Granulosis virus for codling moth management in Ohio apple orchards, 2008

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Background: Granulosis virus is an alternative management tool that some Ohio growers are experimenting with, in their struggle to control large populations of codling moth that are resistant to standard organophosphate insecticides. Use of commercially available virus products has generally shown positive results, although effects of virus are difficult to evaluate because most growers are using virus in conjunction with conventional insecticides. Data are needed on how the virus performs when used both with and without insecticide. A trial was conducted in 2006 in Columbus, and a repeat trial was planned for 2007 but cancelled when the fruit crop was lost to frost; the repeat trial was postponed until 2008. The primary objective was to evaluate control of codling moth by applications of codling moth granulosis virus used alone and combined with insecticide. A secondary objective was to evaluate density of pest mites and predatory mites as part of a long-term study in this orchard on mite tolerance of pyrethroid insecticides.

Materials and Methods:

The trial was conducted in a block of 15-year old Jonafree and Liberty apple trees at Ohio State University's Waterman Laboratory in Columbus, Franklin County, Ohio. Insect control in this block has relied primarily on low rates of pyrethroid insecticides for the past 12 years, and mite control has relied on pyrethroid-tolerant predatory mites. There were four treatments each with four replicates in a randomized complete block design. There were eight adjacent trees per plot: four Liberty and four Jonafree. The four treatments were virus-only, insecticide-only, insecticide plus virus, and untreated.

Treatments for codling moth were initiated on 5/30, which was 238 degree-days (base 50F) after the trap-based biofix on 5/7. The virus-only treatment was codling moth granulosis virus (Cyd-X, 3 fl oz per acre) applied four times at weekly intervals (5/30, 6/5, 6/12, 6/19) for first generation codling moth control, and another four times for second generation control (7/29, 8/5, 8/12, 8/21). The insecticide-only treatment was lambda-cyhalothrin (Warrior 1CS, 2.5 fl oz per acre) applied on 5/30 and 6/12 for first generation codling moth control, and again on 7/29 and 8/12 for second generation codling moth control. The insecticide plus virus treatment was the combination of the two individual treatments at the same rates and timings. All plots except the untreated checks were treated at the half-inch green bud stage (4/10) with Esteem 35WP, 4 oz/A, for San José scale. All plots except the untreated checks were treated twice at petal-fall (5/7 and 5/15) with Calypso 4F (thiacloprid) at 6 fl oz per acre for white apple leafhopper and plum curculio. 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.

A reduced fungicide program was used due to the disease resistance of these cultivars. On all trees including checks, Topsin-M and Captan were sprayed on 7/14 and 7/25 for flyspeck control. Fungicides were applied by an AgTech 4002 airblast sprayer operated at pressure of 20 psi, with TeeJet 6510 and 6520 nozzle tips. For weed control, Princep 4L at 2oz per gal and Cornerstone at 2 oz per gal were applied on 4/21, and Cornerstone at 4 oz per gal was applied on 7/1 and 7/17.

Injury to fruit by first-brood codling moth was evaluated non-destructively on 7/19 on 50 Jonafree fruit and 50 Liberty fruit, randomly selected from the center of each plot. Injury to fruit by second-brood codling moth was evaluated destructively at harvest on 8/26 for Jonafree and on 9/4 for Liberty; for each of the two cultivars, 100 fruit on the tree and 50 dropped fruit beneath the tree were examined in each plot. 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 fruit load in 2008 was heavy in this orchard but the population of codling moth was lighter than normal, most likely due to the crash of the population in 2007 when there was no host fruit available. Pheromone traps detected codling moth and lesser appleworm in 2008 (Figure 1), both at lower density than normal. Internal Lepidoptera affected only 0.0 to 0.5% of fruit evaluated in mid-July, and this injury did not differ significantly among the four treatments (Table 1). Plum curculio oviposition injury was significantly higher in the untreated check than in the virus or insecticide plus virus treatment (Table 1). Tarnished plant bug injury was found in most plots but did not differ significantly among treatments.

At harvest in late August and early September, internal Lepidoptera affected only 0.2 to 0.9% of fruit on the tree (Table 2) and 0.2 to 1.5% of dropped fruit (Table 3), and the internal Lepidoptera injury did not differ statistically among treatments. Injury from leafrollers was significantly higher in untreated plots than in insecticide-only, virus-only, or insecticide plus virus treatments (Tables 2 and 3). Injury from plum curculio, San José scale, tarnished plant bug, and apple curculio were found but did not vary significantly among treatments.

Under the conditions of low pest pressure in this trial, control of codling moth was not significantly affected by eight applications of virus-only (Cyd-X), four applications of insecticide-only (Warrior), or a combination of insecticide and virus. Based on previous work with high pest pressure, virus sprays offer an excellent alternative to conventional insecticides, particularly in orchards where the codling moth population has developed resistance to insecticides or in orchards where organic management is used.

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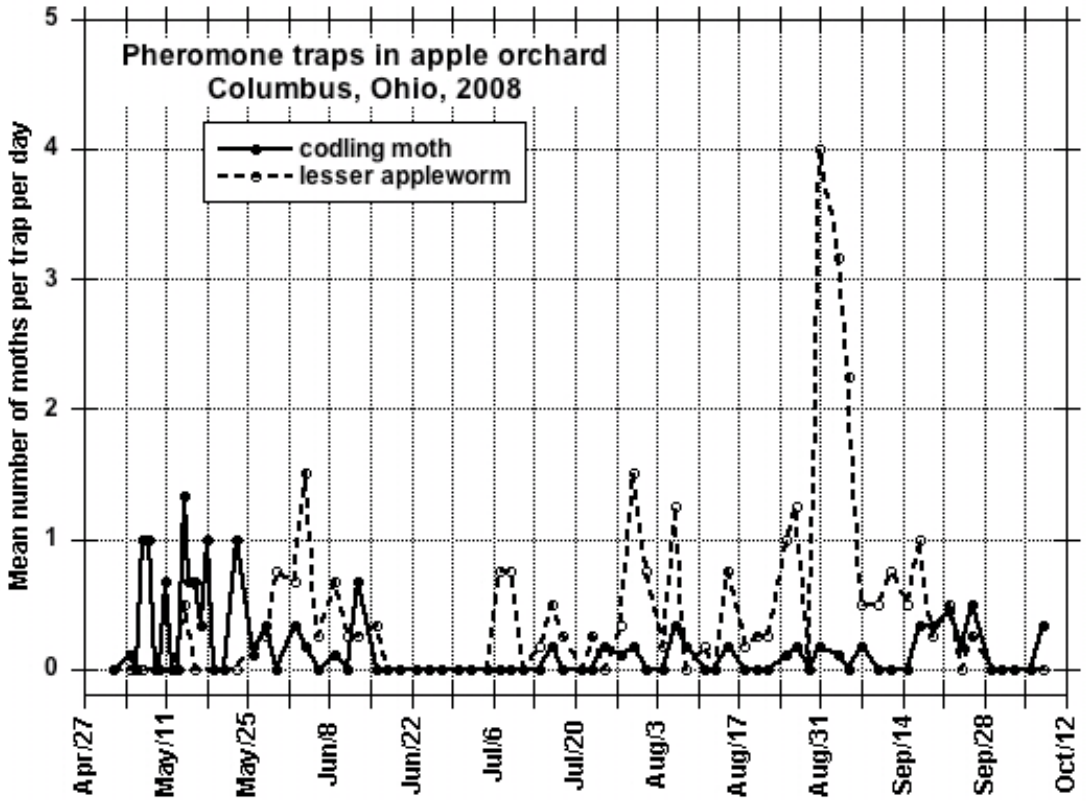

Figure 1. Catch of codling moth and lesser appleworm adults in pheromone traps in apple orchards at Waterman Lab, Columbus, Ohio, 2008.

Table 1. Insect injury to apple fruit after treatment by four management programs, evaluated non-destructively on 7/19/2008; mean of four blocked replicates at OSU's Waterman Lab, Columbus, Ohio.

Treatment	% Internal Lepidoptera (sting)	% Plum curculio egg scar[a]	% Tarnished plant bug	% Clean
Insecticide	0.0	2.0 AB	2.2	97.2
Insecticide + Virus	0.0	0.5 B	1.2	98.2
Virus	0.5	1.0 B	2.0	96.5
Untreated	0.5	4.2 A	3.0	94.0
Probability, treatment effect	*P = 0.62*	*P = 0.042*	*P = 0.64*	*P = 0.76*

[a] Within a 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 on the trees after treatment by four management programs, evaluated destructively at harvest on 8/26/08 for Jonafree (N=100) and on 9/4/08 for Liberty (N=100); mean of four blocked replicates at OSU's Waterman Lab, Columbus, Ohio.

Treatment	% Internal Lepidoptera			% Plum curculio			% San Jose scale	% Tarnished plant bug	% Leaf-roller[a]	% Apple curculio			% Clean
	En-try	Sting	Total	Egg scar	Late feed-ing	Total				Egg scar	Late feed-ing	Total	
Insecticide	0	0.4	0.4	3.5	1.1	4.6	0	1.9	0.0 B	1.0	0.6	1.6	91.6
Insecticide + Virus	0	0.2	0.2	2.2	0.1	2.4	0	2.0	0.1 B	0.1	0.0	0.1	95.1
Virus	0	0.5	0.5	2.1	0.0	2.1	0	1.0	0.1 B	0.0	1.5	1.5	94.8
Untreated	0	0.9	0.9	6.0	0.2	6.2	0.9	2.0	0.8 A	2.4	0.0	2.4	87.5
P value	-	*0.57*	*0.57*	*0.12*	*0.72*	*0.10*	*0.44*	*0.54*	*0.009*	*0.66*	*0.61*	*0.85*	*0.17*

[a] Within a 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 3. Insect injury to dropped apple fruit after treatment by four management programs, evaluated destructively at harvest on 8/2608 for Jonafree (N=50) and on 9/4/08 for Liberty (N=50); mean of four blocked replicates at OSU's Waterman Lab, Columbus, Ohio.

Treatment	% Internal Lepidoptera			% Plum curculio			% San Jose scale	% Tarnished plant bug	% Leaf-roller[a]	% Apple curculio			% Clean
	En-try	Sting	Total	Egg scar	Late feed-ing	Total				Egg scar	Late feed-ing	Total	
Insecticide	0.2	0.0	0.2	3.0	0.5	3.5	0.0	0.2	0 B	1.0	0.0	1.0	95.0
Insecticide + Virus	0.0	0.2	0.2	2.5	0.0	2.5	0.0	1.0	0 B	0.0	0.0	0.0	95.8
Virus	0.0	1.2	1.2	3.0	1.5	4.5	0.0	1.2	0 B	0.0	1.5	1.5	91.8
Untreated	0.0	1.5	1.5	5.0	2.2	7.2	0.8	0.8	1.0 A	0.0	0.0	0.0	89.0
P value	*0.44*	*0.07*	*0.21*	*0.27*	*0.51*	*0.19*	*0.44*	*0.66*	*0.006*	*0.44*	*0.44*	*0.63*	*0.16*

[a] Within a 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.