1. Title: Managing Internal Lepidopteron Worms in Tree Fruit Crops

2. Project Leaders:

Deborah I. Breth, Lake Ontario Fruit Program, Cornell Cooperative Extension

3. Cooperators

Art Agnello and W. H. Reissig, Dept. of Entomology, NYSAES, Geneva
Matt Wells, Motts

4. Type of Grant

Monitoring, forecasting, and economic thresholds

5. Project location

Niagara, Orleans, Monroe, Wayne Counties

6. Abstract

Codling moth (CM) and oriental fruit moth (OFM), have increasingly challenged apple IPM programs since 2000. In 2005, worms were detected in 100 truckloads of apples from 60 farms. There is a USDA standard of zero tolerance for worms in processing fruit diverting it to juice, a 50% loss in value. Accurate timing of appropriate control options is necessary to achieve 99% worm control in an IPM system, which requires the use of monitoring technology including pheromone traps and degree-day models. This project will increase adoption of this technology by growers and consultants, minimizing pesticide inputs and economic losses of rejected fruit loads.

7. Background and Justification

Apple IPM programs are being challenged by internal lepidopteron pests including codling moth (CM), oriental fruit moth (OFM), and lesser appleworm (LAW) that were historically in the background and controlled by broad spectrum materials meant for control of other pests. The Mid-Atlantic and Southern states are suffering big losses due to these pests with over 700 truckloads of apples rejected and diverted to juice annually. Washington State lost the Taiwan export market due to the presence of a few codling moth in the shipment. Projects that address these pests are high priority in the IPM Fruit Commodity and LOF Advisory Committee priority lists since they feed in the flesh of fruit. There is a zero tolerance for these larvae in most fruit markets resulting in intensive control strategies in high pressure orchards. But there may be overreaction in medium to low pressure blocks, with the exception of many producers who stop treating prematurely before these pests complete their seasonal biology. In the early 2000's, these pests were most commonly noted in apples at harvest where insecticides for obliquebanded leafroller were more selective to leafrollers replacing broad-spectrum organophosphates and pyrethroids. Many growers responded to the high economic risk by returning to a broad spectrum cover spray program that may not be necessary based on pest pressure in all orchards.

There have been many IPM methods studied to manage these pests bringing opportunities for extension programs to reduce the economic risk of fruit infestation, and minimize the risks of pesticides used. Pheromone traps have been used globally to monitor first emergence of male moths, and set biofix date (first flight). This date in used in the degree-day model to predict first egg hatch and time insecticide applications. Accurate spray timing is necessary to kill the newly hatched larvae before they are sheltered in the flesh of the fruit. Mating disruption is a new technology which prevents the males from finding the females to mate, reducing the population. But in most cases insecticide sprays must still be incorporated in this technology due to the migration of mated females into the disrupted blocks to lay eggs. Other than looking for damaged fruits, the only way to determine the timing for sprays in these systems is trapping in areas without mating disruption to monitor flight and predict larval development with degree day models.

If these pest pressures develop as they have in other apple growing regions, growers and consultants will need to adjust pest management activities to include strategies for control. The first step in management is to identify the primary species on farms by identification of larvae in fruit at harvest the previous season. The second step is to time insecticide and pheromone application properly for control. These 2 steps can be supported with the establishment of a regional pheromone trap network with results published on the web, through newsletters, faxes, and emails. Consultants and field reps are already stretched thin with the number of traps they can maintain and a supplemental trap network can assist them without increasing the costs to growers and consulting industry. Fine-tuning pest management inputs for these pests can reduce spray costs by $1000's on each farm.

8. Objectives

1. Increase use of pheromone traps and degree-day models to determine need and timing of controls.
2. Identify the pest complex in WNY infested apples in apple samples collected at packer/processor receiving lines
3. Limit economic loss of apples due to worm infestation and overspraying.

9. Procedures

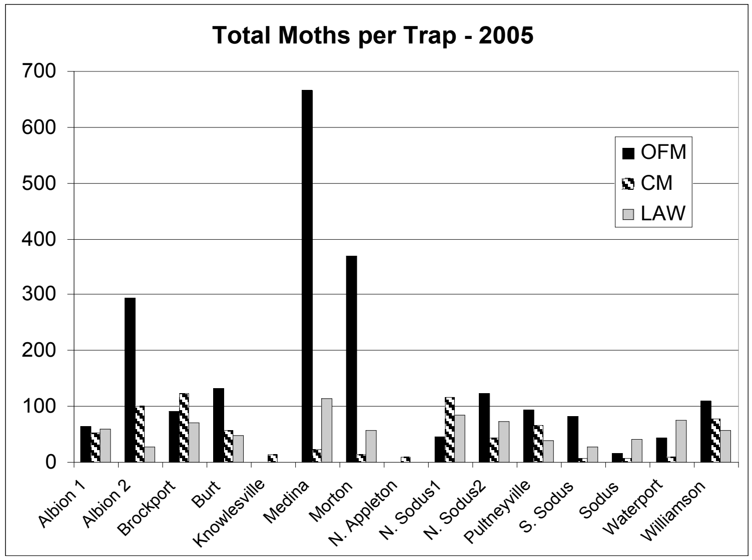
Objective 1: Two pheromone traps were installed in each of 15 locations for each of CM, OFM, and one for LAW in Niagara, Orleans, Monroe, and Wayne Counties with a mix of high and low risk pressure orchards. Trap catch was recorded weekly. Biofixes and trap catch data was used with degree-day models to determine optimum treatment timing for insecticides and mating disruption pheromones. Many growers participated in the trap network by recording trap catch and maintaining traps, and calling in data to be included in the report. Weather data from NEWA was used to calculate degree day accumulation for various locations using a base temperature of 50F for CM, and 45F for OFM. Trap data and degree day model predictions were reported in emails, faxes, and newsletters.

Objective 2: During harvest, processors and packinghouses saved infested apple samples that were found in the inspection process at the receiving lines. Records were kept of the lot number, the farm, the variety, the signs of infestation, and the characteristics of larvae if present. The larvae were preserved for later confirmation of identification. A small harvest evaluation due to lack of funding in 2005 was conducted in the orchards included in the trap network, 50 apples per tree from each of 6 trees.

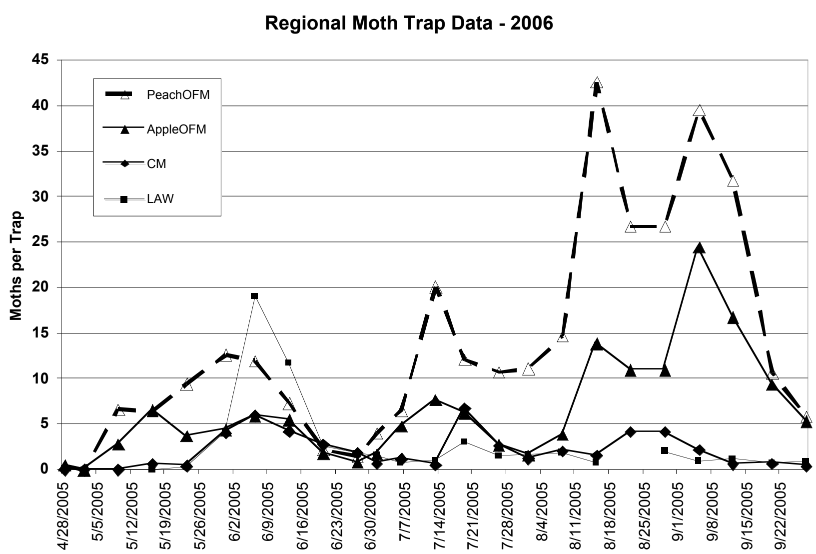
Objective 3: Spray records were collected and will be analyzed for timing based on trap catch and degree day models. Charts will be prepared to use as teaching materials to illustrate the critical spray windows on farms with various levels of worm pressure.

10. Results and Discussion

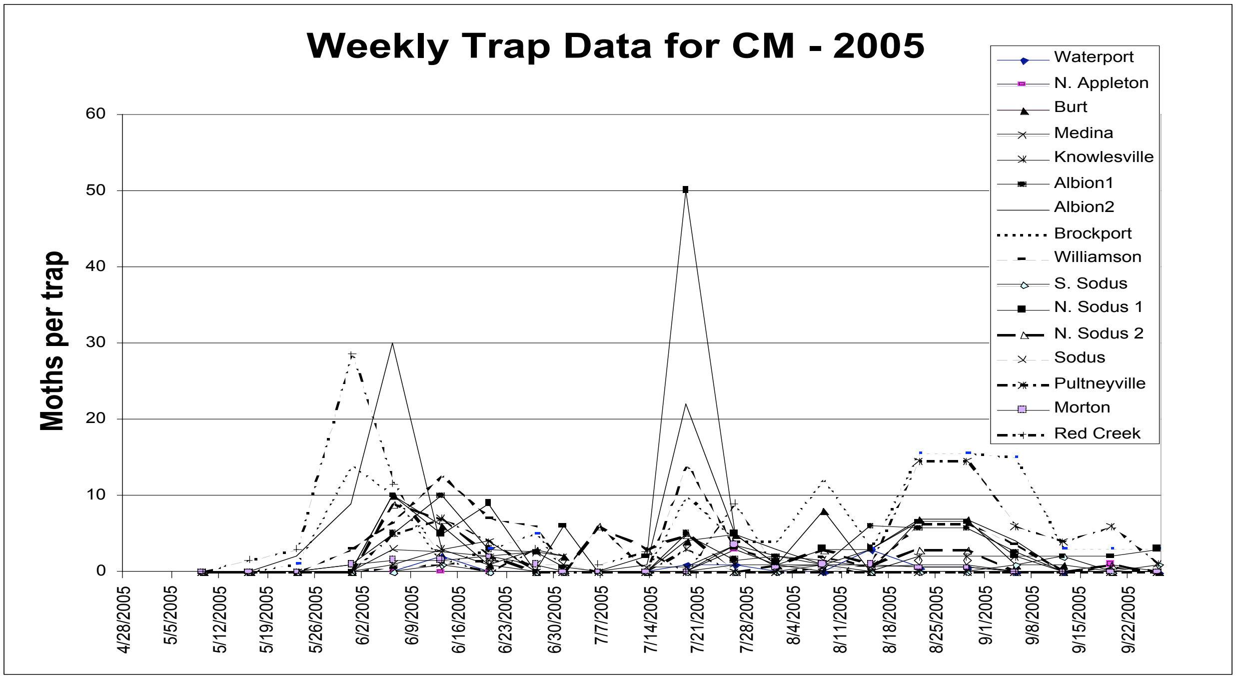
The data from the pheromone traps in apples showed high variability in insect pressure from one block to another. The NAppleton site had very low OFM and LAW trap catch due to the implementation of mating disruption using Isomate M100. The Medina and Morton sites had very high OFM populations but very low CM. This may be related to the adjacent peach orchards that had the crop frozen out in 2005 and were not treated regularly for OFM. Orchards with more than 100 CM caught per season have moderately high pressure as noted in the Albion 2, Brockport, and NSodus1 sites. Seven of the 15 sites had low CM pressure, less than 50 moths per season. This illustrates the value of trapping to identify the high risk pests in an orchard on which to focus control strategies on.



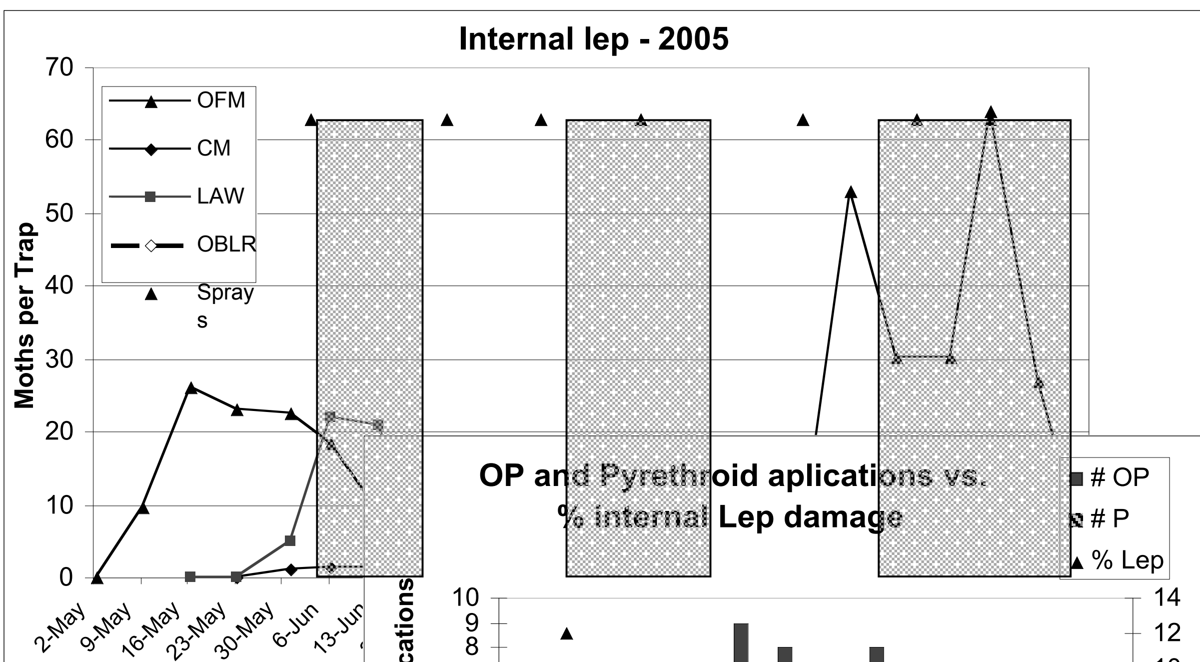
Recommended spray windows based on models or trap data plus models differ among orchards based on high, moderate and low pressure orchards and the insect complex present. The average weekly trap data across the WNY region shows that we had 4 flight peaks of OFM with higher counts in peaches and trap catch was advanced about a week in peaches compared to apples. The CM flight pattern did not coincide with OFM, but was closely correlated with LAW flight. There were 3 peak flights in CM for 2005 leading to a high population of very late hatching larvae.

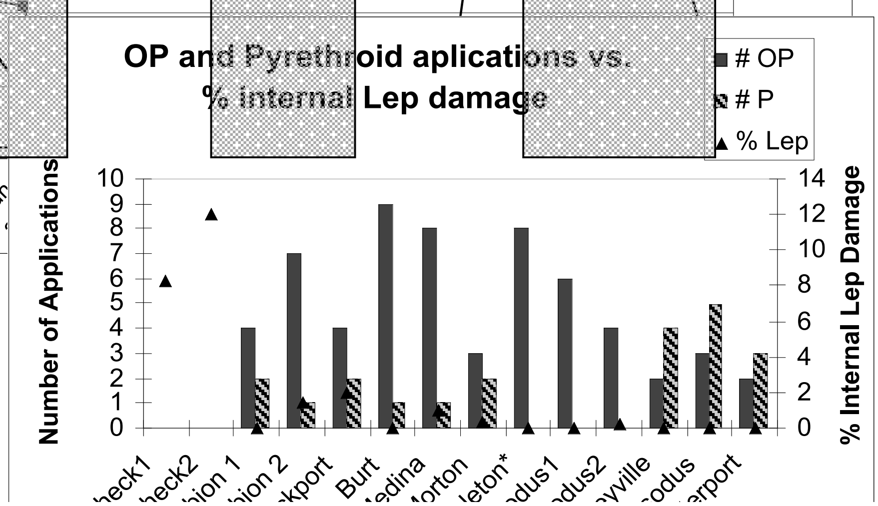


The weekly trap numbers for CM below show the variability in biofix dates (first trap catch) used to start running the degree day model and the population pressure in the area of the network orchards. This emphasizes the importance of growers and consultants increasing the number of pheromone traps to manage internal lep pests.



The spray records will be compiled with the trap data and recommended windows for treatment based on trap catch and degree day models as in the chart on the right to illustrate to growers how to optimize timing of necessary insecticides and how they might time applications of alternatives to organophosphates and pyrethroids.





Harvest evaluations of network orchards

resulted in 0-2% fruit infestation, with 8 and 12 % in two unsprayed orchards. This chart shows the number of applications of organophosphates (OP) and pyrethroids (P) in trap network orchards with the resulting percentage of internal lep damage. This is not the complete story, Burt, and N Appleton were spraying alternate row middle applications on a weekly basis; 9 applications were actually 4.5 applications at the recommended rate per acre. Further analysis of the spray records on a block by block basis will hopefully explain the levels of infestation and how many applications are also necessary.

The Infested Apple Survey of wormy apples included 95 samples from 2 processors and 2 packing houses receiving apples in Western NY from 59 different farms. In the last hot, dry season of 2002, we had a reported 113 samples. In past years, the predominant pest found in apples was OFM, but in 2005, CM outnumbered OFM/LAW by 2 to 1. The OFM and LAW are difficult to distinguish since they both have an anal comb, so more work will be needed to separate the OFM and LAW to determine the extent of damage from LAW. In an orchard with late season worm infestation in the early 2000's, LAW made up 33% of the internal lep pests in the fruit.

There are many benefits of the internal worm trap network in Western New York.

- The traps aid in identification of specific insects that make up the pest complex. If CM numbers are low throughout the year, but OFM are high, growers will only need to address OFM in their pest management programs. If CM and OFM numbers are high, they will need to pay attention to insect development models for both pests.
- An indicator of pest pressure is when the Biofix is set – low populations tend to have late biofix dates and sometimes never exceed the recommended trap thresholds.
- The biofix of first moths caught in the growing season is best used for predicting first brood of egg development, but does not always correlate with subsequent broods. Trap data reinforce the insect development status and assisted in fine-tuning insecticide applications for egg hatch timing.
- Finally, if growers suspect a source of infestation from processor bins that were used the previous season to store wormy fruit, pheromone traps will help detect moth pressure emerging from the bins indicating the relative risk of the bin pile to the apples in the area.

The question remains - to what extent do growers implement mating disruption, or increasing the number of sprays? The survey shows that 37 of 59 farms had only 1 load rejected with a potential loss of $1500 per farm. One additional insecticide spray could cost as much as $20 per acre, but if on a 100 acre farm and the insect pressure is unknown, that would be a loss in just spray cost of $500. But a well targeted spray based on traps, which cost $17 per trap location per season per pest (supplies only), can better predict the risk for each orchard. Eleven farms had 2 infested loads; 9 farms had 3 infested loads; 2 had 4, and 1 farm had 6 infested loads. All of these farms should be adding traps to their pest management program. Since most of the farms have mixed OFM and CM or mainly CM problems, mating disruption on the whole farm is still economically unfeasible. CM disruption materials cost over $100 per acre for materials alone and still require the use of insecticide applications. If growers and consultants can use trap data and degree day models to fine-tune insecticide applications based on the mode of action of the materials, growers will minimize the risk economically and environmentally in meeting grade standards for their apples.

Acknowledgments:
I express gratitude to Motts and growers who continue to subscribe to the Lake Ontario Fruit Program's *Fruit FAX* for support of this trap network.

I thank Drs. Harvey Reissig and Art Agnello for continued support of program in responding with important applied research.

I thank Dr. Juliet Carroll for continued support from the Cornell University IPM Program.