Codling moth management in Ohio apple orchards by multiple insecticides

Celeste Welty, Ted Gastier, and Ron Becker

Final Report, 12/31/04

Background

Codling moth, which is the key pest of apples, has been difficult to control with standard organophosphate insecticides in some orchards in Ohio and nearby States during the past few years. Resistance to organophosphates is suspected as part of the problem. Non-organophosphate insecticides are becoming available but they are generally less reliable and more expensive than organophosphates. New regulations have limited the amount of organophosphates that can be used, so that even at orchards where organophosphates are working well, other insecticides are needed for full-season control of pests. Growers need research data on which of the new insecticides are working best. In addition to codling moth, some apple orchards are having trouble with Oriental fruit moth and lesser appleworm, which also tunnel in the fruit. If more than one species is present, the complex of species is referred to as ‘internal Lepidoptera'.

Research on this pest problem in Ohio was initiated in 2003 at three problem orchards with emphasis on control of first generation larvae by single insecticides. In an OSU research orchard, codling moth control by one organophosphate and seven non-organophosphate insecticides varied from fair to excellent. Control was excellent from all five insecticides (Assail, Avaunt, Danitol, Imidan, Intrepid) tested in replicated plots at a commercial orchard in northwest Ohio. Four of five insecticides were excellent at a commercial orchard in northeast Ohio where they were tested in unreplicated plots. At both commercial orchards, control was better than expected; this might be due to higher volumes of water and more total sprays used, or possibly due to cool wet weather that was not conducive to codling moth survival.

The next step in developing new insecticide recommendations for codling moth is to evaluate control of second generation as well as first generation larvae by several combinations of insecticides. Our objective in 2004 was to determine how well several pairs of new insecticides work at controlling codling moth in apple orchards.

Methods

Field trials on codling moth control were conducted at three sites. At all sites, pheromone traps were used to monitor adult populations of codling moth as well as lesser appleworm and oriental fruit moth. The date of sustained flight of codling moth was used as a biofix to start a degree-day count on which insecticide timing was based. Pherocon-VI sticky traps with long-life lures made by Suterra were used for codling moth. Multi-Pher traps were used for lesser appleworm and oriental fruit moth, with lures made by Trécé. At all sites, treatments were applied twice, 14 days apart, for each of two generations. Insect damage was evaluated on fruit in the center of each plot, non-destructively in mid-July to evaluate first generation damage, and destructively in mid-September to evaluate second generation damage. Sample size for fruit evaluations was 100 fruit per plot in small plots, and 500 or 1000 fruit per plot in large plots. Data from replicated trials were analyzed by analysis of variance with means separated by LSD tests using the microcomputer program SAS 6.12.

Trial 1: A field trial was done in small plots at OSU's Waterman Laboratory in Franklin County, central Ohio in a Melrose apple block that had heavy pressure from codling moth and lesser appleworm in 2002 and 2003. There were 12 treatments each with four replicates in a randomized complete block design with two adjacent trees per plot. Each treatment was sprayed with one product for control of first-generation codling moth and a second product for second-generation control, with rates and timing detailed in Table 1. All 12 treatments were evaluated in mid-July but treatments that used the same insecticide for first generation control were pooled in analysis so that a total of eight treatments were compared. Treatments included the registered insecticides Asana (esfenvalerate), Assail (acetamiprid), Avaunt (indoxacarb), Calypso (thiacloprid), Cyd-X (codling moth granulovirus), Danitol (fenpropathrin), Imidan (phosmet), Intrepid (methoxyfenozide), and Warrior (lambda-cyhalothrin) as well as the unregistered insecticide Rimon (novaluron), and an untreated check. Insecticide treatments were applied by a hand-gun sprayer. At half-inch green on 29 March, all plots including the untreated check were treated uniformly with 2% oil for suppression of European red mite and San José scale. At petal-fall on 3 May, all plots except the untreated check were treated uniformly with Guthion 50WP at 2 lb/A for plum curculio control. No insecticide was used between generations of codling moth. Imidan 70WP at 3 lb/A was applied to all plots except the untreated check on 16 August to control the late-emerging population of codling moth.

Trial 2: A trial was conducted at a commercial orchard in Sandusky County in northwestern Ohio in an apple block that had severe damage from codling moth and oriental fruit moth in 2003. The trial had two treatments each with four replicates in a randomized complete block design. The two treatments were Guthion for first generation codling moth followed by Assail for second generation codling moth, and Calypso for first generation followed by Danitol for second generation. Rates were the same as in Trial 1 (Table 1). Each plot was about 2 acres in area and a mean of 5 rows wide. Jonathan, Gala, Golden Delicious, and Red Delicious were the dominant cultivars among nine cultivars present. Treatments were applied in 50 gallons of water per acre by the grower using an airblast sprayer. Insecticide treatments were applied on 20 May and 2 June for first generation, and on 6 July and 20 July for second generation. The insecticides evaluated were applied in addition to pheromone mating disruption (Isomate C Plus), virus sprays (Cyd-X), and 3M Sprayable OFM pheromone used in 3 of 4 replicates. Pheromone mating disruption and virus were not used in the fourth replicate that was separated from the main part of the block by a corn planting, and it was in this fourth replicate that the pheromone traps were located.

Trial 3: Five experimental treatment pairs were compared in a commercial orchard in Wayne County in northeastern Ohio, in an unreplicated observation trial with one pair of products used in each of five different 3-acre blocks. All blocks had mixed cultivars. Treatment pairs for first and second generations of codling moth were Imidan/Imidan, Calypso/Warrior, Avaunt/Calypso, Danitol/Calypso, and Cyd-X/Intrepid. The Calypso/Warrior treatment was expected to be the most likely to control internal Lepidoptera and thus was used in the block that had the highest pest pressure the previous year. The Cyd-X/Intrepid treatment was expected to be the least likely to control internal Lepidoptera and thus was used in the block that had the lowest pest pressure the previous year. Rates were the same as in Trial 1 (Table 1). Treatments were applied in 100 gallons of water per acre by the grower using an airblast sprayer. Insecticide treatments were applied on 25 May and 12 June for first generation, and on 4 August and 20 August for second generation. In the Cyd-X treatment, 4 sprays were applied at 6- to 11-day intervals rather than two sprays at an 18-day interval; the first spray was Cyd-X plus Imidan at 4 lb/A on 25 May, and the others were Cyd-X alone on 1 June, 12 June, and 23 June. Between generations, all five blocks were sprayed once with Imidan at a rate of 2.3 lb/A on 9 July.

Table 1. Summary of timing and rates of insecticides used in trial at OSU's Waterman Laboratory, Columbus, Ohio.

Treatment		Insecticide for first generation			Insecticide for second generation		
		First spray		Second spray	First spray		Second spray
	Intended timing	75-150 DD after biofix	200-250 DD after biofix	14 d after first spray	75-150 DD after biofix	200-250 DD after biofix	14 d after first spray
	Actual timing	5/11/04 (85 DD)	5/20/04[a] (251 DD)	5/25 Rimon; 6/4 others[a]	7/2 Rimon; 7/6 Intrepid	7/12/04	7/16 Rimon, 7/19 Intrepid, 7/27 others
1		untreated	untreated	untreated	untreated	Untreated	untreated
2		-	Imidan 70WP, 4 lb/A	Imidan 70WP, 4 lb/A	-	Imidan 70WP, 4 lb/A	Imidan 70WP, 4 lb/A
3		-	Assail 70WP, 2.5 oz/A, + 1% ultrafine oil	Assail 70WP, 2.5 oz/A, + 1% ultrafine oil	-	Imidan 70WP, 4 lb/A	Imidan 70WP, 4 lb/A
4		-	Calypso 4F, 6 fl oz/A	Calypso 4F, 6 fl oz/A	-	Imidan 70WP, 4 lb/A	Imidan 70WP, 4 lb/A
5		-	Calypso 4F, 6 fl oz/A	Calypso 4F, 6 fl oz/A	Intrepid 2SC, 16 fl oz/A	-	Intrepid 2SC, 16 fl oz/A
6		-	Calypso 4F, 6 fl oz/A	Calypso 4F, 6 fl oz/A	-	Warrior 1EC, 3.84 fl oz/A	Warrior 1EC, 3.84 fl oz/A
7		-	Calypso 4F, 6 fl oz/A	Calypso 4F, 6 fl oz/A	Rimon 0.83EC, 20 fl oz/A	-	Rimon 0.83EC, 20 fl oz/A
8		Rimon 0.83EC, 20 fl oz/A	-	Rimon 0.83EC, 20 fl oz/A	-	Calypso 4F, 6 fl oz/A	Calypso 4F, 6 fl oz/A
9		-	Danitol 2.4EC, 21 fl oz/A	Danitol 2.4EC, 21 fl oz/A	Rimon 0.83EC, 20 fl oz/A	-	Rimon 0.83EC, 20 fl oz/A
10		-	Avaunt 30WDG, 6 oz/A	Avaunt 30WDG, 6 oz/A	Rimon 0.83EC, 20 fl oz/A	-	Rimon 0.83EC, 20 fl oz/A
11		-	Avaunt 30WDG, 6 oz/A	Avaunt 30WDG, 6 oz/A	-	Asana XL, 12 fl oz/A	Asana XL, 12 fl oz/A
12		-	Cyd-X[a], 3 fl oz/A	Cyd-X[a], 3 fl oz/A	Intrepid 2SC, 16 fl oz/A	-	Intrepid 2SC, 16 fl oz/A

[a] Cyd-X was applied three times: 5/21, 6/4, and 6/11.

Results and Discussion

Trial 1: Pheromone traps indicated the presence of high density populations of codling moth and lesser appleworm (Table 2) but absence of oriental fruit moth in the test orchard. When fruit were evaluated non-destructively in mid-July, all seven insecticide treatments resulted in significantly less damage from internal Lepidoptera than the untreated check. There were no significant differences among the seven insecticide treatments, but damage was lowest in plots where Danitol, Avaunt, or Assail were used (Table 3). Treatment differences were also seen in San José scale, which was most severe where Avaunt was used (Table 3). There was a significant difference in tarnished plant bug damage which was highest where Danitol or Imidan was used (Table 3). There was a trace of damage from leafrollers and fruitworm but no significant treatment effects.

Fruit evaluated in September showed that all eleven insecticide pairs resulted in significantly less damage from internal Lepidoptera than the untreated check (Table 4). Internal Lepidoptera damage was lowest where Calypso was followed by Warrior. The only other category that showed significant treatment effects was leafroller late-season surface damage (Table 4). There was a trend that the treatments with Imidan were among the least effective, even when Imidan followed an insecticide that had performed well for first generation control. Resistance to Imidan is strongly suspected at this site. Treatments with the unregistered product Rimon did well against either the first or second generation of codling moth. The treatment with Cyd-X followed by Intrepid performed surprisingly well considering the high pest pressure in this block and the absence of a broad-spectrum insecticide applied with the Cyd-X. Calypso followed by Warrior or Rimon performed better than Calypso followed by either Intrepid or Imidan

A foliar pest that was present in the test block was white apple leafhopper. Density of leafhopper nymphs in early May was uniform among plots before the test insecticides were applied (Table 5), but there were significant differences in leaf damage that was evaluated in late May once nymphs had completed their development (Table 5). Leafhopper damage was lowest where Avaunt, Danitol, Calypso, or Assail were used for codling moth control (Table 5).

Trial 2: The results of this trial were difficult to interpret due to the inclusion of pheromone mating disruption in most of the block. Pheromone traps indicated high density populations of codling moth and oriental fruit moth and a negligible population of lesser appleworm in the test orchard (Table 6). Fruit evaluated in July showed low damage by internal Lepidoptera, and no significant difference between the Guthion and Calypso treatments, based on the three replicates supplemented with mating disruption (Table 7) or based on all four replicates including the replicate where mating disruption was not used (Table 8). Other than internal lepidoptera, the only pest damage detected was plum curculio (Tables 7 and 8). Fruit evaluated in September showed no significant difference between the Guthion/Assail treatment and the Calypso/Danitol treatment, based on the three replicates supplemented with mating disruption (Table 9) or on all four replicates including the replicate where mating disruption was not used (Table 10). Data for individual replicates shows that the row of Mutsu apples in the Calypso/Danitol plot on the edge of replicate block 4 had much more damage than in the adjacent Guthion/Assail plot (Table 11); the Mutsu, along with Lodi that were harvested earlier, apparently had a higher population of pests due to termination of sprays after the Lodi harvest in previous years.

Trial 3: Pheromone traps indicated that the codling moth population was very high density in the Calypso/Warrior block, and moderate density in the Imidan/Imidan and Danitol/Calypso blocks (Table 12). There was also high density of lesser appleworm, and moderate density of oriental fruit moth in the test orchard (Table 12). Fruit evaluations in July showed less than 1% of fruit were damaged by internal Lepidoptera, with a range from 0.0 to 0.9% damage (Table 13). There was some damage by plum curculio, tarnished plant bug, and San José scale (Table 13). Fruit evaluations in September showed less than 4% of fruit was damaged by internal Lepidoptera, ranging from a low of 0.1% damage in the Imidan/Imidan treatment to 3.1% in the Avaunt/Calypso treatment (Table 14). The Cyd-X/Intrepid treatment performed surprisingly well. Calypso following Danitol performed better than Calypso following Avaunt. The 5 different blocks used in this trial had different pest pressure, thus we must be careful to not consider differences to be statistically different in this unreplicated observation trial. Undoubtedly the use of a high volume of water in the spray applications is contributing to the excellent control obtained at this site where pest pressure is high.

Conclusions

All insecticide pairs tested for control of first and second generation codling moth provided good control, but the best treatment varied among sites. At the Columbus site where pest pressure was high and small plots were used, Calypso followed by Warrior resulted in the least amount of damage by codling moth. At a commercial orchard in northwestern Ohio where large replicated plots were used, Guthion followed by Assail was slightly better than Calypso followed by Danitol. At a commercial orchard in northeastern Ohio where large unreplicated plots were used, the old standard of Imidan followed by Imidan provided the best control. The unregistered insecticide Rimon looks very promising as an alternative to Imidan. The registered but unfamiliar virus product Cyd-X also looks very promising. Although the pyrethroids Warrior, Danitol, and Asana can provide good control of codling moth, we need to learn how to use them without causing flare-ups of San José scale and European red mite.

Table 2. Weekly counts of moths in pheromone traps, and degree-day accumulations, in apple orchard used for codling moth insecticide trial at OSU's Waterman Lab, Columbus Ohio, 2004.

Date	Trap counts		Cumulative degree-days[1] after biofix for codling moth on 5/7/04
	Codling moth (mean of 3 traps)	Lesser appleworm (one trap)	
4/21	0	0	-
4/28	0.0	0	-
5/5	0.3	3	-
5/12	37.0 (peak)	29	106
5/19	35.7	77 (peak)	227
5/26	29.3	76	380
6/2	16.3	17	483
6/9	17.3	10	610
6/16	10.3	4	770
6/23	8.7	6	899
6/30	2.3	2	1008
7/7	6.3	5	1184
7/14	17.0	16	1362
7/21	12.0	15	1508
7/28	13.3	7	1628
8/4	7.0	24 (peak)	1790
8/11	17.7 (peak)	13	1907
8/18	8.0	5	2003
8/25	11.0	22	2148
9/1	6.7	19	2302
9/8	7.0	15	2454
9/15	2.3	8	2576
9/22	2.7	7	2674
9/29	2.0	2	2766
10/6	1.3	1	-
10/13	2.7	2	-

[1] Degree-days calculated as mean of daily maximum and minimum temperature, base 50F.

2 Table 3: Mid–summer evaluation of Melrose apples, 16 July 2004 at Columbus Ohio; 100 fruit per plot.

Treatment (1st generation codling moth)	Percentage of fruit (mean of 4 reps)[1]						
	Internal Lepidop–tera[2]	San José scale	Plum curculio	Tarnished plant bug	Leafroller surface	Deep (leafroller/ fruitworm)	Clean
Danitol	0.0 B	2.0 AB	7.2	1.0 A	0.0	0.0	90.0 A
Avaunt	0.4 B	6.2 A	5.8	0.5 ABC	0.0	0.2	87.2 A
Assail	0.5 B	0.5 B	6.5	0.2 BC	0.0	0.2	92.8 A
Cyd–X	1.0 B	0.5 B	5.5	0.8 AB	0.0	0.0	92.5 A
Calypso	0.8 B	2.5 AB	6.1	0.2 BC	0.0	0.1	90.8 A
Rimon	0.8 B	2.2 AB	8.8	0.0 C	0.0	0.0	88.5 A
Imidan	1.0 B	0.5 B	6.8	1.0 A	0.0	0.2	90.5 A
Untreated	8.8 A	1.0 B	12.8	0.0 C	0.2	0.2	78.0 B
P value[3]	*0.0003*	*0.04*	*0.24*	*0.03*	*0.46*	*0.89*	*0.01*

[1] Within each column, means followed by same letter are not significantly different (P>0.05); mean separations by LSD. Values shown are actual percentages but ANOVA based on transformed values.
[2] The target populations were codling moth and lesser appleworm; Oriental fruit moth was absent.
[3] Treatment effect from ANOVA.

Table 4: Final evaluation of insect injury to apples, 14 Sept. 2004 at Columbus Ohio, 100 fruit per plot.

Treatment		Percentage of fruit (mean of 4 reps)[1]						
1st generation codling moth	2nd generation codling moth	Internal Lepidop–tera[2]	San José scale	Plum curculio	Tarnished plant bug	Leaf–roller late	Early deep	Clean
Calypso	Warrior	0.2 E	11.2	6.0	1.2	0.0 C	0.2	82.2
Avaunt	Asana	0.8 DE	32.1	6.7	0.5	0.2 BC	0	61.6
Danitol	Rimon	1.0 CDE	15.2	8.5	0	0.0 C	0	77.5
Calypso	Rimon	1.8 CDE	29.5	7.1	0.5	0.2 BC	0.2	63.6
Rimon	Calypso	2.0 BCDE	14.2	6.5	0	0.2 BC	0	78.2
Cyd–X	Intrepid	2.0 BCDE	17.3	6.3	1.0	0.0 C	0	74.8
Avaunt	Rimon	3.0 BCD	13.0	10.2	0.5	0.0 C	0.2	75.5
Imidan	Imidan	4.2 BC	15.8	7.5	0	0.0 C	0	75.5
Calypso	Imidan	3.5 BC	25.2	7.0	0.5	1.4 A	0	66.7
Calypso	Intrepid	4.5 B	33.9	6.7	0.2	0.2 BC	0.5	57.8
Assail	Imidan	4.2 B	9.0	6.5	0.2	1.2 AB	0.2	79.5
Untreated	Untreated	21.4 A	11.7	13.5	0.2	2.0 A	0	57.1
P value[3]		*0.0001*	*0.48*	*0.55*	*0.34*	*0.005*	*0.47*	*0.28*

[1] Within each column, means followed by same letter are not significantly different (P>0.05); mean separations by LSD. Values shown are actual percentages but ANOVA based on transformed values.
[2] The target populations were codling moth and lesser appleworm; Oriental fruit moth was absent.
[3] Treatment effect from ANOVA.

Table 5. White apple leafhopper density and damage rating on Melrose apple leaves in 2004 at OSU's Waterman Lab, Columbus, Ohio; mean of four replicates.

Treatment	*Number of leafhopper nymphs per leaf on 7 May (before 1st codling moth spray)*	*Damage rating[1, 2] on 28 May (8 days after 1st codling moth spray)*
Avaunt	0.00	0.32C
Danitol	0.00	0.32 C
Calypso	0.01	0.36 C
Assail	0.02	0.40 C
Cyd-X	0.00	0.55 BC
Imidan	0.00	0.75 B
Rimon	0.00	0.81 B
Untreated	0.01	1.20 A
P value[3]	*0.40*	*0.0001*

[1] Damage rating scale: 0 = none; 1 = light; 2 = moderate; 3 = heavy.
[2] Within each column, means followed by same letter are not significantly different ($P>0.05$); mean separations by LSD.
[3] Treatment effect from ANOVA.

Table 6. Weekly counts of moths in pheromone traps, and degree-day accumulations, in apple orchard used for codling moth insecticide trial, at Clyde, Ohio, 2004.

Date	Codling moth (mean of 3 traps)	Oriental fruit moth (mean of 2 traps)	Lesser appleworm (one trap)
5/11	13.0	48.5	2
5/18	39.7	0.0	1
5/25	34.3	1.5	0
6/1	25.3	1.0	0
6/8	30.3	0.5	0
6/15	27.3	0.0	0
6/22	5.3	1.0	0
6/29	0.7	0.0	0
7/6	1.3	4.0	0
7/13	0.7	4.0	1
7/20	6.0	10.0	3
7/27	6.0	13.0	4
8/3	15.3	2.5	0
8/10	22.7	3.5	0
8/17	7.0	0.5	0
8/24	10.0	12.0	0
8/31	13.3	11.5	2
9/7	1.3	6.0	2
9/14	0.3	1.5	0

Table 7. Mid–summer evaluation of insect injury to apple fruit, 19 July 2004, in 500 fruit per plot, at Clyde Ohio; mean of 3 replicates (excluding isolated fourth replicate that did not get mating disruption).

Treatment		% damaged by internal Lepidoptera			% damaged by plum curculio	% Clean
1st generation	(2nd generation)	entry	sting	total		
Guthion	(Assail)	0.00%	0.40%	0.40%	0.67%	98.93%
Calypso	(Danitol)	0.13%	0.60%	0.73%	0.40%	98.87%
P value (ANOVA trtmt effect)		*0.42*	*0.40*	*0.32*	*0.25*	*0.93*

Table 8. Mid–summer evaluation of insect injury to apple fruit, 19 July 2004, in 500 fruit per plot, at Clyde Ohio; mean of all 4 replicates.

Treatment		% damaged by internal Lepidoptera			% damaged by plum curculio	% Clean
1st generation	(2nd generation)	entry	sting	total		
Guthion	(Assail)	0.05%	0.50%	0.55%	0.75%	98.70%
Calypso	(Danitol)	1.45%	1.70%	3.15%	0.80%	96.05%
P value (ANOVA trtmt effect)		*0.25*	*0.21*	*0.22*	*0.90*	*0.39*

Table 9. Final evaluation of insect injury to apple fruit, 15 September 2004, in 1000 fruit per plot, at Clyde Ohio; mean of 3 replicates (excluding isolated fourth replicate that did not get mating disruption).

Treatment		% damaged by internal Lepidoptera			% damaged by plum curculio	% Clean
1st generation	2nd generation	entry	sting	total		
Guthion	Assail	0.00%	0.20%	0.20%	0.23%	99.57%
Calypso	Danitol	0.03%	0.13%	0.17%	0.73%	99.10%
P value (ANOVA trtmt effect)		*0.42*	*0.20*	*0.42*	*0.42*	*0.45*

Table 10. Final evaluation of insect injury to apple fruit, 15 September 2004, in 1000 fruit/plot, at Clyde Ohio; mean of all 4 replicates.

Treatment		% damaged by internal Lepidoptera			% damaged by plum curculio	% Clean
1st generation	2nd generation	entry	sting	total		
Guthion	Assail	0.12%	0.42%	0.55%	0.32%	99.12%
Calypso	Danitol	3.65%	2.98%	6.62%	1.05%	92.32%
P value (ANOVA trtmt effect)		*0.34*	*0.44*	*0.41*	*0.21*	*0.27*

Table 11. Data for individual plots in final evaluation of insect injury to apple fruit, 15 September 2004, Clyde Ohio.

Blocked replicate[a]	Treat–ment	Cultivar	Number of fruit examined	Percentage of fruit damaged			
				Internal Lepidoptera			Plum curculio
				entry	sting	total	
1 (east, near abandoned orchard)	Guthion/ Assail[b]	Winesap	500	0	0	0.2	0.2
		IdaRed	500	0	0.4		0.8
	Calypso/ Danitol[c]	Melrose	1000	0	0.1	0.1	0.5
2 (east/ center)	Guthion/ Assail[b]	Jonathan	500	0	0	0	0
		GoldenDelic.	500	0	0		0
	Calypso/ Danitol[c]	Jonathan	1000	0	0	0	1.5
3 (west/ center)	Guthion/ Assail[b]	Winesap	500	0	0.6	0.4	0.4
		RedDelic.	500	0	0.2		0
	Calypso/ Danitol[c]	Jonathan	1000	0.1	0.3	0.4	0.2
4 (west, isolated rows by houses)	Guthion/ Assail[b]	Melrose	500	0.6	1.6	1.6	0.6
		Jonathan	500	0.4	0.6		0.6
	Calypso/ Danitol[c]	Mutsu	1000	14.5	11.5	26.0	2.0

[a] Replicate blocks 1, 2, and 3 were treated with Isomate C+, Cyd–X, and sprayable OFM pheromone. The fourth replicate block was not treated with Isomate C+ or Cyd–X.
[b] Guthion for first generation; Assail for second generation.
[c] Calypso for first generation; Danitol for 2nd generation.

Table 12. Weekly catch of moths in pheromone traps in apple orchard used for codling moth insecticide trial at Moreland, Ohio, 2004.

Date	Codling moth				Lesser appleworm	Oriental fruit moth
	West block (Imidan/Imidan treatment)	East block (Danitol/Calypso treatment)	South block (Calypso/Warrior treatment)	mean		
5/18	4	18	61	27.7	20	4
5/25	7	19	52	26.0	60	20
6/2	9	9	80	32.7	34	0
6/8	11	10	53	24.7	7	14
6/15	1	1	26	9.3	20	0
6/22	3	1	21	8.3	5	0
6/29	0	1	33	11.3	3	2
7/8	3	3	15	7.0	8	0
7/13	1	0	3	1.3	2	0
7/20	6	15	–	11.5	5	0
7/27	32	38	71	47.0	13	2
8/3	18	18	47	27.7	11	0
8/10	12	45	22	26.3	2	0
8/17	15	16	–	15.5	9	0
8/24	10	21	19	16.7	10	0
8/31	4	11	20	11.7	14	2

Table 13. Mid-summer evaluation of insect injury to apple fruit on 14 July 2004 in 1,000 fruit per treatment, at Moreland Ohio.

Treatment (first generation)	Internal Lepidoptera			Plum curculio	Tarnished plant bug	San José scale	Clean
	entry	sting	total				
Imidan	0.1%	0.0%	0.1%	0.4%	0.2%	0.0%	99.3%
Calypso	0.4%	0.0%	0.4%	1.7%	0.1%	0.0%	97.8%
Avaunt	0.9%	0.0%	0.9%	0.1%	0.1%	0.5%	98.4%
Danitol	0.2%	0.0%	0.2%	0.0%	0.0%	0.0%	99.8%
Cyd-X	0.0%	0.0%	0.0%	0.4%	0.2%	0.0%	99.4%

Table 14. Final evaluation of insect injury to apple fruit, 13 September 2004 in 1,000 fruit per treatment, at Moreland Ohio.

Treatment (first/second generation)	Internal Lepidoptera			Plum curculio	Tarnished plant bug	San José scale	Clean
	entry	sting	total				
Imidan/Imidan	0.1%	0.0%	0.1%	0.6%	0.0%	0.0%	99.3%
Calypso/Warrior	1.2%	1.1%	2.3%	1.5%	0.0%	0.0%	96.3%
Avaunt/Calypso	0.8%	2.3%	3.1%	0.2%	0.0%	0.0%	96.7%
Danitol/Calypso	0.7%	0.3%	1.0%	0.5%	0.0%	0.0%	98.5%
Cyd-X/Intrepid	0.1%	0.2%	0.3%	0.7%	0.0%	0.1%	98.9%