Efficacy of Rynaxypyr insecticide for control of codling moth in Ohio apple orchards

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SUMMARY: A field trial was conducted to evaluate the efficacy of the experimental insecticide Rynaxypyr for codling moth control, in comparison to standard insecticides. The standard insecticide programs used one product for control of first generation codling moth and one product for control of second generation codling moth, while Rynaxypyr was used for both first and second generations. The programs were 1) Rimon followed by Assail, 2) Guthion followed by Asana, 3) Guthion followed by Guthion, 4) Rynaxypyr at two rates, and 5) no insecticide. Fruit were evaluated for insect injury in mid-summer and at harvest. The mid-summer evaluation showed that all insecticides provided control of codling moth that was significantly better than the untreated check treatment; Rynaxypyr was as effective as Rimon or Guthion. For full season control of codling moth, equally excellent results were provided by all insecticide programs (both rates of Rynaxypyr, Rimon followed by Assail, Guthion followed by Asana, and Guthion followed by Guthion). Rynaxypyr will be an excellent alternative to organophosphates once it becomes registered for use on apple.

Background: Codling moth is the key pest of apples, and it must be managed if the crop is to be successfully marketed. While organophosphate insecticides such as Imidan and Guthion have provided effective control of codling moth for many years, there is interest in alternative insecticides due to recent restrictions on the use of organophosphates and due to failing efficacy of organophosphates for codling moth control at some orchards. Rynaxypyr, made by DuPont, has shown excellent results on apples in other apple-growing States, but data had not yet been obtained from Ohio.

Objective: Evaluate control of codling moth and other insect pests in Ohio apples by Rynaxypyr at two rates, in comparison with typical insecticide programs.

Methods:

The trial was conducted in small plots in a block of 4-year old Scarlet Spur Delicious apple trees at Ohio State University's Waterman Laboratory in Columbus, Franklin County, central Ohio. There were six treatments each with three replicates in a randomized complete block design, with three adjacent trees per plot.

Each treatment included one product for control of first-generation codling moth and one product for control of second-generation codling moth. For first generation codling moth, Rimon was applied on 5/10/06 (87 degree days after biofix) and 5/24/06. Guthion and Rynaxypyr were applied on 5/26/06 (234 degree days after biofix) and 6/8/06. For second generation codling moth, Assail, Asana, and Rynaxypyr were applied on 7/19/06 and 8/3/06. For late season control, insecticides with shorter pre-harvests intervals were applied on 8/17 and 8/31; Assail was used in plots that had been treated with Assail or Asana for second brood; Imidan was applied in plots that had been treated with Guthion for second brood; no insecticide was used for third brood in plots treated with Rynaxypyr for second brood.

Formulations and rates of insecticide treatments were: Asana XL 0.66EC (esfenvalerate) at 4.8 fl oz per acre, Assail 30SG (acetamiprid) at 5 oz per acre applied with oil at 0.5%, Guthion 50WP (azinphosmethyl) at 2 lb per acre, Imidan 70WP (phosmet) at 3 lb per acre, Rimon 0.83EC (novaluron) at 20 fl oz per acre, and Rynaxypyr 35WG at 2 oz per acre and 3 oz per acre. All plots except the insecticide checks were treated at petal-fall with Avaunt 30WDG (indoxacarb) at 6 oz per acre. For mite control in all plots including the check, Envidor 2SC (spirodiclofen) was applied on 5/19/06 at 6 fl oz per acre. There was a guard row of Gala, Fuji, and Golden Delicious between adjacent treatment rows. The guard rows were not sprayed with miticide but were sprayed with Avaunt at petal-fall and Imidan at first cover and second cover. Insecticides and miticide 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 standard fungicide program was used in all plots. Fungicides were applied by an AgTech 4002 airblast sprayer operated at pressure of 20 psi, with TeeJet 6510 and 6520 nozzle tips. On all trees including checks, Kocide was sprayed on 4/6/06. Fungicides applied were Mancozeb at 3/4-inch green on 4/12/06, at pink on 4/19/06, and at bloom on 4/26/06; Captan at petal-fall on 5/2/06, and in a cover spray on 5/15/06; Mancozeb on 6/5/06 and 6/22/06; Captan on 7/6/06; Captan plus Topsin-M on 7/21/06 and 8/9/06 .

Pheromone traps were used to monitor adult populations of codling moth and lesser appleworm. 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. Multipher-3 funnel traps were used with lures made by Trécé; for codling moth, long-life lures were changed every 8 weeks, while for lesser appleworm, standard lures were changed every 4 weeks. Oriental fruit moth was not monitored due to its absence at this site in the previous few years.

Insect injury to fruit was evaluated on 100 fruit in the center of each plot, non–destructively on 7/21/06 to evaluate injury by first–brood codling moth, and destructively at harvest from 9/25/06 to 9/29/06. 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:

Fruit evaluated in mid–summer showed that the most important insect injury was internal Lepidoptera, which affected 0.0 to 6.4% of fruit (Table 1). Injury from internal Lepidoptera was significantly less where any insecticide was used than in the untreated check treatment, but there were no significant differences among the insecticides. Tarnished plant bug injury and plum curculio oviposition injury were found in most plots but these did not differ significantly among treatments. There was a trace of San José scale, late leafroller damage, and early fruitworm damage but without significant treatment effects.

At harvest in September, the most important insect injury was internal Lepidoptera, which affected 0.3 to 14.9% of fruit (Table 2). Injury from internal Lepidoptera was significantly less where insecticides were used than in the untreated check treatment. Tarnished plant bug injury and plum curculio oviposition injury were found in most plots but did not vary significantly among treatments. A few plots had injury from late plum curculio adult feeding, San José scale, late leafroller, and early fruitworm, but these did not vary significantly among treatments. There was damage in some plots from an unidentified pest, possibly apple curculio larvae, but this damage did not vary significantly among treatments. Damage by the undetermined pest caused internal damage. At harvest, this damage was clearly different than internal Lepidoptera damage, but at the mid–summer non–destructive evaluation, it would have been recorded as internal Lepidoptera damage. It will be important for Rynaxypyr to be used in conjunction with other insecticides that will control non–Lepidopteran pests.

Insecticide treatments were well timed based on population trends apparent in trap data. Codling moth adults reached peak density in pheromone traps on 6/21/06 for the overwintering generation, on 8/9/06 for the summer generation, and on 8/30/06 for a partial third generation (Table 3). Lesser appleworm adults peaked on 5/31/06 and 8/2/06 (Table 2). Based on an estimate of 1118 degree days per generation, the cumulative degree–days showed the potential for a third brood of larvae (Table 3).

Conclusions: All insecticide programs provided control of codling moth that was significantly better than the untreated check treatment. There was no difference between Rimon, Guthion, and Rynaxypyr for control of first brood codling moth. For full season control of codling moth, all insecticide programs (both rates of Rynaxypyr, Rimon followed by Assail, Guthion followed by Asana, and Guthion followed by Guthion) provided equally excellent results. Rynaxypyr will be an excellent alternative to organophosphate insecticides once it becomes registered for use on apple.

Table 1. Effect of insecticide program on insect injury by early-summer insects to Delicious apple fruit, by non-destructive evaluation on 7/21/06, mean of three blocked replicates at OSU's Waterman Lab, Columbus, Ohio.

Treatment	Percentage of fruit[a]						
	clean	Internal Lepidoptera[b]	Tarnished plant bug	Plum curculio oviposition	San José scale	Leafroller	Fruitworm
Rimon	95 AB	0.0 B	4.7	0.3	0	0	0
Guthion	96 A	0.0 B	4.0	0.3	0	0	0
Rynaxypyr 2 oz	96 A	0.3 B	3.3	0.0	0	0	0
Rynaxypyr 3 oz	90 BC	2.7 B	6.0	0.3	1.3	0	0
untreated	86 C	6.4 A	3.2	2.6	0	0.7	0.7
Probability value for treatment effect from ANOVA	*0.035*	*0.017*	*0.93*	*0.10*	*0.46*	*0.46*	*0.46*

[a] Within each column and group, 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.
[b] Damage by an undetermined pest, possibly apple curculio larvae, caused internal damage in some plots. At harvest, this damage was clearly different than internal Lepidoptera damage, but at the mid-summer non-destructive evaluation, it was recorded as internal Lepidoptera damage.

Table 2. Effect of insecticide program on insect injury to Delicious apple fruit at harvest, September 2006, mean of three blocked replicates at OSU's Waterman Lab, Columbus, Ohio.

Treatment	Percentage of fruit[a]										
	Clean	Internal Lepidoptera[b]			Tarni-shed plant bug	Plum cur-culio ovipo sition	Plum curculio late feeding	San José scale	Leaf-roller	Fruit-worm	Unide ntifie d[c]
		entry	sting	total							
Rimon/Assail	87 A	0.0 B	0.3 B	0.3 B	11.7	0.7	0	0	0.3	0	0.3
Guthion/Asana	92 A	1.0 B	0.3 B	1.3 B	5.0	1.0	0	0	0	0	0.7
Guthion/Guthion	91 A	0.7 B	0.3 B	1.0 B	6.3	2.0	0	0	0	0	0
Rynaxypyr 2 oz	91 A	0.0 B	0.3 B	0.3 B	7.0	1.0	0.7	0	0	0	0.3
Rynaxypyr 3 oz	85 A	0.3 B	0.0 B	0.3 B	5.4	1.7	3.1	2.7	0	0	3.3
none/none	67 B	11.6 A	3.3 A	14.9 A	2.6	8.0	0.7	1.3	1.0	0.3	5.6
Probability value for treatment effect from ANOVA	*0.03*	*0.001*	*0.04*	*0.004*	*0.67*	*0.19*	*0.71*	*0.11*	*0.18*	*0.47*	*0.58*

[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.
[b] The target populations were codling moth and lesser appleworm; Oriental fruit moth was absent.
[c] Damage by an undetermined pest, possibly apple curculio larvae, caused internal damage in some plots.

Table 3. Seasonal activity of codling moth and lesser appleworm as monitored by pheromone traps, and degree days for codling moth after trap-based biofix on 5/4/06, in orchards at OSU's Waterman Lab, Columbus Ohio.

Date	Codling moths caught in previous 7 days				Lesser appleworm caught in previous 7 days	Cumulative degree days[c] after biofix
	Trap 1[a]	Trap 2[a]	Trap 3[b]	Mean of 3 traps		
4/26	0	0	0	0.0	0	–
5/3	1	1	0	0.7	5	–
5/10	4	7	12	7.7	19	87
5/17	7	0	5	4.0	1	131
5/25	11	10	5	8.7	6	192
5/31	13	7	4	8.0	50	358
6/7	9	6	13	9.3	22	470
6/14	3	1	4	2.7	9	562
6/21	28	9	12	16.3	11	709
6/28	7	4	5	5.3	7	861
7/5	6	0	0	2.0	5	1020
7/12	7	0	2	3.0	10	1165
7/19	14	6	2	7.3	29	1365
7/26	16	4	11	10.3	18	1538
8/2	14	7	9	10.0	34	1749
8/9	22	5	6	11.0	21	1936
8/16	12	3	7	7.3	6	2094
8/23	14	5	9	9.3	5	2251
8/30	21	10	12	14.3	7	2413
9/6	8	8	8	8.0	12	2508
9/13	14	6	5	8.3	22	2632
9/20	10	5	1	5.3	6	2719
9/27	6	2	2	3.3	3	2797
10/4	2	2	2	2.0	2	2878
10/11	3	0	0	1.2	2	2942

[a] Traps 1 and 2 located in check plots in apple orchard where trial was conducted.
[b] Trap 3 located in check plot in older apple orchard 50 meters from orchard where trial was conducted.
[c] Degree-days calculated as mean of daily maximum and minimum temperature, base 50F, with low cutout at 50F (50F substituted for minimum temperature if actual minimum below 50F) and high cutout at 88F (88F substituted for maximum temperature if actual maximum above 88F).