Codling moth management by insecticides in Ohio apple orchards, 2008

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Introduction: New insecticides were evaluated for control of codling moth, which is challenging in some Ohio orchards due to resistance to organophosphate insecticides. Efficacy of the recently registered products Altacor (chlorantraniliprole [Rynaxypyr]) and Delegate (spinetoram) was evaluated in comparison with Assail (acetamiprid) and the standard organophosphate Imidan (phosmet). The use of a pyrethroid in late summer was included despite its known harshness to natural enemies. This is the sixth year that codling moth evaluations have been conducted at this site.

Materials and Methods:

The trial was conducted in a block of 6-year old apple trees at Ohio State University's Waterman Laboratory in Columbus, Franklin County, Ohio. There were six treatments, each with five replicates in a randomized complete block design. There were six adjacent Red Delicious trees per plot. There was a guard row of Golden Delicious, Gala, and Fuji between adjacent treatment rows.

The trap-based codling moth biofix was 5/7. For control of first-generation codling moth, Altacor 35WG (3 oz/A), Assail 30SG (5 oz/A) plus oil (PureSpray, 0.5%), Delegate 25WG (6 oz/A), and Imidan 70WP (3 lb/A) were applied on 5/30, which was 238 degree-days after biofix, and again on 6/12. For control of second-generation codling moth, all insecticides were applied on 7/29, which was 1590 degree-days after biofix, and again on 8/12. One treatment used Imidan for first generation, followed by Imidan for the first spray of second generation and with lambda-cyhalothrin (Warrior 1CS, 2.5 fl oz/A) for the second spray. Insecticides were applied in a dilute volume of 150 gallons of water per acre by a handgun sprayer operated at pressure of 100 psi, with a D6 ConeTip nozzle tip.

All plots except the untreated check were treated with pyriproxyfen (Esteem 35WP, 4 oz/A) plus oil (PureSpray, 2%) at half-inch green on 4/10 for control of San Jose scale, with chlorpyrifos (Lorsban 75WG, 1.3 lb/A) at early pink on 4/18 for control of rosy apple aphid, and with indoxacarb (Avaunt 30WDG, 6 oz/A) at petal-fall on 5/5 for control of plum curculio. For disease control on all trees, including checks, Captan was applied on 4/10 (half-inch green), 4/18 (early pink), and 4/24 (bloom); Dithane and Nova were applied on 5/15; and Captan on 5/27, 6/10, 6/24, 7/10, and 7/25; and Topsin-M was applied on 7/14 and 7/25. Fungicide was applied by an AgTech 4002 airblast sprayer operated at pressure of 20 psi, with TeeJet 6510 and 6520 nozzle tips.

Insect injury was evaluated on 100 randomly selected fruit from the center of each plot, non-destructively on 7/9 to 7/10, and destructively at harvest on 9/10 to 9/11. Data were subjected to analysis of variance (ANOVA) and mean comparisons by least significant difference (LSD) tests in the SAS 9.1 microcomputer statistics program. Percentage data were transformed by arcsine square root before analysis.

Results and Discussion:

The apple crop was large but the codling moth population was smaller than usual in 2008 due to the lack of host fruit in 2007 after a severe freeze during bloom. Pheromone traps detected codling moth and lesser appleworm in 2008 (Figure 1), both at lower density than normal. The first codling moth was caught in a trap on 5/5.

The percentage of fruit damaged by internal Lepidoptera was significantly lower in all five insecticide treatments than in the untreated check in July, which reflects control of first generation

internal Lepidoptera (Table 1), and in September, which reflects control of the second generation of internal Lepidoptera (Table 2). There were no significant differences in internal Lepidoptera among the five insecticide programs in July or September. Imidan alone had the same efficacy as Imidan followed by Warrior. It is possible that the damage from second generation internal Lepidoptera occurred in treated plots because the insecticides applied on 7/29 were too late; 7/29 was 1590 degree-days after biofix. Although the degree-day count showed that egg hatch should have begun by 7/15, which was 1250 degree-days after biofix, we waited for a surge in trap catch to re-set the biofix date, but the surge was minimal. The degree-day count and the trapping showed evidence of a small third generation in September (Figure 1). Other insects that caused damage to fruit were tarnished plant bug, plum curculio, rosy apple aphid, apple curculio, and leafrollers (Tables 1 and 2). No phytotoxicity was observed. Altacor and Delegate look very promising for control of internal Lepidoptera.

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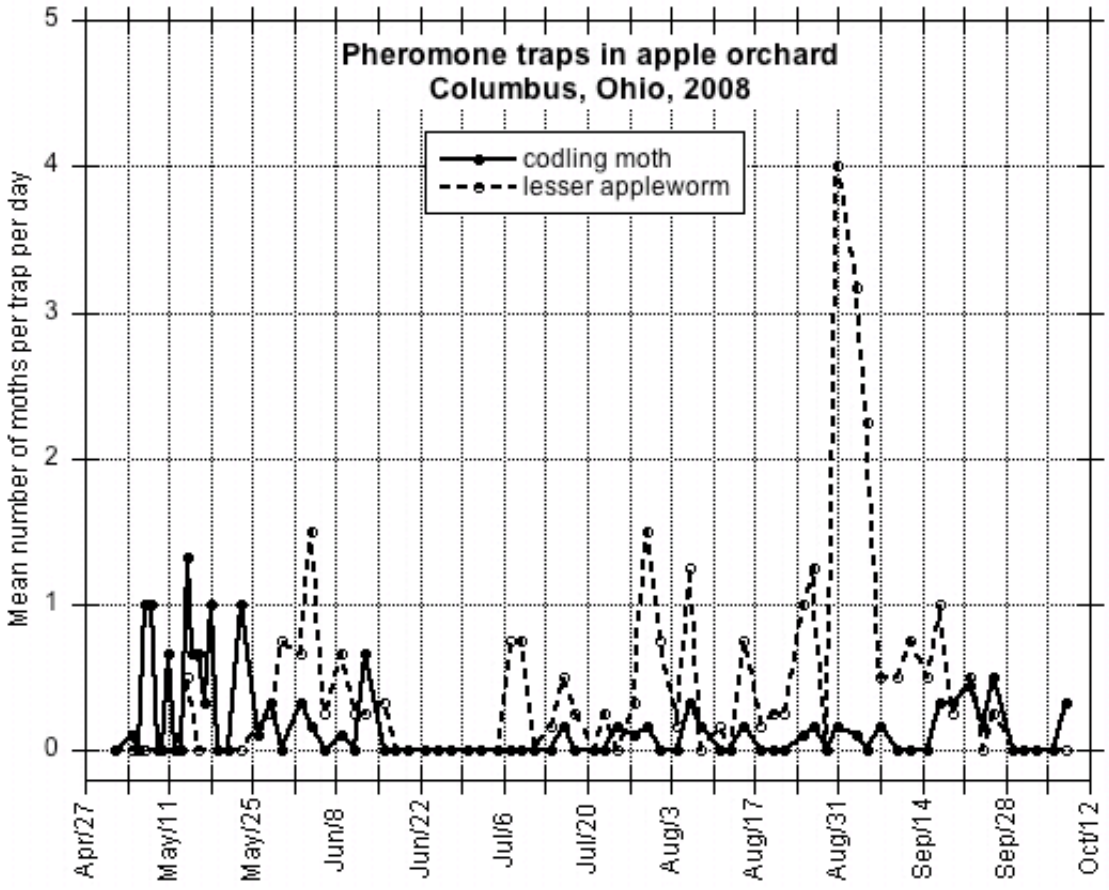

Figure 1. Catch of codling moth and lesser appleworm adults in pheromone traps in apple orchards at Waterman Lab, Columbus, Ohio, 2008.

Table 1. Insect injury to apple fruit after treatment by six insecticide programs, evaluated non-destructively on July 9-10, 2008; mean of five blocked replicates at OSU's Waterman Lab, Columbus, Ohio.

Treatment	% Internal Lepidoptera			% Tarnished plant bug	% Plum curculio	% Rosy apple aphid	% Clean
	Entry[a]	Sting	Total[a]				
Altacor	0.0 B	0.2	0.2 B	6.0	0.2	0.0	93.6
Imidan	0.2 B	0.4	0.6 B	4.6	0.4	0.0	94.4
Assail	0.0 B	0.0	0.0 B	3.0	0.2	0.0	96.8
Imidan/Warrior	0.0 B	0.6	0.6 B	5.2	0.0	0.2	94.0
Delegate	0.0 B	0.0	0.0 B	4.4	0.4	0.0	95.2
untreated	3.2 A	3.4	6.6 A	4.8	0.4	0.0	88.2
probability	*P=0.0002*	*P=0.31*	*P=0.005*	*P=0.65*	*P=0.77*	*P=0.44*	*P=0.06*

[a] 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.

Table 2. Insect injury to apple fruit after treatment by six insecticide programs, evaluated destructively at harvest, September 10-11, 2008; mean of five blocked replicates at OSU's Waterman Lab, Columbus, Ohio.

Treat-ment	% Internal Lepidoptera			% Tar-nished plant bug	% Plum curcu-lio	% Apple curcu-lio	% leaf-roller[a]	% Clean[a]
	Entry[a]	Sting[a]	Total[a]					
Altacor	0.0 B	0.0 B	0.0 B	4.8	2.0	0.0	0.0 B	93.2 AB
Imidan	0.0 B	0.0 B	0.0 B	4.4	1.0	0.0	0.0 B	94.6 A
Assail	0.2 B	0.0 B	0.2 B	3.8	1.0	0.0	0.0 B	95.0 A
Imidan/ Warrior	0.0 B	0.4 B	0.4 B	7.0	1.6	0.0	0.0 B	91.0 BC
Delegate	0.4 B	0.2 B	0.6 B	5.2	1.8	0.0	0.0 B	92.4 AB
untreated	2.9 A	1.3 A	4.2 A	4.7	2.6	5.3	0.4 A	88.5 C
probability	*P=0.014*	*P=0.005*	*P=0.0001*	*P=0.17*	*P=0.68*	*P=0.13*	*P=0.053*	*P=0.003*

[a] 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.