Final Project Report to the NYS IPM Program, Agricultural IPM 2000-2001

Controlling Oriental Fruit Moth in Peaches Using Pheromone Disruption

Project Leader:
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Cooperator(s):
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Type of grant:
Pheromones, biorationals, microbials, and conventional pesticides.
Training practitioners to use IPM techniques.

Project location(s):
Niagara County

Abstract:
Oriental fruit moth (OFM) has been an economic pest in peaches, apples and pears for several years. In 2000, mating disruption techniques were applied in 80 acres of peaches with good results, requiring some refinement. Trap catch and egg development were monitored to validate control timing models. OFM adults were monitored for resistance to insecticides. In 2001, mating disruption was as effective as the chemical control orchards in most cases as long as size and shape of the orchard allowed for a wide area to be flooded with the sex pheromone to prevent the male moths from mating with the females. In general, the 4-5 insecticide applications were made in the mating disruption plots while 8-9 applications were made in chemically contolled plots. There was very little difference in cost for either strategy although mating disruption does require a higher level of management. In the long run, a combination of mating disruption and chemical controls will be the most sustainable approach to OFM control in peaches and other tree fruit. Resistance screening in 2001 continues to show there are low levels of resistance in the OFM populations to organophosphates, and the best management of these populations is to continue using mating disruption and rotate the insecticide classes used between generations of OFM.

Background and justification:
The NY Ag. Statistics (1999-2000), there are 1600 bearing acres of peaches with a utilized production value in '99 of over $5.4 million. The majority of acreage is located in Niagara Co. and is increasing across the Lake Ontario fruit region with the demand for processing peaches. Over the past several years, we have noticed an increase in Oriental fruit moth (OFM) damage in peaches, both in shoots and fruit at harvest. We have also noted more fruit infestation late in the season in pears and apples. OFM is coming through IPM strategies in New Jersey and Pennsylvania in apples as we switch to more selective insecticide chemistry and alternative controls for other pests. Materials such as Confirm, Spintor, and B.t. sprays have little to no effect on Oriental fruit moth. Although insecticides may still be required in control of OFM, there is potential to mitigate or reduce pesticide inputs for this pest.

This pest attacks the growing shoots in its first generation, the second generation attacks the shoots and green fruit, the third and fourth generation larvae feed primarily within the fruit thereafter. The larva enters the green fruit on the side, or at the stem end late in the season, and proceeds to feed in the area around the pit. External evidence of this infestation late in the season may go unnoticed unless the fruit is cut. This concealed aspect of its feeding activity naturally makes chemical control of the insect very difficult unless it can be contacted with a pesticide spray before it enters a fruit or shoot.

Under high populations, OFM control usually requires 7-9 insecticide sprays a season using either pyrethroids or organophosphates on a rotational basis. With limited choices of insecticide chemistry, development of resistance is highly likely. Pesticide resistance is documented in nearby growing areas of Ontario's Niagara Peninsula. The resistance monitoring methods used by Pree have been used since 1999 to monitor orchard populations of OFM in western NY. Under the instruction of Dr. David Pree, 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, the results ranged from 15-25% survival with carbofuran, and 0-20% survival when exposed to cypermethrin. With increased reliance on pyrethroids in controlling the first generation of OFM, we need to continue to monitor resistance levels.

The potential for resistance and the imminent regulatory changes in the use of organophosphates stemming from the Food Quality Protection Act will require at least a shift to different chemistries or to alternative control methods such as mating disruption. Hopefully these alternatives will be available and affordable. Due to the current circumstances, the use of pheromone mating disruption is considered a potentially useful tactic that needs to be evaluated under Western N.Y. growing conditions. In contrast to other tortricid fruit pests commonly encountered in eastern orchard crops, the OFM has shown itself to be potentially amenable to acceptable control by using commercial mating pheromone dispensers that are already registered and available. Isomate M-100 is available and effective for 80-100 days. Isomate Rosso is available for testing on 10 acres and effective for up to 5 months.

A team effort between Extension, growers and their consultants started in 1998 with better monitoring of pheromone trap catch information to sharpen up timing of insecticide applications in peaches where infestation levels were economically damaging. In 1999, in spite of adequate control timing, there was 20% fruit damage in the first picking of peaches, and additional damage in following pickings. There was also continued shoot damage noted mid-season in both bearing and nonbearing peaches, and bearing apples. 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. In 2000, the flight continued in September increasing the risk of infestation in later season peaches.

Under a SAR Grower grant (2000) to demonstrate the use of mating disruption for control of OFM in peaches, we had much improved control, in general less than 5% fruit infestation by OFM. Other pest damage noted included plant bug cat-facing injury and feeding on the surface. The Isomate-M100 is effective for about 3 months of mating disruption. Applied in mid-June, it should have been effective through mid-September. But since there were infested fruits in mid-September, we need to consider the possible reasons for the infestation.

Three approaches may be taken to improve this system: 1) make a second application of Isomate M-100 for the later flight in August and September, 2) use a longer lasting formulation of twist tie dispensers, or 3) apply border sprays of insecticides or complete sprays to prevent gravid females from entering the block during peak flight periods. A scouting protocol should include a sweep net and beating tray to determine the potential for fruit damage from the plant bug complex. Peach growers will still need to make some chemical applications to prevent fruit damage from direct fruit pests such as plum curculio, tarnished plant bug, aphids, and borers. Other researchers are consistently reporting that mating disruption is most effective if starting with a low population of OFM. Some chemical applications are probably necessary to prevent mated females outside of the orchard from infesting the disrupted orchard as long as contiguous areas are not disrupted.

This project addresses three priorities in the IPM grants program. It addresses the FQPA impending changes with the loss of organophosphates and carbamates, the need to demonstrate alternative pest management products, and it will deliver a new IPM technique to the grower community.

Objectives:

1) To demonstrate and evaluate the efficacy of pheromone disruption in controlling OFM in peaches.
2) To continue screening the OFM population for insecticide resistance.
3) Project Evaluation

Procedures:

Objective 1: Evaluate Mating Disruption of OFM Using Pheromone Twist Tie Dispensers
Treatments included:

a) Isomate M-100
b) Rosso Isomate
c) Insecticide only based on adult flight

This mating disruption program was concentrated in an area of production in Niagara county with 3 producers, disrupting all peach, nectarine, apricot and plum acreage on the 3 farms, with a total of 80 acres. All orchards disrupted were not contiguous; many were bordered by sweet or tart cherries, apples or pears that were not disrupted.

Isomate M-100 plots were treated with insecticide applied for first generation larvae at petal fall and two weeks later. The isomate M100 dispensers were hung in the trees at the rate of 100-150/acre in mid-June before the second flight began. In the outer 3 rows, every tree had a dispenser; in the interior rows, every other tree. Border sprays or whole orchard sprays of insecticide were applied shortly after peak flights in July and August where preharvest intervals would allow. Blocks treated with Isomate M-100 that were followed throughout this program are referred to as "Baehr," "Ellnor, " and "S6."

Isomate Rosso plots were set up in three sites, referred to as "Green Lane," "Murray Fresh," and "Murray Process." The twist ties are effective for up to 5 months, and were applied before the first generation flight on April 26-27 at a rate of 200 ties per acre. The "Green Lane" site, 2 acres, had various planting distances between rows and trees, as a planting system demonstration. The ties were applied in each tree in the 2 rows of apples on the east side of the drive lane from the peaches, on every tree in the outer 3 rows around the perimeter of the peaches, and every 2-3 trees in the interior. The south and west edges of the planting were surrounded by brush and woods. The "Murray Process"and "Murray Fresh" plots were contiguous blocks with a total of 8 acres, surrounded by apples to the north and east, and peaches to the south to be disrupted for the second flight. The western edge was a cabbage field. Border sprays were recommended in disrupted plots based on trap catch information for each flight, and some blocks had complete sprays applied based on scouting information in the disrupted orchards.

Other orchards were treated with a standard insecticide program rotating between organophosphates, carbamates, and pyrethroids. These blocks are referred to as "G7," "Storage," and "Transit."

OFM adult flight was monitored twice per week using pheromone traps starting at early pink bud on peaches. The traps were hung in the outer perimeter and inside of the disrupted orchards to help us determine if mating disruption was successful. Pheromone traps hung in non-disrupted blocks were monitored to assess the normal flight pattern of moths and to predict when shoot and fruit infestations would occur. Trap catch data were disseminated throughout the industry to help time control applications in the remainder of the orchards.

To evaluate control, the total number of shoots infested per tree was recorded in each of 20 trees on outside rows, and 20 trees in interior of each orchard. These counts were taken in late June to early July after all of the first generation larvae could do their damage and before the second generation was active. Fruit infestation was evaluated in mid-August after the third generation larvae by collecting 20 fruit per tree on each of 10 trees on outside rows, and 10 trees in interior of each orchard. Evaluations were conducted along edges and in the center of the blocks to determine if there is an edge effect due to migration of gravid females into the blocks. OFM infestation and plant bug stings were recorded.

All disrupted and conventional comparison blocks were monitored for plant bug populations. Plant bug populations were monitored by making 50 sweeps with a sweep net across the orchard floor and groundcover, and 20 taps on branches using a beating tray (until the peaches started to fall off.)

Spray records were collected for all disrupted and chemically controlled plots.

Objective 2: Resistance Monitoring
Resistance screening was continued in four non-disrupted sites in the region. We installed 4 Universal Traps, yellow and white, each with 2 pheromone treated rubber septa to attract the adult male moths in each site. We collected the adults 3-5 times a week and transferred them to a container with a cotton ball wet with a 5% sugar solution to reduce stress in the adults. Twelve to 24 hours later, the moths were transferred to glass vials coated with carbofuran @ 0.2 μg/vial, or cypermethrin @ 5 μg/vial, or a control vial without pesticide residue. In 24 hours, the moths are evaluated for survival. In non-disrupted comparison blocks, moths for each of 3 flights were tested for each material in each site. Sites tested include "G7," "Storage," "Hall," and "Burroughs."

Preferred Customer
Comment:

Objective 3: Project Evaluation
The potential peach acreage impacted by this project is 700 acres in Niagara Co., but it could also impact on pears and apples in the region. The number of growers potentially impacted is estimated at 50 in Niagara and Orleans counties. As the project gains success in refining the strategy, it will be applicable across the state in peaches as well as apples.

In early winter of 2001-2002, surveys will be sent to cooperating growers to determine their satisfaction with this technique in final fruit quality for market. Final reports will be sent to peach producers to help encourage them to adopt this technique. This implementation project compliments other research in pest phenology models, insecticide resistance monitoring, and screening other control materials and pheromone formulations funded by NEIPM for Reissig and Agnello.

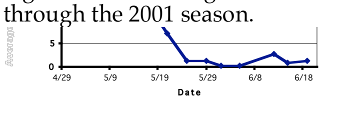
Results and discussion:

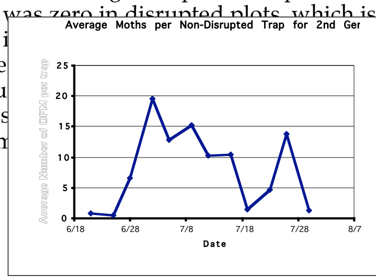
Objective 1: Evaluate Mating Disruption of OFM Using Pheromone Twist Tie Dispensers

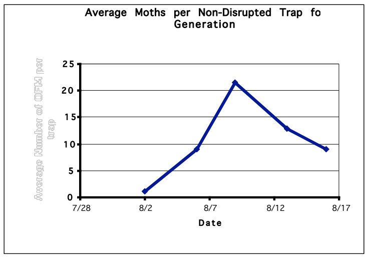
The flight pattern of OFM in 2001 in orchards not disrupted showed first flight during pink bud on peaches, April 30, with significant flight noted by May 3. Figure 1 shows the average moths per trap caught for the first through fourth flight. The peak of the first flight was noted on May 10 with flight subsiding for approximately 4 weeks starting on May 25-29 in most blocks. The second flight started on June 25, with peak flight on July 2. The second flight was significant throughout most of July and does not clearly separate from the 3rd flight. However, there was a significant peak for the third flight on August 9. The moths continued to fly through September 22 in orchards where we continued to trap for resistance monitoring.

The Mid-Atlantic Orchard Monitoring Guide recommends an insecticide application within 7-10 days after an average of 6-8 moths per trap per week are caught. Based on the trap catch data in non-disrupted blocks, controlling OFM can require as many as 9 insecticide applications on late harvested cultivars, with some of the insecticides having multiple pest control effects.

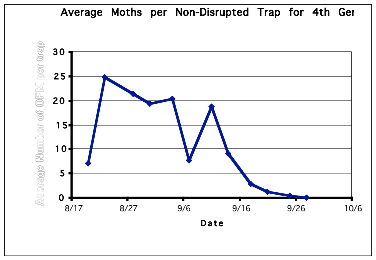
The trap catch data for orchards under mating disruption compared with chemical control plots are shown in Figure 2. Trap catch was zero in disrupted plots, which is one of the indicators that mating disruption is working i … Rosso plots were essentially zero through mid-Septe … alled in mid-June just prior to second flight held trap cou … occasional moth was noted traps. Trap catch increased s … by mid-late August.
Figure 1. The average number of m … chards for each fl;ight through the 2001 season.





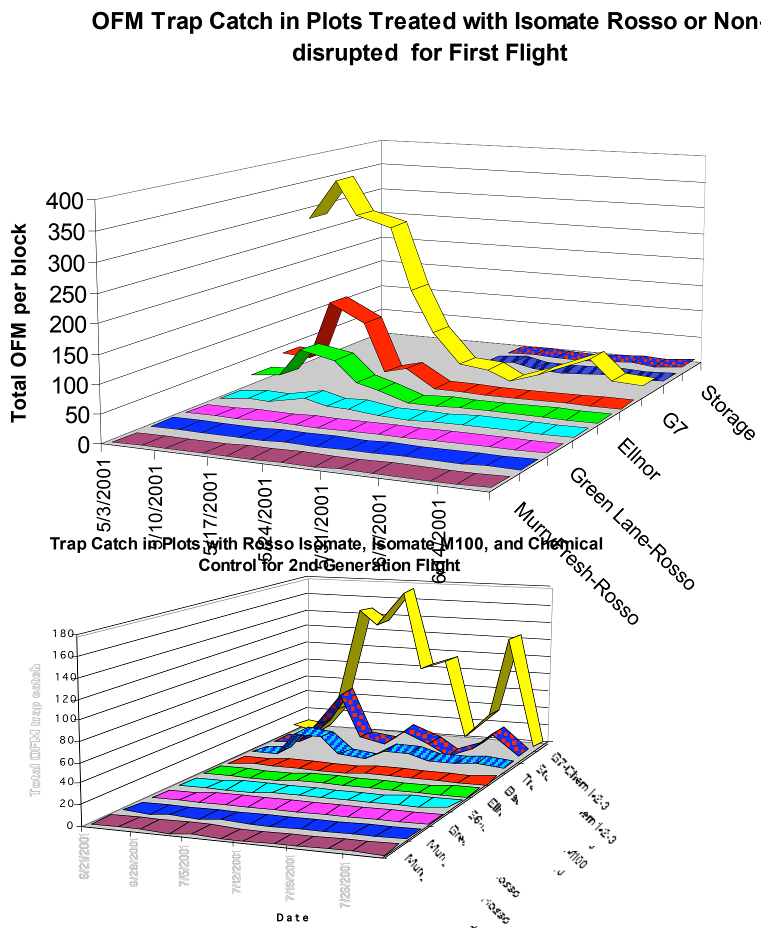


Average Moths per Non-Disrupted Trap fo
Generation
Average Number of OFM per trap
25
20
15
10
5
0
7/28
8/2
8/7
8/12
8/17
Date

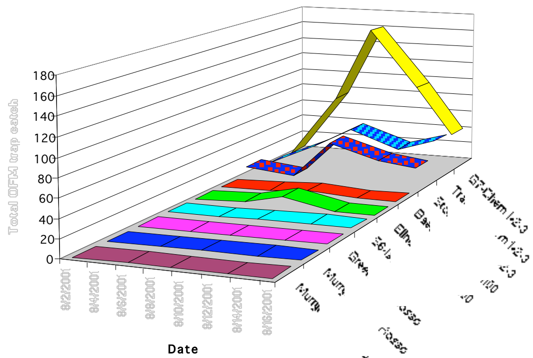


Average Moths per Non-Disrupted Trap for 4th Ge
Average Number of OFM per trap
30
25
20
15
10
5
0
8/17
8/27
9/6
9/16
9/26
10/6
Date

Figure 2. These figures show the trap catch data for blocks disrupted with Isomate M-100 and Rosso, compared to trap catch data in blocks controlled with an insecticide program.



Trap Catch in Plots with Rosso Isomate, Isomate M100, and Chemical Control for 3rd Generation Flight



Trap Catch in Plots with Rosso Isomate, Isomate M100, and Chemical Control for 4th Generation Flight

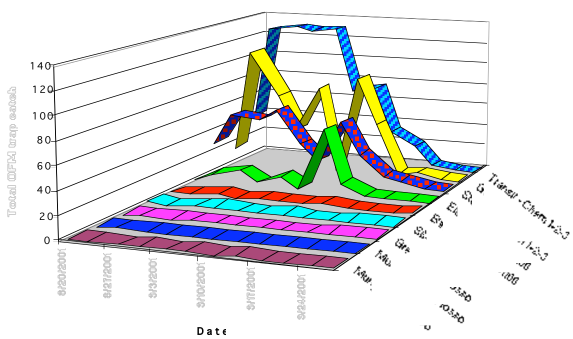


Table 1. Comparison of Shoot Infestation after 1st Generation and Fruit Infestation after 3rd Generation

Block	Treatment	Total Shoot Infestation on Outside (20 Trees)	Total Shoot Infestation on Inside (20 Trees)	% Fruit Infestation on Outside	% Fruit Infestation on Inside
Murray Fresh	Rosso	**1**	**0**	**2.0**	**0.0**
Murray Process	Rosso	**4**	**1**	**0.0**	**1.0**
Green Lane	Rosso	**89**	**73**	**1.0**	**0.0**
S6	Chem 1+ Isomate M-100	**13**	**10**	**9.0**	**3.0**
Ellnor P4	Chem 1+ Isomate M-100	**0**	**3**	**1.0**	**0.0**
Baehr	Chem 1+ Isomate M-100	**3**	**2**	**2.5**	**0.0**
G-7	Chem 1+ 2-3	**N/A**	**N/A**	**2.0**	**0.0**
Storage	Chem 1+ 2-3	**7**	**3**	**2.5**	**0.5**
Transit	Chem 1+ 2-3	**18**	**7**	**0.0**	**0.0**
G-7*	Untreated	**N/A**	**N/A**	**9.0**	**8.0**

Rosso = Isomate applied before first flight (for up to 5 months); Chem 1 + Isomate M-100 = Asana at PF + 10 days + Isomate M-100 before second flight (good for 80-100 days); Chem 1+2-3 = Insecticides used throughout season

Table 1 reports the total shoot infestation in 20 trees in the interior and outer perimeter of the orchard. There is slightly more damage in the outer perimeter of the orchard than the interior, but it may not be statistically significant. The fruit infestation levels are consistently higher in the perimeter of the orchards than the interior. This suggests an edge effect of Oriental fruit moth infestation in both chemically managed orchards as well as pheromone disrupted blocks.

Two of the plots had unusually high levels of damage, the Rosso “Green Lane” and “S6,” which resembled the data in the untreated portion of “G7*.” The “Green Lane” plot was a very small plot and block size is usually recommended to be at least 5 acres of contiguous disrupted area in size. This block needed to be sprayed more than others under the disruption program due to the pressure from outside this orchard. The “S6” block is planted at 22 x 24 foot row spacing, with many missing trees in the orchard. It is very difficult to flood a block with the sex pheromone if there is nothing to hang the dispensers on over a large area. The remaining orchards were more closely planted at 12-15 x 18-20 foot row spacing. Block shape is also important; a long, skinny block with only 5 or so acres will be less successful than disrupting a block with a square configuration. It is important to have a large area under pheromone disruption even if the twist ties are hung in none host areas. OFM can be a pest on many hosts including most fruit crops, suggesting a need to flood all tree fruit species to get the best results. This is commonly done under other disruption program ssuch as codling moth in the Northwest.

Table 2 shows the level of fruit damage recorded due to catfacing and surface scarring from plant bug feeding. Plant bugs are mainly controlled using insecticides in any system, in combination with either clean cultivation, or grassy sod middle with herbicide strips reducing the broadleaf host weeds in the orchard.

Table 2. Percentage of plant bug injury found on fruit in mid-August.

		% Plant Bug Damage on Fruit*		
Block	Treatment	Inside Rows	Outside Rows	Groundcover System
Murray Fresh	Rosso	3.5	8	sod** middle/herbicide strip under trees
Murray Process	Rosso	3	3	cultivated
Green Lane	Rosso	3.5	3	cultivated
S6	Chem 1+ Isomate M-100	10	22	sod middle/herbicide strip under trees
Ellnor P4	Chem 1+ Isomate M-100	0.5	0.5	sod middle/herbicide strip under trees
Baehr	Chem 1+ Isomate M-100	1	1	sod middle/herbicide strip under trees
G-7	Chem 1+ 2-3	6	3	sod middle/herbicide strip under trees
Storage	Chem 1+ 2-3	1.5	0.5	cultivated
Transit	Chem 1+ 2-3	1.5	0	cultivated
G-7*	Untreated		7	sod middle/herbicide strip under trees

* includes both catfacing damage and surface scarring

** sod is a combination of grasses and broadleaves

In order for any new strategy to be adopted, it must be effective and economical. The components of the mating disruption strategy using Isomate M-100 and the chemical control strategy are identified to run a simple economic analysis. The Isomate M-100 strategy requires purchase of twist tie dispensers for at least a five-acre block, application costs of the dispensers, the costs of 4 pheromone traps and lures for a 5-10 acre block, scouting costs, and 4 insecticide applications necessary to produce clean fruit. In disrupted blocks, it will require 2 applications of Asana at 10-12 oz./acre, followed up with 2 full sprays or at least border sprays shortly after peak flight for the second and third flight using Guthion at 1 lb./acre or Imidan at 1.5 lb./acre. The chemically controlled plots require a regional trap catch program using 10-20 traps per geographical region, at $10 per trap. If spread over 100 acres of peaches, that will only cost $2 per acre or $10/5 acres. The traps will need to checked twice weekly to get a closer handle on peak flights and timing. The chemically controlled plots require up to 9 insecticide applications and scouting costs.

The two systems have several components in commom. The heavy reliance on pyrethroids for insect control of plant bugs and rotation of insecticide classes for resistance management guarantees the need for a miticide application in both systems. The application costs of insecticides are necessary in both chemical and disrupted blocks and should cancel out since fungicides are still required in disrupted blocks. There is a more intensive trap system required in disrupted blocks, but the traps could be monitored on a weekly basis instead of twice per week as done in the chemical control blocks. It is also necessary to scout all blocks for other pests, especially plant bugs, aphids, and borers. The approximate cost of scouting blocks is $25/acre per season. Table 3 shows the costs included in this analysis for a 5-acre block followed by the cost per acre of each system.

Table 3. The cost of components of OFM control programs on a 5-acre basis, and cost per acre.

Component	Isomate M 100	Chemical Control
Isomate M-100 dispensers ($38/acre)	$190	----
Application of dispensers ($4/acre)	$ 20	----
Pheromone trap supplies ($10/trap with 4-5 traps per 5-10 acre block)	$ 40	$10
Scouting ($25/acre)	$125	$125
Insecticides + Miticide	$420	$720
Total cost in 5 acres	$795.00	$855.00
Total estimated cost per acre	$159	$171

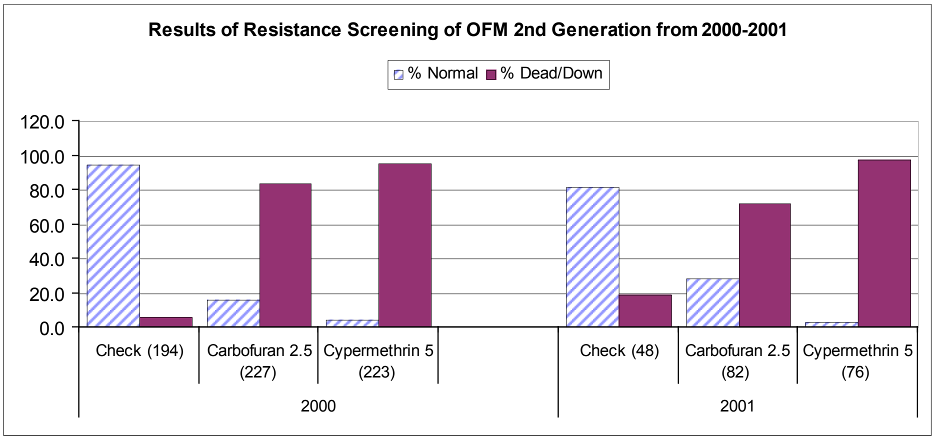
There appears to be a savings of about $12 per acre, or the price of one application of an organophosphate spray in the blocks using the mating disruption program. But this simple economic analysis does not tell the whole story. In general, it requires more management skill and supervision to get clean fruit in the mating disruption strategy, as opposed to applying a rotation of cover spray insecticides on a 10-14 day interval. Some may even argue you could cut the cost of the scouting if you only need to check traps to ensure the proper timing of insecticide for OFM. But the argument against the chemical program is the pending loss of azinphos-methyl in 4 years and phosmet in 5 years in peaches through regulatory channels and the loss of efficacy of organophosphates and pyrethroids due to insecticide resistance. A combination of the two system may be the best approach.

Objective 2: Resistance Monitoring

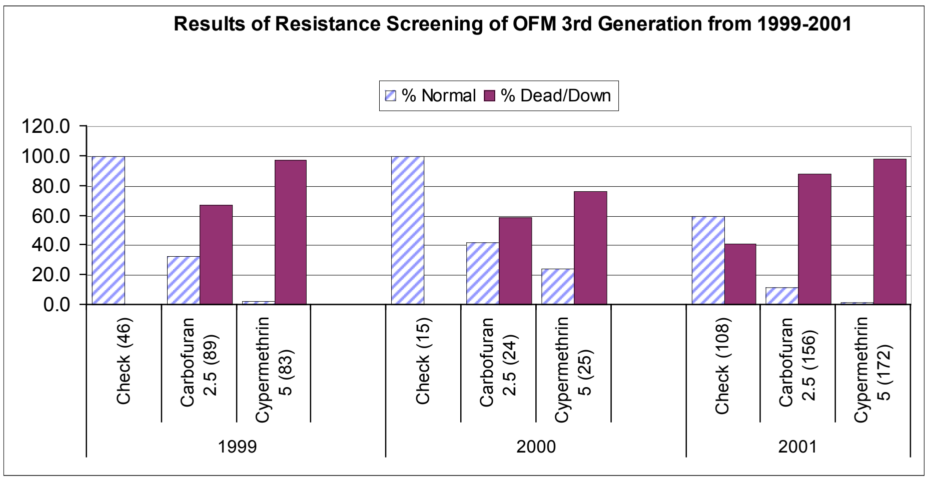
Figure 3 shows there is some level of resistance to organophosphates indicated by the survival rates (%Normal) of OFM when exposed to carbofuran. However, the resistance levels noted to the pyrethroid (cypermethrin) is minimal. The reduced survival rate in the checks from the 2001 season was due to the longer intervals between insect collection for testing, and the hot dry weather that stressed the insects in the traps. This is especially true of insects tested in the third flight and stress may have reduced the survival rate of resistant individuals. In 1999, there was a total of 33% survival of OFM in the third flight in the carbofuran tests, and minimal in the cypermethrin. The industry increased the use of pyrethroids in 2000. The survival of third flight OFM in 2000 in the carbofuran treatment was approximately 40%, and in cypermethrin treatments, over 20%. In looking at the 2001 data in Figure 4, it is evident that resistance levels are present in different orchards for different insecticide classes, from one generation to the other. Although a statistical analysis has not been done on these data, it appears that cypermethrin is still effective, but the organophosphates may be failing in 2 of the 4 sites. Rotation of materials and mating disruption are probably the best ways to handle these orchards for the near future.

The feedback from Dr. Pree on this data is that we have generally controllable populations of OFM but need to continue rotation of insecticide classes from one generation to the next to minimize resistant populations.

Figure 3. Summary of results of resistance screening for second and third flights of OFM between 1999-2001.

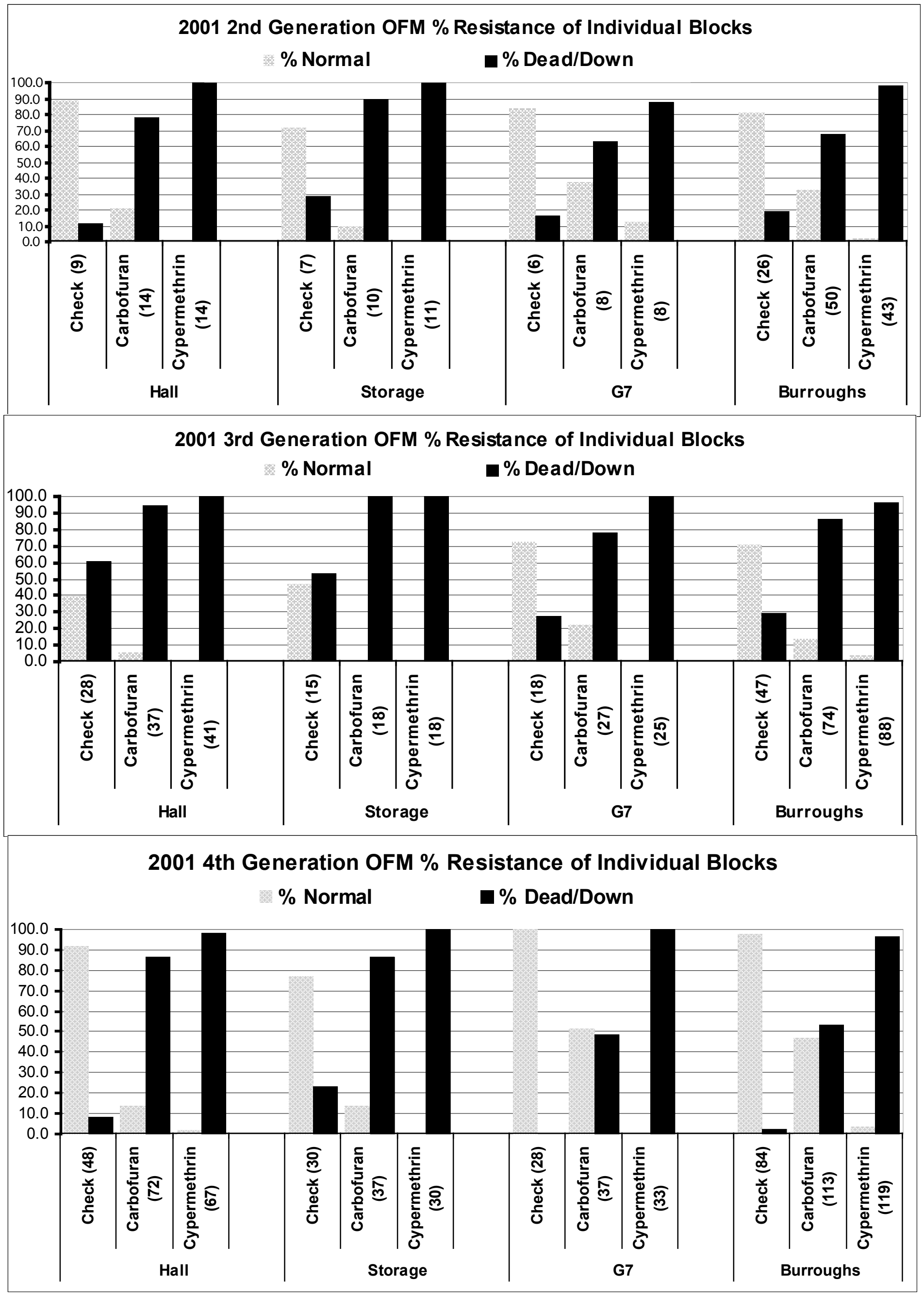


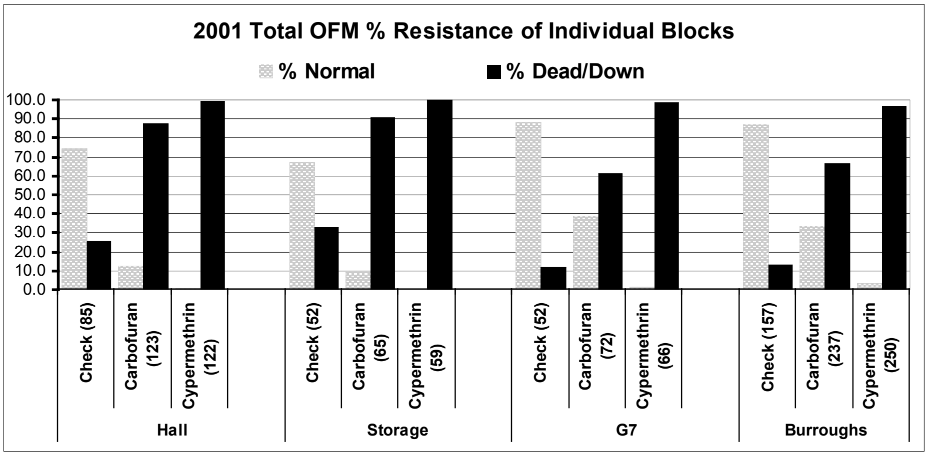
Results of Resistance Screening of OFM 2nd Generation from 2000-2001
% Normal
% Dead/Down
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Check (194)
Carbofuran 2.5 (227)
Cypermethrin 5 (223)
Check (48)
Carbofuran 2.5 (82)
Cypermethrin 5 (76)
2000
2001



Results of Resistance Screening of OFM 3rd Generation from 1999-2001
% Normal
% Dead/Down
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Check (46)
Carbofuran 2.5 (89)
Cypermethrin 5 (83)
Check (15)
Carbofuran 2.5 (24)
Cypermethrin 5 (25)
Check (108)
Carbofuran 2.5 (156)
Cypermethrin 5 (172)
1999
2000
2001

Figure 4. Results of resistance screening for second, third, and fourth flights of OFM and summary in 4 orchards in Western New York for 2001.





References: (if applicable)

H. W. Hogmire, editor. Mid-Atlantic Orchard Monitoring Guide. NRAES-75. Page 272.