Codling moth management by insecticides in Ohio apple orchards, 2007

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Introduction: Codling moth continues to be challenging to control in some Ohio orchards due to resistance to organophosphate insecticides such as Imidan (phosmet). Data is needed on how well alternative insecticides work. A trial was done in 2007 to evaluate control of codling moth and other insect pests under five insecticide programs in comparison with untreated plots. This was the second year for evaluating Altacor (rynaxypyr), which is not yet registered. We continue to evaluate whether recently registered products such as Rimon (novaluron) and Assail (acetamiprid) work better for first generation control or second generation control. We continue to evaluate other new registered products such as Calypso (thiacloprid) and Baythroid (cyfluthrin), as well as new unregistered products such as Engeo, a premix of Warrior (lambda-cyhalothrin) plus Actara (thiamethoxam).

Materials and Methods

The trial was conducted in small plots in a block of 5-year old apple trees at Ohio State University's Waterman Laboratory in Columbus, Franklin County, central Ohio. There were six treatments each with five replicates in a randomized complete block design, with nine adjacent trees per plot comprised of three Golden Delicious, three Gala, and three Fuji. There was a guard row of Red Delicious between adjacent treatment rows. The guard rows were sprayed with Avaunt at petal-fall, miticides at first cover, and Imidan in four cover sprays, applied by a hand-gun sprayer.

The trap-based codling moth biofix was 5/6/07. For control of first generation codling moth, Rimon 0.83EC (20 fl oz/A) was applied on 5/7/07, 18 degree-days after biofix, and again on 5/22/07; Assail 30SG (5 oz/A) plus oil (Purespray, 0.5%), Calypso 4F (6 fl oz/A), Altacor 35WG (3 oz/A), and Imidan 70WP (3 lb/A) were applied on 5/22/07, 241 degree-days after biofix, and again on 6/6/07. For control of second generation codling moth, all insecticides were applied on 7/19/07, 1530 degree-days after biofix, and again on 8/6/07. Plots treated with Altacor for first generation were also treated with Altacor for second generation. Plots treated with Rimon for first generation were treated with Assail for second generation. Plots treated with Assail for first generation were treated with Rimon for second generation. Plots treated with Calypso for first generation were treated with Baythroid XL 1EC (2.8 fl oz/A) for the first spray and Imidan for the second spray for second generation, because Baythroid is allowed only one spray per year. Plots treated with Imidan for first generation were treated with Engeo 24.7SC (8 fl oz/A) for second generation. 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.

For control of mites in all plots including the checks, oil (Damoil, 2%) was applied at half-inch green on 3/27/07. For control of plum curculio in all plots except the checks, Avaunt (indoxacarb) 30WDG (6 oz/A) was applied at petal-fall on 5/3/07. For disease control on all trees, including checks, Captan was applied on 5/1/07 (petal-fall), 5/30/07 (second cover), 6/15/07 (third cover), 7/10/07 (fourth cover), and 8/13/07 (seventh cover). Fungicide was applied by an AgTech 4002 airblast sprayer operated at pressure of 20 psi, with TeeJet 6510 and 6520 nozzle tips.

Because of a very light fruit load, due to a severe freeze (21^{o}F) during the pink bud stage on 4/7/07, insect injury on fruit was evaluated on all fruit in every tree per plot, rather than the usual fixed sample size of 100 fruit per plot. Fruit were evaluated for codling moth non-destructively on 7/6/07 to 7/9/07 for injury by first-brood, and destructively at harvest from 9/12/07 to 9/19/07 for injury by second-brood. 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 number of fruit per plot ranged from 9 to 186 with a mean of 96. Due to the light fruit load, damage by internal Lepidoptera was unusually heavy: 57% of fruit were damaged in the untreated checks by July (Table 1) and 81% by September (Table 2). Based on pheromone traps, the internal Lepidoptera

complex was made up of codling moth and lesser appleworm, but no oriental fruit moth. Other insects that caused damage were plum curculio, tarnished plant bug, San Jose scale, and rosy apple aphid (Tables 1 and 2). The percentage of fruit damaged by internal Lepidoptera was significantly lower in all insecticide treatments than in the untreated check, both in July (Table 1) and September (Table 2). There were no significant differences in internal Lepidoptera among the five insecticide programs in July, but in September the Altacor/Altacor and Calypso/Baythroid/Imidan programs had significantly less damage by internal Lepidoptera than the Assail/Rimon treatment, while the Rimon/Assail and Imidan/Engeo treatments were intermediate (Table 2). No phytotoxicity was observed. Altacor looks very promising for codling moth control, even under very heavy pest pressure, although it will need to be supplemented by another insecticide in blocks where San Jose scale is present. The combination of Rimon and Assail was better when Rimon was used for first generation and Assail was used for second generation than the inverse.

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Table 1. Effect of insecticide program on insect injury by early-summer insects to apple fruit, by non-destructive evaluation, July 2007; mean[a] of five blocked replicates at OSU's Waterman Lab, Columbus, Ohio.

Treatment for first generation	% Clean	% Internal Lepidoptera			% Plum curculio	% Tarnished plant bug	% San Jose scale	% Rosy apple aphid
		Entry	Sting	Total				
Altacor	77.4 a	1.3 b	0.2	1.5 b	7.0	0.9	3.9 a	5.5
Calypso	78.6 a	1.8 b	0.4	2.2 b	4.6	2.0	1.2 bc	11.2
Imidan	90.1 a	1.9 b	0.3	2.2 b	1.8	1.2	0.2 c	3.7
Assail	86.0 a	2.9 b	0.1	3.0 b	1.9	0.8	0.0 c	8.2
Rimon	78.8 a	6.3 b	0.3	6.6 b	2.7	0.9	3.7 ab	6.0
untreated	39.9 b	56.7 a	0	56.7 a	0.9	0.0	1.0 bc	1.0
Probability (treatment effect)	*0.0021*	*<0.0001*	*0.73*	*<0.0001*	*0.23*	*0.21*	*0.0166*	*0.25*

[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. Effect of insecticide program on insect injury to apple fruit at harvest, September 2007; mean[a] of five blocked replicates at OSU's Waterman Lab, Columbus, Ohio.

Treatment for first generation/second generation	% Clean	% Internal Lepidoptera			% Plum curculio	% Tarnished plant bug	% San Jose scale	% Rosy apple aphid
		Entry	Sting	Total				
Altacor/Altacor	65.7 a	1.3 c	0.6 b	1.9 c	8.4	1.0 a	15.3 a	15.4
Calypso/Baythroid,Imidan	62.5 a	4.7 bc	0.8 b	5.4 c	3.1	0.0 c	2.9 b	21.7
Rimon/Assail	64.6 a	5.8 bc	1.7 ab	7.5 bc	6.7	0.1 c	1.4 b	17.1
Imidan/Engeo	75.7 a	6.3 bc	1.2 ab	7.5 bc	3.8	0.8 ab	0.0 b	10.8
Assail/Rimon	61.0 a	11.3 b	3.6 a	15.0 b	2.3	0.1 bc	0.3 b	19.2
untreated/untreated	17.8 b	78.6 a	2.5 ab	81.1 a	1.0	0.0 c	5.3 ab	18.4
Probability (treatment effect)	*<0.001*	*<0.001*	*0.24*	*<0.001*	*0.06*	*0.02*	*0.04*	*0.81*

[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.