Codling Moth Control with Rimon (Novaluron) and Other Reduced Risk Insecticides
2006 Research Trial and Demonstration
IPM Apple Orchard, Kaysville, UT

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Objectives: To evaluate and demonstrate the efficacy of reduced risk insecticides for first and second- generation codling moth (CM) management in apple.

Methods:

Plot Design and Treatments

The trial was conducted in a 2-acre apple orchard with a mixture of cultivars ('Delicious', 'Gala', 'Idared', 'Jonathan', 'Mutzu', and 'Prime Gold'), at the Utah State University research farm in Kaysville, UT. The orchard was 12 rows wide by 30 trees in length (12 ft × 20 ft spacing) (see map). Plot size was 3 rows × 5 trees (60 ft × 60 ft). Each treatment was replicated four times in a RCB design.

Insecticides were applied with an air blast sprayer at 70 gpa of dilute spray to provide full coverage.

Treatments:
Rimon Efficacy Trial (Chemtura Protocol 110)

Table 1. Insecticide treatment applications and timings. The actual dates of application are provided.

Trt	1st generation CM				2nd generation CM			
1	Rimon 50-75 DD May 15	Rimon 14 d later May 30	Assail 14 d later Jun 12		Rimon 1000 DD Jul 6	Rimon 14 d later Jul 22	Assail 14 d later Aug 2	
2		Rimon + Assail 250 DD May 24	Rimon 14 d later Jun 7	Calypso 7 d later Jun 14		Rimon + Assail 1200 DD Jul 12	Rimon 14 d later Jul 26	Calypso 13 d later Aug 8
3	Esteem 100 DD May 18	Assail 350 DD May 30	Intrepid 14 d later Jun 12		Esteem 1050 DD Jul 6	Assail 1380 DD Jul 22	Intrepid 16 d later Aug 7	
4	Oil 150-200 DD May 19	Intrepid 350 DD May 30	Assail 14 d later Jun 12		Oil 1100 DD Jul 10	Intrepid 1380 DD Jul 22	Calypso 16 d later Aug 7	
5		Guthion 250 DD May 24	Assail 14 d later Jun 7	Calypso 7 d later Jun 14		Guthion 1200 DD Jul 12	Calypso 16 d later Jul 28	Calypso 11 d later Aug 8
6								

Codling moth development targets:

- 50-75 DD and 1000 DD after biofix - before egg-laying of each generation
- 100 DD and 1050 DD after biofix - early in egg-laying period of each generation
- 150-200 DD and 1100 DD after biofix - mid egg-laying period, before egg hatch begins
- 250 DD and 1200 DD after biofix - beginning of egg hatch of each generation
- 350 DD and 1380 DD after biofix - beginning of peak egg-hatch period of each generation

Insecticide rates:

- Rimon 0.83 EC @ 32 oz/acre + 0.25% v/v horticultural mineral oil (HMO)
- Assail 30SG @ 6 oz/acre + 0.25% v/v HMO
- Rimon 0.83 EC @ 32 oz/are + Assail 30SG @ 6 oz/acre + 0.25% v/v HMO
- Esteem 35WP @ 5 oz/acre + 0.25% v/v HMO
- Intrepid 2F @ 16 oz/acre + 0.25% v/v HMO
- Guthion Solupak 50 @ 2 lb/acre + 0.25% v/v HMO
- Calypso 4F @ 6 oz/acre + 0.25% v/v HMO

Codling Moth Monitoring

Codling moth male populations were monitored with pheromone traps (Delta trap with long-life codlemone lure) placed in the study orchard and in a nearby orchard. First moth catch, or biofix, occurred on May 10. A codling moth degree-day model was followed for timing the development of first and second generations. Moth densities caught per night were graphed to evaluate densities and follow progression of generations.

Fruit Injury Sampling

At the conclusion of the 1st CM generation (Jun 28), 100 fruit were inspected for injury (stings and larval entries) in each plot (400 fruit per treatment). Following the 2nd CM generation (Aug 17), a second sampling of 250 fruit per plot (1,000 fruit per treatment) was conducted. Fruit were randomly selected from trees in the center row of each plot. The percentage of fruit with stings and entries was compared among treatments with analysis of variance. Proportion values were arcsine-square root transformed before analysis to meet normality assumptions. When different, means were separated by LSD.

Mite Sampling

Densities of phytophagous and predaceous mites were determined on the leaves of trees on Aug 22 after all of the insecticide applications had been completed. The effect of insecticide treatments on biological control of phytophagous mites was evaluated by comparing the number of mites among treatments with analysis of variance. Count data were square root (x+0.1) transformed before analysis to meet normality assumptions. When different, means were separated by LSD.

Results:

Codling Moth Populations

First moth catch (biofix) occurred on May 10. Male trap catch ranged from 0.1 to 14.4 moths per night in the study orchard and was similar to a nearby apple orchard (Fig. 1). Based on degree-day model predictions, larval emergence of the first generation occurred from May 23-Jul 1, the second generation from Jul 8-Aug 15, and the third generation from Aug 17 to approximately Sep 15.

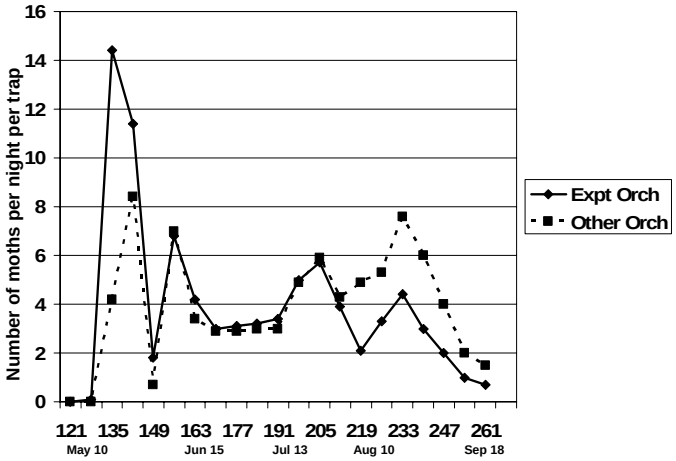


Figure 1. Number of male moths caught in pheromone-baited traps in the experimental and another nearby apple orchard on the Kaysville Research Farm, 2006.

Fruit Injury

Fruit injury caused by CM was found in all treatments after both the first and second generations (Table 1). Following completion of the first generation, the most effective treatments were 5 (Guthion-Assail-Calypso) and 3 (Esteem-Assail-Intrepid). The two treatments with Rimon (1 and 2) were not different from the former two treatments and the Oil-Intrepid-Assail treatment (4), but were significantly better than the untreated control. Treatment 4 did not differ from the untreated control. Following completion of the second CM generation, the percentage of fruit with stings was less than after the first generation, but the incidence of larval entries was similar or greater (Table 1). All treatments protected fruit significantly better than the untreated control and there was no statistical difference among treatments although Treatment 4 had numerically more injury than the other insecticide treatments. Total fruit injury (combined stings and

entries) was numerically lowest in the two Rimon and Guthion treatments (1, 2, and 5). There was no difference between the two Rimon treatments.

Table 2. Mean apple fruit injury caused by codling moth (CM) following completion of the first (Jun 28) and second CM generations (Aug 17) at the Kaysville Research Farm in 2006.

Trt #	Insecticides*	% fruit with injury (Jun 28)			% fruit with injury (Aug 17)		
		Stings	Entries	Total	Stings	Entries	Total
1	Ri-As-Ri	1.8 c	3.0 ab	4.8 bc	1.1	1.9 b	3.0 b
2	Ri+As-Ri-Ca	2.0 bc	2.5 abc	4.5 bc	1.4	0.8 b	2.2 b
3	Es-As-In	2.3 c	1.8 bc	4.0 c	2.1	3.3 b	5.4 b
4	Oi-In-As/Ca	5.0 ab	2.8 abc	7.8 ab	2.5	4.1 b	6.6 b
5	Gu-As/Ca-Ca	2.3 c	1.3 c	3.5 c	1.3	1.0 b	2.3 b
6		6.0 a	4.5 a	10.5 a	2.1	12.8 a	14.9 a
P>F		0.04	0.05	0.01	0.61	0.005	0.01

*Insecticides applied for each CM generation: As = Assail, Ca = Calypso, Es = Esteem, Gu = Guthion, In = Intrepid, Oi = Oil, Ri = Rimon

Proportion data values were arcsine-square root transformed for analysis. Means within the same column with different letters were significantly different (p<0.05) and separated with LSD test.

Effects on Mites

Two spotted spider mite, brown mite, and apple rust mite were the species of phytophagous mites found on leaves. Both *Typhlodromus* and *Zetzellia* were observed, but Zetzellia was much more abundant. There were no differences in densities of phytophagous mites among treatments although numerically there were more in Treatment 1 (Rimon-Assail-Rimon) (Table 2). Variability in counts was high, so these differences were not significant. Predaceous mite densities were significantly greater in the Guthion (5), untreated (6), and Esteem (3) treatments than in the Rimon+Assail treatment (2). Numbers of predaceous mites were intermediate in the Rimon (1) and Oil (4) treatments.

Table 3. Mean number of mites per 20 leaves as influenced by insecticide treatments on Aug 22 in the study apple orchard at the Kaysville Research Farm, 2006.

Trt #	Insecticides*	Mean # mites per 20 leaves				
		Phyto Mites^	Phyto Mite Eggs	Pred Mites~	Pred Mite Eggs	Thrips
1	Ri-As-Ri	33.8	8.8	67.8 bc	11.8	0.3
2	Ri+As-Ri-Ca	4.3	0.3	36.5 c	1.8	0.0
3	Es-As-In	0.3	0.0	153.3 ab	9.8	0.3
4	Oi-In-As/Ca	0.0	1.0	51.0 bc	1.7	0.0
5	Gu-As/Ca-Ca	1.5	5.5	331.8 a	31.3	0.3
6		1.0	2.5	162.3 ab	14.5	0.0
P>F		0.13	0.76	0.01	0.11	0.8

*Insecticides applied for each CM generation: As = Assail, Ca = Calypso, Es = Esteem, Gu = Guthion, In = Intrepid, Oi = Oil, Ri = Rimon

^Phyto Mites = phytophagous mites (two spotted spider mites, brown mites, and rust mites)

~Pred Mites = predaceous mites (*Typhlodromus* and *Zetzellia*)

Count data were square root (x+0.1) transformed for analysis. Means within the same column with different letters were significantly different (p<0.05) and separated with LSD test.

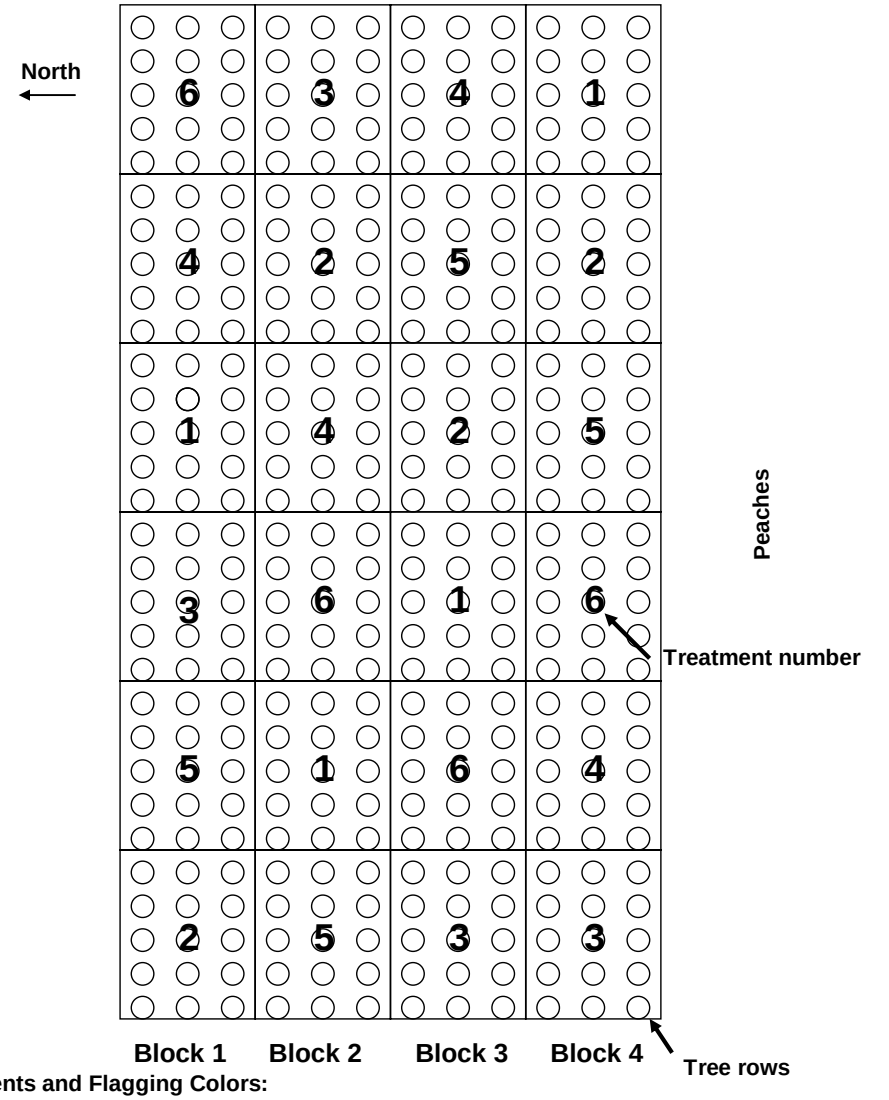
Conclusions

Under moderate codling moth densities observed in this trial, all insecticide programs performed better than the untreated control. All programs were treated with three insecticide applications per generation for a total of six applications for two generations. After the second generation of CM, total fruit injury ranged from 2.2 to 6.6% in the insecticide treatments and injury was 14.9% in the untreated control. The majority of fruit injury was from larval entries in the second generation. There was no difference in efficacy between the two Rimon treatments where Rimon was applied before egg-

laying (Trt 1) as compared to combining it with Assail and waiting until the beginning of egg hatch (Trt 2). Although numerically there were more phytophagous mites in Rimon treated plots on Aug 22 after all insecticide applications had been made, because of high count variability, differences were not significant. There were fewer predaceous mites in one of the Rimon treatments (Trt 3) than in most others suggesting that Rimon was toxic to the predators. *Zetzellia* was the most abundant predator found on leaves and Rimon seems to have been especially toxic to *Zetzellia*.

Map of Kaysville IPM Apple (Mixed cultivars) Orchard
2006 Codling Moth Control Trial

(12 rows X 30 trees: 12' X 20' spacing)



Treatments and Flagging Colors:

1 Rimon-Assail Rotation – Blue
2. Rimon-Assail Tank Mix – Orange
3. Esteem-Assail-Intrepid Rotation– Lime
4. Oil-Intrepid-Assail Rotation – Pink
5. Guthion-Neonic Rotation –Yellow/Black Stripe
6. Untreated Control - White

Plot map of 2006 experimental orchard