 2000-2001 seasons, a field bioassay to screen for OFM populations with insecticide resistance in peaches was done in Niagara County orchards. The results showed a reduction in adult mortality when exposed to vials treated with carbofuran residue, an indicator used in Ontario to detect OP resistance. The consequence of this resistance was not that we completely lost control, but this served as an indication of the need to alternate chemical mode of action from one generation to another. There was little or no resistance to pyrethroids at that time.

The Western NY Trapping Network

In 2003 and 2004, we established a trapping network across the Lake Ontario fruit region. A total of 150 traps were installed across the region. Each of the selected blocks received two Pherocon IIB traps for OFM and CM each, and one trap for LAW. Traps were monitored weekly by the Lake Ontario Fruit Program-CCE and by some growers. The number of moths caught was recorded and summarized to incorporate into Fruit Notes, emails, and Fruit FAX, all available to growers, consultants, distributor field reps, and faculty. These counts were used to set the biofix for the degree-day models for OFM and CM and assist growers to properly time mating disruption and insecticide applications.

Identifying Lepidopteran Pests in the Trapping Network. It is important to know which pests are causing the fruit infestation problems, since the timing for control differs with each. Although mating disruption for OFM will also affect LAW, the control timing for LAW using insecticides will be similar to that for codling moth timing, not that for OFM. So, if high populations of LAW are present in the area but not high populations of CM, there is an increased threat of fruit infestation by LAW. LAW larvae can be easily misidentified as OFM since they both have an anal comb at their posterior end. This reinforces the need to identify the worms that are found in fruit to ensure that the proper control strategy is taken.

How Many Traps are Needed to Monitor These Pests? There are a number of recommendations for how many traps are necessary. Scientists from Michigan State University recommend one trap for every 10 acres. The Penn State University guidelines suggest two traps for every 10 acres. Of 14 farms analyzed in the 2003 trapping network, six orchards each with two OFM traps had one trap above a suggested threshold (8-10 moths per trap per week) and one below the threshold for at least one of the peak flights in the season. Since wind direction and source of infestation outside of the orchard will vary, at least two traps would give a better picture of the population. If there is more than one trap and the mower gets one, you will at least have some information you can count on. Pick the highest risk orchards next to abandoned sites or those with a history of fruit rejections, and monitor adult moth flight in those orchards. Maintaining two traps per farm would be an improvement over no monitoring at all. For orchards using mating disruption, trap catch data from non-disrupted orchards are critical to time insecticide sprays.

Trap Maintenance. Maintenance of traps is also important. Using pheromone traps to monitor moth activity is effective only if traps are managed well. There are some basic guidelines for managing traps to ensure good information is obtained:

- For OFM, CM, and LAW, we have been using Pherocon IIB traps, and lures made by various companies. These can be obtained from several suppliers.
- Place pheromone traps in orchards about a week before expected first flight. Oriental fruit moths are usually caught when peaches show pink bud. Codling moths usually start flight as apples approach petal fall, so traps should be hung during bloom. Lesser appleworm flight resembles that of CM.
- Never handle lures for more than one species at a time to avoid cross contamination of the traps.
- Hang the traps on the windward side of the orchard so the pheromone will permeate into the area where the insects will come from. The insects will fly upwind to the trap.
- Hang the trap at eye level; as the crop sets and branches hang lower, you may need to move it higher in the tree.
- The trap should be hung in the outer canopy of the tree, a few rows in from the edge of the orchard.
- Be sure to label each trap with the date hung, and the insect being trapped.
- Check the traps weekly (preferably the same day every week), record the counts, and clean out insects and anything else trapped in the tanglefoot.
- If the trap is full of dirt from a driveway, or insect wing scales, it will not be as effective and counts will be artificially low. If traps are dirty, replace the trap and transfer the lure to the clean trap.
- Replace lures every month unless using long-term lures.

Degree Day Models

Control of internal leps requires close timing that will coincide with hatching of larvae. The larvae must contact the insecticide before entering the fruit. This can best be estimated by the use of degree-day mathematical models. Current models predict that the first spray for CM should be timed for 250 degree days (DD) base 50°F after sustained trap catch. In high pressure blocks, a second application should be made about 10-14 days later. In low pressure blocks, a suggested trap threshold of five or more moths per week, 10-14 days after the insecticide application, can be used to determine if a second application is necessary. The spray for the second generation should be applied at 1260 DD base 50°F after sustained trap catch.

The OFM model is not quite as clear, since the population development is different between peaches and apples. We are currently using a developing model from Penn State University. The first insecticide application should be applied about 175-200 DD base 45°F after sustained trap catch for the first generation. Until we can validate the model, the suggested timing of insecticide sprays for subsequent OFM generations is at 175 DD base 45°F after a significant increase in trap catch and with a suggested weekly trap threshold for a second and third flight of 10 moths per trap per week. Drs. Reissig, Agnello, and Nyrop are researching the trap catch threshold and a proposed scouting protocol to determine the need for special insecticide applications for OFM.

Trap Network Observations. The results of the WNY trapping network demonstrated that there is a lot of variability in pressure from each of the internal lepidopteran pest species from one farm to another. Figure 1 shows that the total number of OFMs trapped per block for the entire season ranged from 17-403 in 2003, and 16-568 in 2004. Figure 2 shows that CM, in general, is not a major issue for most of Western New York, except for a few high-pressure locations. The total CMs caught per trap per season ranged from less than 5 to 167 in 2003, and 1 to 108 in 2004. Figure 3 shows that LAW is also a factor in the internal lep complex. Lesser appleworm trap catches ranged from 14-117 in 2003, and 6-68 in 2004. Figure 4 shows how individual orchards

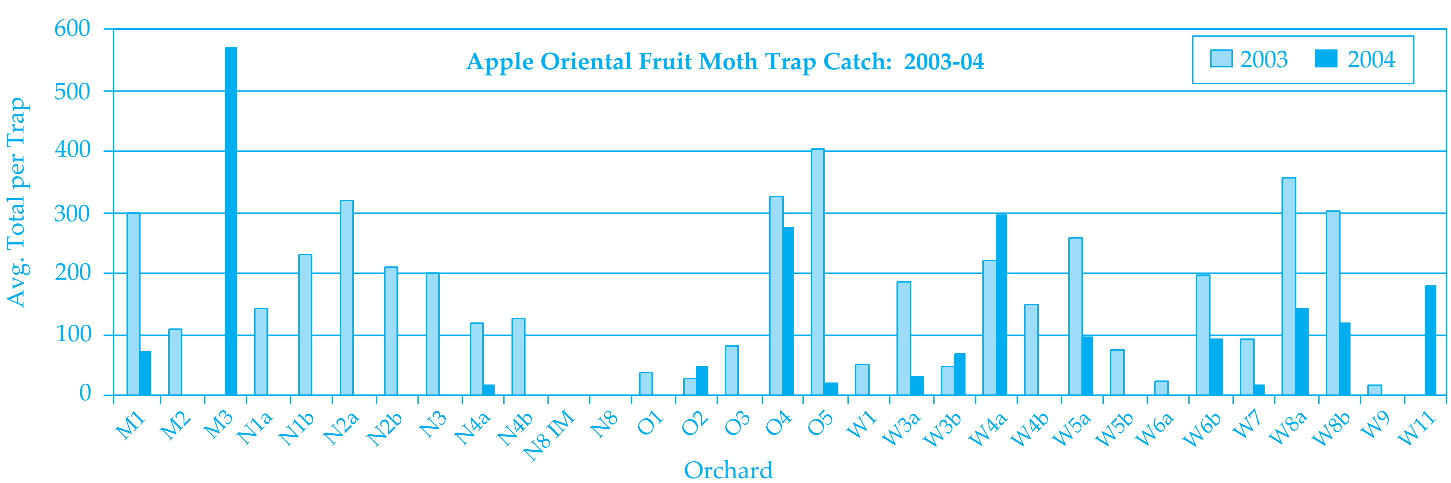

Figure 1. Apple Oriental Fruit Moth trap catch, 2003-04.

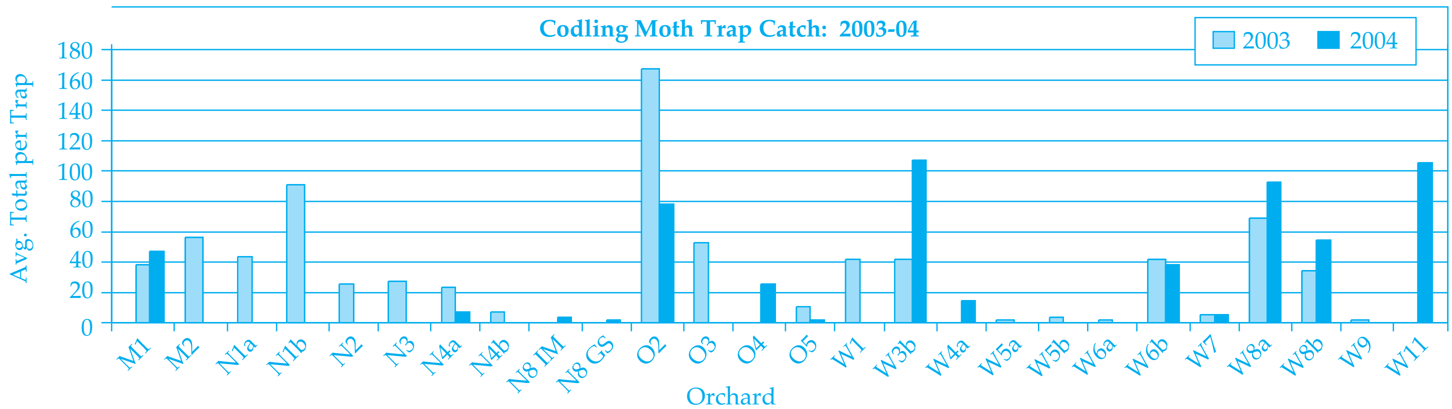

Figure 2. Coddling moth rap catch, 2003-04.

differed in the predominant pest species in 2004. In 2003, for example, block "O5" had the highest number of OFM, very few CM, and moderate levels of LAW. Block "O2" had the highest CM trap catch, one of the lowest OFM trap catches, and moderate catch levels of LAW. Very low populations of all three lep species were found in block "W9". In block "N1b", high populations of all three species existed. In 2004, blocks "M3" and "W4a" had very high levels of OFM but low populations of other pests. Blocks "O2" and "W3b" had higher populations of CM than OFM. Since CM was a significant factor in 4 of the 14 sites monitored, it is critical for growers to survey the population of at least OFM and CM on their farms to determine the appropriate control strategies. LAW will be caught in OFM traps and should be identified if high numbers are present. The variability in populations of internal lep species can only be detected with the installation and maintenance of traps for each species on the farm.

Other Observations from the Trapping Network Include:

- Weekly trap counts can differ between adjacent farms, and will depend on spray schedules and insecticides used. This emphasizes the importance of monitoring each farm.

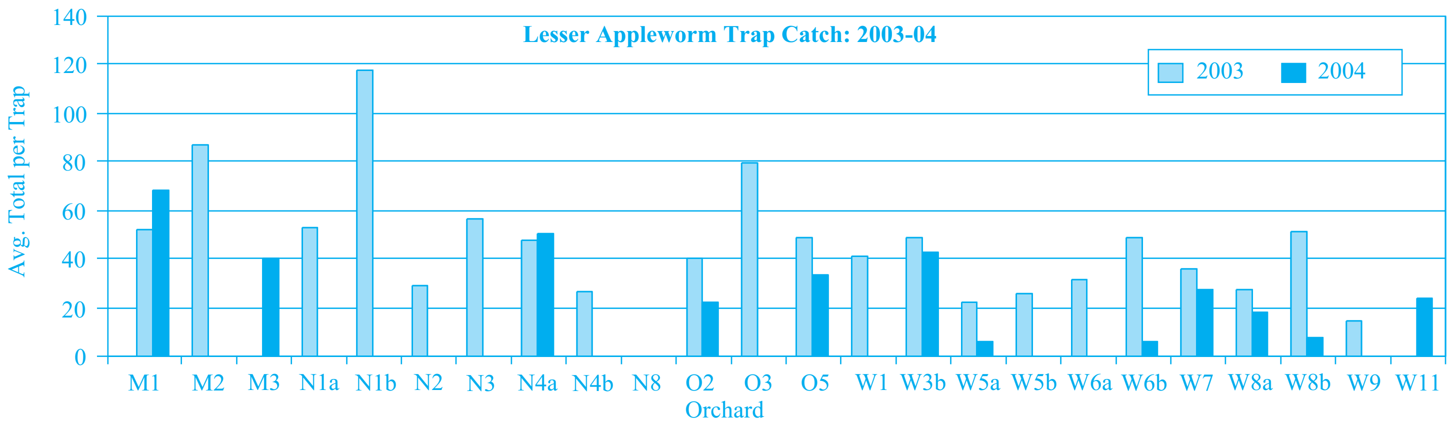

Figure 3. Lesser Appleworm trap catch, 2003-04.

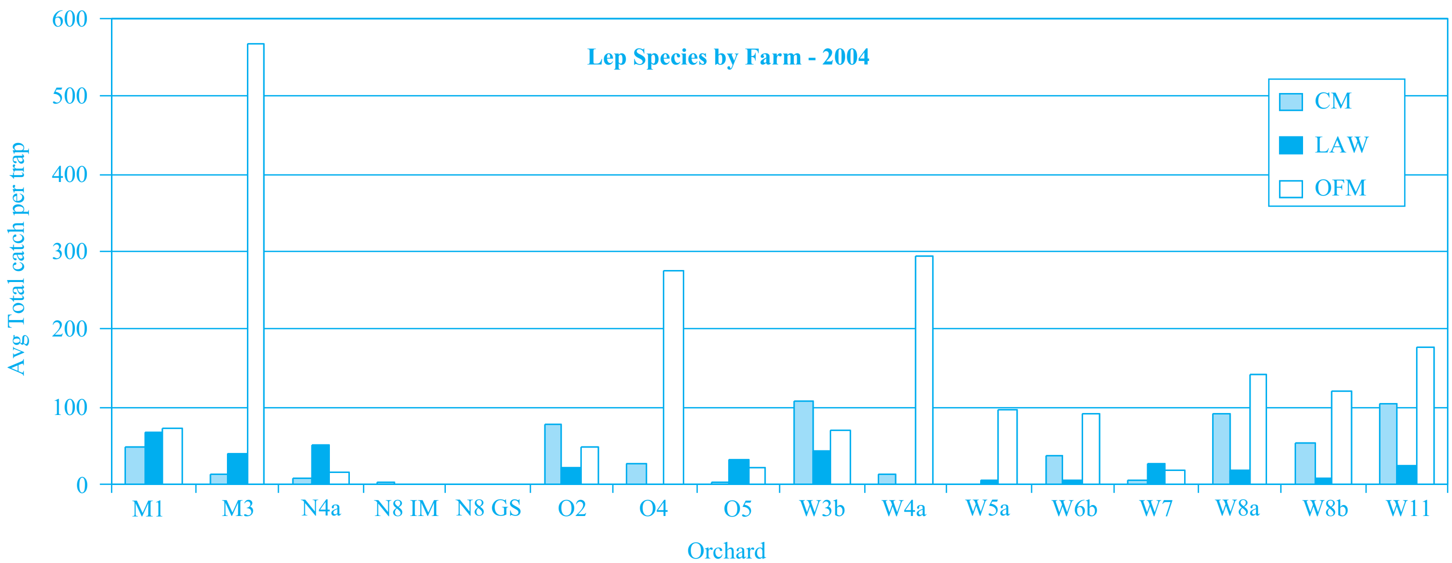

Figure 4. Lep species by farm, 2004.

- Peak flight used in timing insecticide applications may differ from one trap location to another on the same farm.
- The peak flights between the OFM population in a peach block and that in an apple block on the same farm will not be the same. According to the PSU research (unpublished data), OFM have a preference for peach shoots during the shoot growth phase and have a slower rate of larval development when feeding on apples versus peaches. Therefore, one cannot rely on trap count data from peaches to plan for apple sprays, or vice versa.

Harvest Evaluations. Fruit quality evaluations at harvest in 2003 and 2004 showed little internal lep damage. With the exception of one chemical control block in 2003, and the three mating disruption blocks, there was no internal lep infestation of fruit detected. In 2004, there was only 1% internal lep damage detected in an adjacent, presumably unsprayed orchard (check plots) compared to a much higher 22% in 2003. This indicates that there was significantly less success of penetration into the fruit by newly hatched larvae in 2004. This was likely due to the cool wet season, resulting in increased mortality of eggs and hatching larvae.

Current Control Options

The number of options has increased for controlling internal leps in NY since we started to have problems with these pests. After the loss of post-bloom Lorsban applications, we were limited to a group of organophosphates. These include azinphos-methyl (Guthion) and phosmet (Imidan). We also had a couple pyrethroids, including esfenvalerate (Asana) and fenpropathrin (Danitol, for apples and pears only). Under these limitations and high trap catches, peaches require six to eight insecticide sprays per season.

Mating disruption techniques have been introduced against OFM, mainly using Isomate M 100. After controlling the first generation with petal fall sprays necessary for other pests, the pheromone twist ties are applied prior to the second OFM flight around mid-June. Mating disruption used in areas on a region-wide scale has been successful in reducing the OFM population after a couple of years, but the level of control has not eliminated the need for well-timed insecticides. OFM has three to four generations per season. Although insecticides will still be needed to control OFM, there is the potential to minimize pesticide inputs using proper timing and mating disruption. Mating disruption has some impact on LAW as well, since it is also attracted to the OFM lures. Mating disruption for CM control is more difficult unless used on a very large scale.

The NYS Department of Environmental Conservation has recently registered several new insecticides that can help to control internal lep pests. Avaunt (indoxycarb) is a broad-spectrum oxadiazene for pome fruit that has insecticidal properties when ingested by an insect or absorbed through the insect's cuticle. Intrepid (methoxyfenozide) is an insect growth regulator that induces premature molting (shedding of the exoskeleton as the insect grows), making it impossible for the insect to complete the shedding of the exoskeleton. It is effective against both leafrollers and internal leps. Assail (acetamiprid) is a neonicotinoid insecticide but is broader in its control of many groups of insects, including internal leps. Additional pyrethroids have been registered in NY including Warrior (lambda-cyhalothrin) and several others are in the registration process. Calypso (thiocloprid), a neonicotinid, is awaiting NYS registration.

Timing of application of any of these insecticides, using a combination of degree-day models and moth trap catch, is critical for the best control of internal lep pests. Once the larvae hatch and bore into the shoots, in the case of OFM; or the fruit, in the case of OFM, CM, and LAW, they are protected from the insecticide. Orchards with mixed populations of OFM and CM are especially challenged since these two pests have different critical timings necessary for insecticide application. LAW can be controlled by mating disruption for OFM, or by insecticides timed for CM.

Spray Costs

The cost of arthropod pest management continues to rise as new materials are registered. At the same time, there have been more pyrethroids registered in NY for pome and stone fruits and generally available at a lower cost compared to other insecticide classes. The concern about the harmful effects on biological controls, such as predator mites is still an issue with pyrethroids; however, there are many effective miticides available to fruit growers to combat this problem. Arthropod management costs have increased overall since 2002 because of the risk of rejected apples at the processors or the risk of consumers or importers finding a worm in a fresh apple. In observing spray records and total number of moths caught, no statistical relationship was detected between the number of pyrethroids applied and the number of moths caught.

The general trend noted in Western New York has been an increase in the number of broad-spectrum insecticides, especially pyrethroids (SP). According to the National Agricultural Statistics Services (http://www.nass.usda.gov/ny/statisticspub.htm),pyrethroids pesticide use in New York apple orchards has increased by 500% from 1999 to 2003, compared to the use of organophosphates (OPs), which decreased by 48% between 1999 and 2003. The reasons for this have been a combination of the increased risk of internal lep pests infesting the fruit, the relative low cost of pyrethroids, and the higher cost of the new, more selective chemistry.

Conclusions

The Western NY trapping network has been useful in increasing awareness of the internal lep population in Western NY. The benefits of the trapping network are:

- Using pheromone traps provides relative numbers of insect pressure and allows identification of the predominant pest in the internal lep complex, as well as peak flight times.
- Using pheromone trap catch data of first moth catch or sustained trap catch is essential to setting a biofix date for use in the degree-day models.
- Pheromone trap catch records reinforce the suggested timing of insecticide control sprays predicted by degree-day models.
- Pheromone traps around the region can be used to assist insecticide timing in orchards where mating disruption has been implemented. Where Isomate M100 twist ties are hung the previous year, there are very few moths caught the following season.

In orchards where infested fruit has been detected in previous seasons, there has been a general response of implementing some of the broad-spectrum insecticides that were not included in earlier IPM programs. This may be the reason our industry has not suffered the severity of fruit infestations that have plagued other areas. We have many options for control, so rotation between chemistry classes for each generation of egg hatch will be important in delaying chemical resistance by the pests. In other areas lep pests have developed resistance to pyrethroids and organophosphates. With internal lep pressure in 2003 and 2004 declining to more manageable levels, it should be possible to cut back on the number of broad-spectrum cover insecticides based on trap information and scouting results. This hypothesis is being tested by Dr. Harvey Reissig, and is being funded by NY Apple Research and Development Program.

References

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