"Final Project Report to the NYS IPM Program, Agricultural IPM 2002–2003."

Controlling Oriental Fruit Moth in Peaches Using Mating Disruption and Assessing the Problem in Apples

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Type of grant:
Pheromones; biorationals; microbials; conventional pesticides

Project location(s):
Niagara, Orleans, Monroe, and Wayne Counties and applicable to all Northeast where OFM are endemic.

Abstract:
There has been an increase of peach acreage in NY by 11%, and 30% in numbers of peach trees planted. The increase has mainly been in processing peaches. Most of these plantings are interplanted near apple and pear orchards. The Oriental fruit moth (OFM) larva is an internal fruit pest of peaches, apples, and pear, and it feeds on shoots of peaches and apples. Two factors may be contributing to the increase in pressure from this pest: 1) OFM is less susceptible to the current pesticides used and 2) many apple growers are reduce the use of OP's and other broad-spectrum insecticides in apples. Mating disruption (MD) was implemented in 210 acres of peaches using Isomate M100 twist ties. The principle behind MD is to flood the orchard with the sex attractant pheromone naturally exuded by the female OFM to attract the male. The males are not able to locate the female moths with the saturation of the orchard and so mating is prevented. Orchards under MD were compared to orchards under conventional insecticide management. Trap counts were essentially zero compared to much higher counts in Chem orchards. Fruit damage by plant bugs and OFM was on average lower than Chem treatments. Costs were higher in MD orchards compared to Chem orchards. There is a zero tolerance for internal worms in the fruit. Insecticide resistance bioassays were done for one generation of moths indicating up to 79 % survival of moths exposed to carbofuran, an indicator for organophosphate and carbamate resistance. If this actually reflects the whole population of OFM, it only allows for 2 alternative controls in peaches including MD and pyrethroids. Although the costs are higher in MD orchards in apples and peaches, the pesticide programs alone are not resulting in clean fruit which is impacting on growers decisions to increase the use of mating disruption in the area in both apples and peaches. There are several limitations to the success of MD for control of OFM and the technique must be thoroughly understood before implementation.

Background and justification:

The 2001 NY Ag. Statistics Tree and Vineyard Survey[1] reports 1795 acres of peaches with a utilized production value in '99 of over $5.4 million. This is an 11% increase in acreage from the 1996 Tree and Vineyard Survey, a 30% increase in tree numbers, and 23% increase in number of farms with peaches in NY. Niagara Co. has 35% of the acreage and 40% of the trees. Wayne Co. is second with 16% of the acreage, and Orleans Co. is fourth with 8%. Acreage has been increasing across the Lake Ontario fruit region with the demand for processing peaches from Kraft, CAN.

Over the past several years, Oriental fruit moth (OFM) damage in peaches, both in shoots and fruit at harvest, has been increasing. Mating Disruption is a new technology that utilizes the specific sex attractant pheromones to confuse the males so they are not able to locate the females and mate with them. The pheromone is applied in twist ties hung in the trees to essentially flood the orchard with the pheromone. We demonstrated in many orchards between 2000-2001 that mating disruption is fairly successful in controlling OFM but there are limitations. Although insecticides will still be required for control of OFM, and other pests such as plum curculio, and the plant bug complex, there is potential to mitigate or reduce pesticide inputs in controlling OFM using proper insecticide timing, better groundcover management, and mating disruption.

A team effort between Extension, growers and their consultants has been working since '98 to improve control starting with better monitoring with pheromone trap catch information to sharpen up timing of insecticide applications in peaches. In '99, in spite of adequate control timing, there was 20% fruit damage in the first picking of peaches, and additional damage in following pickings. If applications had been made when we continued to exceed 6-8 moths per trap per week, we would have required insecticide applications for this insect every 10-14 days after the first flight. OFM flight continues in September every year increasing the risk of infestation in later season peaches, pears and apples. Under a SAR Grower grant (2000) to demonstrate the use of mating disruption for control of OFM in peaches, we had less than 5% fruit infestation by OFM. In 2001 we held trap catch numbers to zero in disrupted orchards from mid-June through August. There was 0-2.5% fruit infestation in outside rows of most disrupted orchards, the same as conventional orchards. The worst case had 9% infestation due to low tree density and many missing trees. Other pest damage noted included plant bug cat-facing injury and feeding on the surface. Whole orchard sprays are necessary for these insects. The edge effect of OFM will require border sprays or complete sprays of insecticides to prevent gravid females from entering the block a few days after peak flight and after pheromones lose effect in August.

The use of insecticide is not always effective due to reduced susceptibility of the insect to the materials. Under the instruction of Dr. David Pree[2], University of Guelph, a preliminary insecticide resistance screening of adult OFM moths exposed to insecticide treated vials in '99 resulted in 30-35% resistance to carbofuran, an indicator for organophosphate and carbamate resistance and 2-3 % survival for cypermethrin; in 2000, 15-25% survival with carbofuran, and 0-20% survival to cypermethrin; in 2001, 10-38% survival in carbofuran. With continued reliance on pyrethroids and OP's in controlling the first generation of OFM, we need to continue to monitor resistance levels until alternatives are registered. The LOF advisory committee rated resistance management of insects like OFM as "important."

Western New York has approximately 25,000 acres of apples and pears. In 2001, processors in New York first reported rejecting approximately 30 truckloads of apples due to internal lepidopteron larvae for which the tolerance is zero in canning apples. OFM was identified as the main larva found. Locations of rejected fruit include Niagara, Orleans, Wayne and Monroe counties. Every truckload of apples rejected as canners diverting them to juice reduced the

value by $1500 per load, if they have a juice market at all. OFM is coming through IPM strategies in North Carolina, Virginia, and Pennsylvania in apples as they switched to more selective, more environmentally sound chemistry and alternative controls resulting in rejection of over 500 truckloads in one season. It is time to expand monitoring practices for OFM and codling moth to the rest of the Lake Ontario region before NY is impacted to this level.

This project addresses the FQPA impending changes with the loss of organophosphates and carbamates, it demonstrates alternative pest management products, it supports IPM decision support systems, and delivers a management system to the grower community. The advisory committee of Lake Ontario Fruit Program of Cornell Cooperative Extension recommended continuing this project and expanding OFM trapping.

Objectives:

1) Demonstrate and evaluate the efficacy of pheromone disruption in controlling OFM in peaches.
2) Screen the OFM population for insecticide resistance.
3) Assess OFM population in processing apple region.
4) Program Evaluation

Procedures:

Objective 1: Evaluate Mating Disruption of OFM Using Isoamte M100

A third year of pheromone disruption was conducted in Niagara Co. peach orchards in cooperation with consultants. One orchard in Monroe Co. was included in the project. Treatments demonstrated include:

A. MD = Insecticide applied for first generation, followed by one application of Isomate M-100 at the rate of 100-150/acre in June, followed by border sprays or complete sprays for peak flight in July, August, and September where preharvest intervals allow.
B. Chem = Insecticide alone rotating between organophosphates, carbamates, and pyrethroids, based on adult flight.

Farm maps were obtained to determine block shapes and surroundings that may be relevant to OFM infestation sources, and plan installation of twist ties in the project. OFM adult flight was monitored using pheromone traps starting at early pink bud on peaches. Traps were cleaned twice per week. The traps were hung in the outer perimeter and the inside of the disrupted orchards. Shoot infestation was evaluated for the first generation in each block, and fruit evaluations for 3rd and 4th generation. Evaluations were made from the perimeter and the interior of the blocks. Pheromone traps were hung in non-disrupted blocks to assess the normal flight pattern of moths throughout the season and to predict when shoot and fruit infestations will occur. All disrupted and conventional comparison blocks were monitored for plant bug populations.

Trap catch data was disseminated in faxes, emails, and newsletters to help growers and consultants time control applications in the remainder of the orchards. Spray records were collected at the end of the season.

Objective 2: Resistance Monitoring

Resistance screening was conducted in five non-disrupted sites in Niagara County. Four Universal Traps, each with 2 pheromone treated rubber septa to attract the adult male moths were placed in each site. The following day, we collected the adults and transferred them to a container with a cotton ball moistened with a 5% sugar solution to reduce stress in the adults. The next day, the moths were transferred to glass vials coated with carbofuran @ 0.2 μg/vial, cypermethrin @ 5 μg/vial, and a control vial without pesticide residue. After 24 hours, the moths were evaluated for mortality numbers. The traps were checked daily during the second flight. No screening was done in mating disrtuption sites due to extremely low trap catches for

the first flight and even fewer numbers after the pheromone was installed for the second flight. In non-disrupted comparison blocks, 50 moths were tested for each material in each site. Resistance levels were reported to the cooperators and a summary will be provided to the industry through newsletters and the LOF Winter Fruit Schools.

Objective 3: Assess OFM pressure in processing apple producing areas

To meet this objective, the OFM trapping network was expanded into Orleans, Monroe, and Wayne Co. relying on consultants to monitor pheromone traps (4-5 per site) in about 4 locations in Wayne county. Lake Ontario Fruit team monitored 1 location in Monroe, and 1 location in Orleans. Trap were checked twice per week, data was sent by email or fax to the fruit team to summarize and publish in the Fruit FAX, recorded fruit message, and newsletter. For lack of other thresholds available, we considered using the Mid-Atlantic threshold of 6-8 moths per trap per week as an action threshold.

Project Evaluation:

Objective 1: The success of this project will be shown in control results of OFM. Measurements of success include percent fruit infestation and shoot infestation compared to chemical programs. Costs of OFM control inputs for each system was calculated. Grower remarks will document cooperator satisfaction with the program. Reports will be sent to peach producers to help encourage them to adopt this technique.

Objective 2. Spray records were collected to examine use patterns of classes of insecticides in peaches. Resistance screening results will reflect the best choice of materials when an insecticide is required.

Objective 3. The expansion of the monitoring network for OFM had the potential to impact on 25,000 acres of apples and pears in the region. The processing apple industry is significantly larger with greater potential impact to fruit quality. There is a zero tolerance to internal worms in apples to meet USDA grading standards. The measure of success will be the number of truckloads rejected from processors in 2002.

Results and discussion:

Objective 1: Evaluate Mating Disruption of OFM Using Isomate M-100

Peaches were in bloom as early as April 19 in some sites and varieties, but processing peaches in Niagara County held back until April 23, petal fall was around May 17. We had very cold wet conditions that were not conducive for OFM flight and egg hatch stalling the need to apply insecticides for OFM or plum curculio. Peaches were approaching shuck split on May 20. In searching for OFM eggs, the first significant numbers were detected May 13. As temperatures started to rise the last week of May, so did the "B" peak of the first flight of OFM from the overwintering larvae. The first OFM sprays were recommended the end of the week of May 20.

Table 1. Shoot Tip Infestation after Control of First Flight

		Infested Shoot Tips/tree	
Farm	Treatment*	Interior	Perimeter
Storage	Chem	0	0
Transit	Chem	nd	0.4
K3	Chem	0.3	0.3
Beebe	Chem	0.2	4.7
S6	Chem	0.6	6.8
K1	MD	0.5	0.2
BN	MD	0	0.1
BS	MD	nd	nd
P123	MD	0	1.4
S3	MD	0	2.6
G7	MD	0.7	3.1

Growers in this study applied their first insecticide in peach orchards from May 23 to May 29 with the second application on June 6-June 14.

The levels of shoot tip infestation suggest that in some blocks the first generation were not controlled adequately. According to previous research done by Walker in Ontario, CAN, edge effects would be obvious as shown in Table 1. In orchards such as Beebe, S6, S3, and G7, the

pressure was fairly high and would challenge a successful program of mating disruption. This may have been a result of a less susceptible population to OP's as indicated by previous resistance field bioassay (Pree, et al.) which held in 2002 as well. See Objective 2.

* Chem = orchards under chemical treatment without mating disruption; MD = orchards where Isomate M 100 would be applied mid-June before the second flight.

One of the methods of evaluating mating disruption is to determine if trap catch is shut down. Figure 1 shows that even though there were no new Isomate M100 twist ties hung in orchards prior to the first flight, trap catch numbers remained very low compared to orchards where mating disruption has not been used in the past. Figure 2 shows the second flight of OFM started around June 24. Growers had applied the Isomate M 100 (100-120 twist ties per acre) on June 20-24. Trap counts in these blocks remained at zero through late August. The orchards under chemical control had trap counts of approximately 25 moths per trap per week through July, and peaked the first week of August with the third flight at 50 moths per trap per week. Trap counts declined but remained at significant levels through August. The fourth flight showed a sharp increase in trap counts the first week of September. Figure 1 and 2 also show the cumulative DD45 from biofix of first flight on May 5. The arrows indicate the egg hatch percentage based on the preliminary model developed by Hull, et al, in PA (unpublished). The arrows correspond to 5-15% and 65-75% egg hatch for each brood. This degree-day model is still under refinement in PA.

Figure 1. OFM Trap Catch for 1st Gen in Peaches

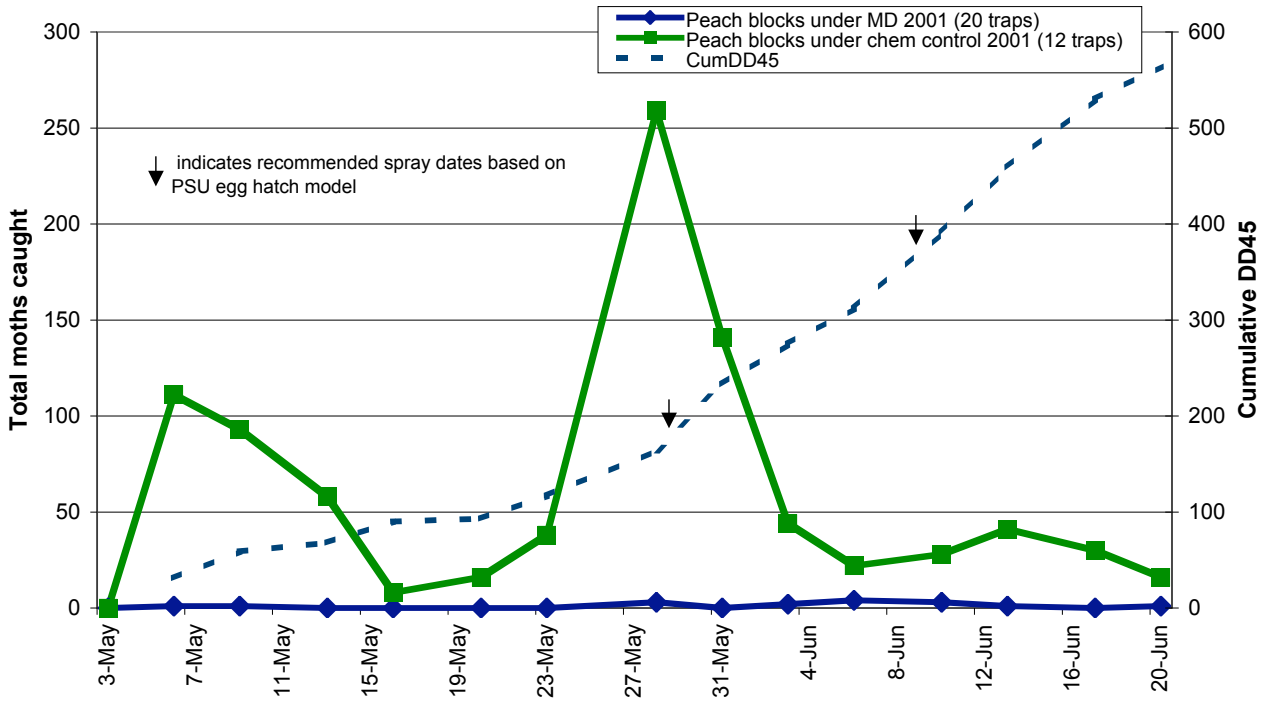


Table 2 shows the results of the fruit evaluation at harvest. The interior trees in the Chemical treatments had a range of 0 to 6% of fruit infested by OFM (average 2.8%), and 0 to 5% (average 2.0%) in the Mating Disruption treatments. The Perimeter had a higher incidence of infested fruit ranging from 0 to 24% (average 8.2%) in the Chemical treatments, and 1 to 11% (average 5.1%) in the Mating Disruption treatments. The higher percentage of fruit infestation in the perimeter of "Storage" and"Beebe" was probably a function of early varieties in the interior and later harvested varieties in the perimeter. In most peach plantings in NY, there is a wide range of ripening and harvest dates complicating insecticide applications to protect from OFM and adhere to preharvest intervals. But varietal differences are not responsible for the edge effect in G7, and S3 since they are solid blocks of Babygold 5 or 7 generally harvested the first to second week of September. These orchards had higher than desirable levels of OFM shoot infestation from the first generation, impacting on OFM populations in the orchard. G7, S3, Murray, Countyline, and P123 had no insecticide applications after July 15.

Table 2. Insect Damage in Peaches under Chemical Control and Mating Disruption

		Interior				Perimeter			
Farm	Treatment	% Clean	% OFM	% PB Sting	% Catfacing	% Clean	% OFM	% PB sting	% Catfacing
Storage	Chem	88	6	6	0	87	10	2	1
Transit	Chem	97	0	3	0	98	0	2	0
K3	Chem	80	3	17	0	93	3	4	0
Beebe	Chem	74	0	25	1	91	4	5	0
S6	Chem	93	5	1	0	69	24	2	5
Average		**86.4**	**2.8**	**10.4**	**0.2**	**87.6**	**8.2**	**3.0**	**1.2**
K1	MD	88	1	11	0	95	2	3	0
BN	MD	98	1	1	0	95	2	3	0
BS	MD	98.5	1.5	0	0	94.5	5	0.5	0
P123	MD	96.5	0.5	3	0	95.5	1	3.5	0
S3	MD	93	5	0	2	88	11	1	0
G7	MD	90	5	4	1	88	10	0	2
Countyline	MD	91	2	7	0	85	1	13	0
Murray	MD	100	0	0	0	89	9	2	0
Average		**94.4**	**2.0**	**3.3**	**0.4**	**91.3**	**5.1**	**3.3**	**0.3**

Cost analysis of implementing mating disruption vs. a conventional insecticide program needs to include the materials cost, the time needed for applications, cost of application equipment, and the cost of scouting and scouting supplies. Table 3 shows the cost if insecticide and miticide plus Isomate M100 for all orchards according to spray records submitted. Preliminary analysis of spray records provided by the cooperators showed lower cost of materials in the Chem treated blocks than insecticide and miticide costs in the MD treated orchards. But the Chem orchards did not have as effective control in 2002 as that noted in 2001. There was increased damage due to plant bug and stink bug injury, possibly due to the drought conditions and the common cultivation system used for ground cover management. There was significantly more OFM injury in the Chem orchards than last season, and on average more than in the MD treated orchards in 2002. A miticide application was noted in spray records from BN, BS, E1, and Countyline resulting in higher cost. The need for miticides will often be a part of a program relying heavily on pyrethroids such as Asana. Table 4 shows the heavy reliance peach growers are placing on pyrethroids for control of OFM and plant bugs in the system.

Table 3. Basic cost comparison of insecticide costs and number of complete sprays applied.

Block	Treatment	Insecticide Cost on 5 acres $	# complete applications*
Storage	Chem	347.91	5.5*
Transit	Chem	347.91	5.5*
K3	Chem	137.43	2.5*
Beebe	Chem	316.94	7
S6	Chem	377.76	5
K1	MD	309.90	2*
BN	MD	731.37	4.5
BS	MD	731.37	4.5
P123	MD	664.44	3
S3	MD	525.69	4
G7	MD	525.69	4
Countyline	MD	797.04	3
Murray	MD	525.69	4

* = most applications were made alternate row middle, 1 complete spray equals 2 ARM sprays.

Table 4. Average amount of specific insecticides and miticides applied per acre ac orchards under Chem vs. MD treatments.**

	Pesticide							
Treatment	Asana oz.	Guthion lb.	Provado oz.	Imidan lb.	Pyramite oz.	Apollo oz.	Thiodan lb.	Isomate M100
Chem	32.4	3.6	1.0	0.0	0.0	0.0	0.4	0.0
MD	14.1	3.5	4.4	0.2	1.7	0.8	0.0	1.0

** = Pesticide rates may appear very low on a per acre basis since not all blocks we treated with each of the pesticides.

Mating Disruption certainly is a viable option for control of OFM in peaches, but it is clear that there are limitations in using this technology. The biggest limitation is the configuration, size and shape, of the orchard to be disrupted. Long skinny blocks such as BS and orchards with a lot of space between trees such as S6 (disrupted in 2000-01) and newly planted blocks will not result in adequate control without overlaying pesticide treatments. The greatest damage is usually detected along the perimeter of the orchard suggesting that border sprays are necessary. The final challenge is the ground cover management to prevent plant bug and stink bug injury. More work must be done on a larger scale to demonstrate area-wide mating disruption where peach, apple, and pear orchards are interplanted.

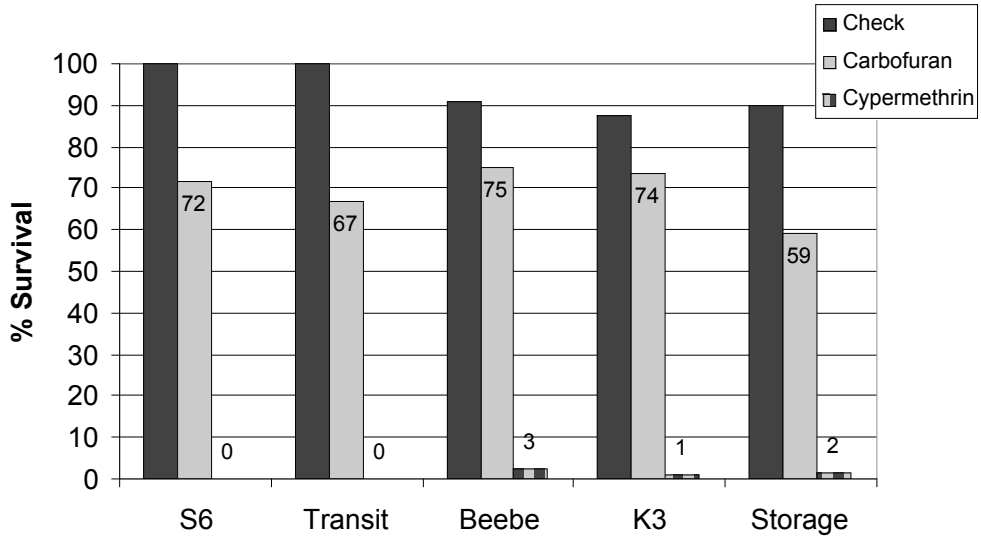
Objective 2: Resistance Monitoring

The second flight of moths (from the first generation of larvae for 2002) was tested for susceptibility to organophosphates, carbamates, and pyrethroids. This field bioassay is very time- intensive since it is necessary to collect the moths from traps every day. If trapped moths

are not collected every day, mortality is high due to stress. This test can only indicate the susceptibility of the male moth population. In 2001, a small sample of moths caught in Storage, G7, and Beebe were bioassayed through the 2nd flight with 10%, 38%, and 32% survival in the vials treated with carbofuran, the indicator bioassay for carbamate and organophosphate resistance. By the fourth flight in the end of the season, they had 14%, 51%, and 47% survival indicating decreasing susceptibility to OP's.

Figure 3 shows the percent survival of moths exposed to vials treated with carbofuran, cypermethrin and the check vials in 5 orchards in Niagara Co. in 2002. In testing these same orchards, Beebe and Storage had 75% and 59% survival in the carbofuran vials. G7 could not be tested since it was being managed with mating disruption. Other blocks tested had 67 to 74% survival to the OP's. None of the orchards tested had more than 3% survival in the cypermethrin vials.

Figure 3. Survival of OFM Moths in Vials treated with Carbofuran and Cypermethrin



Pyrethroids are still fairly effective at knocking down male moths. The next step will be to ensure the male and female moths are equally susceptible to the insecticides, and to determine if the percentage of survival carries through to the larvae. This will require a comparison of results on the same population using the Pree method and the topical application method of adult bioassay. The next step is to comparte the Pree field bioassys with the larval bioassay method.

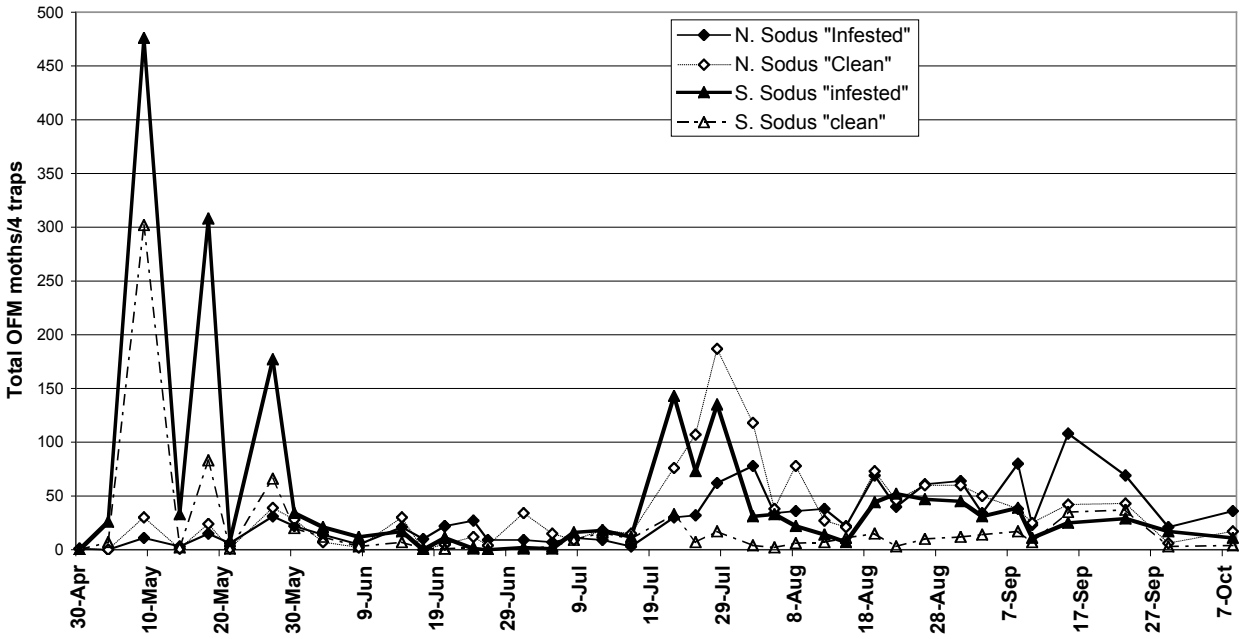
It is not likely that reliance on pyrethroids exclusively will be a sustainable system in peaches. It is important for peach growers with only Asana and Guthion or Imidan for control of OFM to use alternative control methods such as mating disruption to keep the populations down to manageable levels. In controlling plant bug and stink bugs, a sod row middle management system has been shown by other researchers to be a better control strategy.

Objective 3: Monitoring OFM populations in processing apple region of Wayne Co.

Pheromone traps were hung in apple orchards in Wayne Co. that have never had mating disruption techniques used. Traps were located in two areas, north and south of Rt. 104 in the Sodus area (N Sodus and S Sodus, respectively). Half of the traps in each location were hung in blocks where OFM was detected in fruit in 2001, and the other half in blocks where fruit loads were not rejected due to internal worms.

Figure 4 shows surprising numbers of moths caught during peak flights and throughout the season. The North Sodus site had lower numbers of OFM caught in the first flight than in South Sodus. The "clean" site in South Sodus had fewer moths caught than in the "infested" site. But the North Sodus "clean" and "infested" sites had comparable numbers throughout the season. The peak trap counts resembled those in peaches with the first flight occurring through May, and the second flight between mid-July and the first week of August. Significant numbers of moths, greater than 6-8 moths per trap per week, were caught through August and September. The orchards were evaluated for fruit damage in each of the blocks where trapping was done. North Sodus "infested" was a RI Greening block, with approximately 1-5% damage, the North Sodus "clean" and South Sodus "infested" blocks were Idared orchards with 10-20% fruit infested. The South Sodus "clean" block was Jonamac, Empire, and Golden with a few Gala with no report of infestation. The orchards with infestation last season clearly had pressure in 2002.

Figure 4. Total OFM Moths Caught in Apple, Wayne Co.



According to one processor cooperating with the project, there were 113 loads of apples rejected due to internal worms from 48 growers across Western NY. This is an increase over the 30 loads from 2001. There was an increase in pesticide application in WNY apples in many areas due to the threat of OFM either by including a broad-spectrum insecticide with the selective leafroller materials and/or by continuation of insecticide application into late August to mid-September in later harvested varieties. It is unclear what level of insecticide resistance is contributing to this problem. This project will continue through the winter months while spray records for many orchards are collected, and tabulated to determine if there were any trends that can be isolated to help in future management of this insect.

References:

1 NYS Agricultural Statistics Services. 2001 NYS Tree and Vineyard Survey. http://www.nass.usda.gov/ny/FruitTree/fruittree2002txt.pdf

2 LHB Kanga, DJ Pree, JL van Lier, and GM Walker. 1999. Monitoring for Resistance to Organophosphorus, Carbamate, and Pyrethroid Insecticides in Oriental Fruity Moth (Lepidoptera:Tortricidae). The Canadian Entomologist 131:441-450.