ARTHROPOD MANAGEMENT STUDIES ON FRUIT AND VEGETABLE CROPS IN WESTERN NORTH CAROLINA

2008

ANNUAL REPORT

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Acknowledgments

This report is a summary of pest management-related studies conducted on fruit and vegetable crops in 2009 under the supervision of James F. Walgenbach, Extension Entomologist, North Carolina State University. Additional information (i.e., surveys, pest population trends, etc.) that may be of interest to extension agents, growers, industry representatives and consultants in western North Carolina are also presented.

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2008 Weather Data - Mountain Horticultural Crops Research Station, Fletcher, NC.

March

Day	Temp (°F) High	Temp (°F) Low	Rain (in.)
1	48	29	0
2	58	23	0
3	63	26	0
4	64	31	0.24
5	61	34	1.63
6	61	27	0
7	63	32	0.26
8	55	43	0.70
9	45	24	T
10	51	24	0
11	61	26	0
12	58	29	0
13	63	29	0
14	73	29	0
15	61	36	0.01
16	58	42	0.63
17	53	29	0
18	53	30	0
19	56	42	0.06
20	63	37	1.25
21	51	27	0
22	65	27	0
23	70	34	0
24	53	28	0
25	42	21	0
26	54	23	0
27	58	30	0
28	71	38	0
29	72	38	0.15
30	55	36	0.18
31	43	36	0.03
			5.11

April

Day	Temp (°F) High	Temp (°F) Low	Rain (in.)
1	60	39	0.02
2	78	51	T
3	70	47	0.15
4	54	41	0.22
5	65	52	0.55
6	57	48	0.60
7	65	47	0
8	64	47	0
9	57	43	T
10	73	42	0
11	72	46	0
12	73	59	0.05
13	73	42	0.12
14	52	35	T
15	45	36	0.02
16	57	27	0
17	68	31	0
18	76	36	0
19	7	43	T
20	65	40	0.10
21	60	44	0
22	67	47	0
23	72	48	0
24	74	43	0
25	76	45	0
26	76	49	0.10
27	76	52	0.18
28	66	55	0.84
29	62	36	0.07
30	53	30	0
			3.02

May

Day	Temp (°F) High	Temp (°F) Low	Rain (in.)
1	69	36	0
2	73	44	0
3	74	57	0
4	66	49	0
5	76	49	0
6	74	41	0
7	76	48	0
8	77	53	0
9	77	56	0.21
10	79	56	0.06
11	75	53	0.16
12	75	50	0.03
13	62	38	0
14	73	46	0
15	68	52	0.03
16	67	57	0.23
17	72	46	0
18	71	44	0
19	70	41	0.18
20	74	48	0
21	81	45	0.02
22	70	40	0
23	77	50	0
24	82	53	0
25	76	47	0
26	78	52	0
27	80	56	0.08
28	81	60	0.07
29	59	54	0.52
30	78	55	0
31	83	60	0
			1.59

June

Day	Temp (°F) High	Temp (°F) Low	Rain (in.)
1	88	58	0
2	80	59	0.06
3	84	54	0
4	82	60	0
5	91	59	0
6	90	59	0
7	91	62	0
8	92	62	0.09
9	93	62	0
10	94	63	0
11	91	64	0.28
12	86	63	0
13	85	64	0.42
14	84	61	0
15	82	63	0.04
16	84	55	0
17	87	62	0.03
18	83	51	0
19	77	50	0
20	80	50	0
21	79	55	0
22	79	56	0
23	82	58	0.06
24	83	52	T
25	85	51	0
26	89	53	0
27	87	59	0
28	88	61	0.07
29	88	62	0.25
30	85	59	0
			1.30

2008 Weather Data - Mountain Horticultural Crops Research Station, Fletcher, NC.

July

	Temp (°F)		Rain
Day	High	Low	(in.)
1	81	49	0.20
2	78	47	0
3	93	49	0
4	85	57	0
5	93	61	0.43
6	82	65	0.12
7	82	63	0.96
8	86	63	0.03
9	81	64	0.09
10	86	64	0.25
11	78	67	0.18
12	84	60	0
13	88	62	0
14	83	65	0.59
15	81	59	0
16	83	57	0
17	83	57	0
18	83	54	0
19	86	59	0
20	87	57	0
21	89	63	0
22	82	60	0
23	91	64	0
24	91	55	0
25	85	61	0
26	82	64	0
27	84	64	0.16
28	89	59	0
29	89	64	T
30	88	66	0.11
31	91	65	0
			3.12

August

	Temp (°F)		Rain
Day	High	Low	(in.)
1	86	68	0.04
2	88	61	0
3	93	62	0
4	89	61	0
5	93	61	0
6	92	66	0
7	94	66	0
8	85	62	0
9	81	51	0
10	83	58	0.15
11	82	56	0
12	82	52	0
13	81	55	0.11
14	76	62	T
15	85	56	0
16	84	59	0.27
17	82	61	0.03
18	81	58	0
19	86	58	0
20	91	57	0
21	86	57	0
22	83	60	0
23	81	65	0
24	82	59	0
25	83	65	0.04
26	76	67	1.29
27	70	67	4.61
28	80	68	0.05
29	78	61	0.06
30	85	57	0
31	97	58	0
			6.65

September

	Temp (°F)		Rain
Day	High	Low	(in.)
1	86	62	0
2	75	61	0.22
3	82	59	0
4	84	53	0
5	81	55	0
6	83	60	0
7	82	59	0
8	84	58	0
9	84	59	0.01
10	78	64	0.09
11	79	64	0.61
12	76	64	0.06
13	80	66	0
14	85	63	0
15	81	65	0
16	75	60	0.16
17	64	59	T
18	71	55	0
19	78	50	0
20	73	51	0
21	74	51	0
22	71	49	T
23	80	47	0
24	72	46	0
25	73	44	0
26	74	46	0
27	72	58	0.35
28	74	59	0
29	77	53	0
30	78	48	T
			1.50

October

	Temp (°F)		Rain
Day	High	Low	(in.)
1	77	49	0
2	65	38	0
3	63	35	0
4	71	36	0
5	74	39	0
6	78	46	0
7	78	45	0
8	63	47	0.05
9	59	56	0.55
10	74	55	T
11	71	59	T
12	71	59	0
13	72	53	0
14	74	42	0
15	80	43	0
16	82	46	0
17	78	49	0.19
18	64	45	0.10
19	54	31	0
20	63	30	0
21	68	31	0
22	66	34	0
23	65	31	0
24	54	32	0.07
25	52	44	1.02
26	58	38	0
27	66	37	0
28	48	35	0
29	43	32	T
30	55	26	0
31	63	26	0
			1.98

Insect Control on Cabbage – 2008

CABBAGE: *Brassica oleracea* var. *capitata* L. 'Bravo'

Cabbage looper (CL): *Trichoplusia ni* (Hubner)
Imported cabbageworm (ICW): *Pieris rapae* (Linnaeus)
Diamondback moth (DBM): *Plutella xylostella* (Linnaeus)
Cross-striped cabbageworm (CSCW): *Cotesia orobenae* (Forbes)
Harlequin bug (HB): *Murgantia histrionica* (Hahn)

Six-wk-old greenhouse-grown cabbage transplants ('Bravo') were transplanted on 28 May in plots consisting of two 25-ft long rows on 3-ft centers. Plants were spaced 15 inches apart within rows. Treatment rows were separated by 10 ft of bare ground, and replicates were separated by 30 ft of bare ground. Each treatment was replicated four times in a RCBD. Treatments and rates are listed in the tables. The 3-application Rimon treatment was applied on 13 Jun and 3 and 23 Jul. All other treatments were applied on 13 and 23 Jun, and 3, 16, 23, and 30 Jul. All treatments were applied with a tractor-mounted boom sprayer delivering 50 GPA through 3 hollow cone nozzles per row (two drop and one overhead). Larval populations of CL, ICW, DBM, and CSCW, as well as HB adults, were monitored at weekly intervals from 19 Jun through 4 Aug by counting the number of insects on each of 10 heads per plot. Quality ratings were made on 19 Aug by rating 20 randomly selected heads per plot head on a scale of 0 to 5, where 0 = no feeding damage, 1 = feeding damage on frame leaves, 2 = minor feeding damage on wrapper leaves, 3 = severe feeding damage on wrapper leaves, 4 = feeding damage to head, and 5 = severe defoliation. Cabbage heads receiving a rating of ≤2 were considered marketable. All data were subjected to two-way ANOVA and means were separated by LSD ($P = 0.05$).

Lepidopterous larval populations were relatively low in this trial, with season total CL, ICW, DBM, and CSCW populations across all six sample dates averaging 5.5, 24.2, 0.8 and 19.0 larvae per 10 heads, respectively (Table 1). All treatments provided excellent control of lepidopterous larvae. Harlequin bug populations reached a season total of 26 adults per 10 heads in the control. However, there was high within treatment variability of counts, and the only treatments that significantly reduced counts below the control were the three-applications of Rimon, Coragen, two Synapse treatments without Induce, Voliam Xpress, and Avaunt. All treatments except control had quality ratings <1 and exceeded 98% marketability.

Table 1. Season total number of insects per 10 heads of cabbage (cv. Bravo) sprayed with various insecticides. Mills River, NC, 2008.

		Insects per 10 heads						
Treatment[1]	Rate/A	Cabbage looper	Imported cabbageworm	Diamondback moth	Cross-striped cabbageworm	Harlequin bug	Quality rating[2]	% Marketable
Rimon 0.83EC – 3 applic.	12 oz	0.0a	0.2a	0.0a	0.8a	3.2ab	0.41a	100a
Rimon 0.083EC alter. Coragen 1.67SC	12 oz 5.0 oz	0.0a	0.8a	0.0a	0.0a	8.0abc	0.19a	100a
Rimon 0.83EC	12 oz	0.2a	0.8a	0.0a	0.0a	5.8abc	0.24a	100a
Coragen 1.67SC	5.0 oz	0.0a	0.0a	0.0a	0.0a	1.2a	0.08a	100a
Radiant 1SC	7.5 oz	0.0a	0.0a	0.0a	0.0a	15.8abcd	0.24a	100a
Synapse 24WG	2.0 oz	0.5a	0.8a	0.0a	0.8a	2.2a	0.28a	100a
Synapse 24WG + Induce	2.0 oz 0.25%	0.0a	0.2a	0.0a	0.0a	23.0bcd	0.21a	98.8a
Synapse 24WG	3.0 oz	0.0a	0.0a	0.0a	0.0a	1.0a	0.33a	100a
Synapse 24WG + Induce	3.0 oz 0.25%	0.2a	1.0a	0.0a	0.0a	34.0d	0.23a	100a
Voliam Xpress 150ZC	5.0 oz	0.0a	0.2a	0.0a	0.0a	0.5a	0.08a	100a
Avaunt 30WDG	3.5 oz	0.2a	0.2a	0.0a	0.0a	0.8a	0.43a	100a
Control	-	5.5b	24.2b	0.8b	19.0b	26.0cd	2.93b	30.0b

Means in the same column followed by the same letter are not significantly different by LSD (p=0.05).

[1]The 3 application Rimon treatment was applied on 6/13, 7/3, and 7/23. All other treatments were applied on 6/13, 6/23, 7/3, 7/16, 7/23 and 7/30. All treatments were applied at 79 GPA through 3 hollow cone nozzles per row (two drop and one overhead).

[2] Quality ratings were based on 20 heads per plot, with 0 = no damage, 1 = frame leaf damage, 2 = minor wrapper leaf damage, 3 = significant wrapper leaf damage, 4 = head damage, and 5 = severe damage.

Insect Control on Tomatoes with Foliar Insecticides - 2008

TOMATO: *Lycoperiscon esculentum* Miller 'Crista'

Tomato fruitworm (TFW): *Helicoverpa zea* (Boddie)
Brown stink bug (SB): *Euschistus servus* (Say)
Green stink bug (SB): *Acrosternum hilare* (Say)
Western flower thrips (WFT): *Frankliniella occidentalis* (Pergande)
Potato aphid (PA): *Macrosiphum euphorbiae* (Thomas)
Twospotted spider mite (TSSM): *Tetranychus urticae* (Koch)

Five-week-old 'Crista' tomato transplants were planted on 4 June at the Mountain Horticultural Crops Research Station (Mills River, NC). Plants were spaced 18 in. apart within rows, and rows were 20-ft long and spaced on 10 ft centers. Single-row plots were arranged in a RCBD with four replications. Plants were set in black plastic mulch supplied with drip irrigation, and tomatoes were staked and strung as needed. A season-long fungicide program was applied to all plots, and, with the exception of insect control, standard practices for staked tomato production in western NC were followed. Insecticide materials and rates are listed in the tables. Treatments were applied with a tractor-mounted boom sprayer that delivered 54 GPA on the 27 Jun application (through 4 hollow cone nozzles, 2 on each side of the row), 84 GPA on the 3 and 14 July application (through 6 hollow cone nozzles per row, 3 on each side of the row), and 114 GPA for all remaining applications (7 hollow cone nozzles per row, 3 on each side of the row and one overhead). Twospotted spider mites (TSSM) were monitored by counting the total number of motile mites on 10 new (recently expanded) leaflets per plot. Potato aphids (PA) were assessed by observing 10 leaves (third leaf down) per plot and recording the number infested with apterous aphids. Western flower thrips (WFT) populations were monitored both on foliage and in flowers: on foliage, immatures were counted on 10 leaflets per plot (from a mid-plant leaf), and in flowers, 10 flowers were removed and placed in 50% ETOH to dislodge thrips, which were then counted under a stereomicroscope. Season total cumulative TSSM-days and WFT-days were calculated by multiplying the mean population of two successive sample dates by the sampling interval (days), and cumulating mite and thrips days for successive sample dates. Vine-ripe fruit were harvested at two-week intervals from 6 Aug to 18 Sep, and the total number of fruit, along with those damaged by LEP larvae, SB, and WFT were recorded. All data were subjected to two-way ANOVA and means were separated by LSD ($P = 0.05$).

Based on cumulative TSSM mite-days, mite populations were significantly higher than the control in both the seasonal-long Rimon and Voliam Xpress treatments (Table 1). None of the other treatments significantly affected mites compared with the control, although mite populations were generally lower in the four Synapse + Induce treatments. By the last sample date on 9 September, PA populations peaked at 92.5% infested leaves in the control (Table 2). All treatments except those that rotated Rimon with either Coragen or Radiant significantly reduced populations below the control – it is noteworthy that applications of Provado to these treatments did not markedly reduce aphid populations. Based on cumulative thrips-days, The seasonal Rimon treatment was most effective in suppressing foliar populations of western flower thrips, followed by Voliam Xpress and the Rimon alternated with Radiant treatment (Table 3).

Weekly counts of thrips in flowers fluctuated from wk to wk, but were at their highest during the month of July. Treatments most effective in suppressing thrips in flowers were those sprayed with Voliam Xpress, Warrior, Voliam Flexi, and Radiant during this time period (Table 4). Fruit damage due to tomato fruitworm was very low in this trial, with the highest damage in the control recorded on the first harvest date (5.4% damaged fruit), and season average damage of only 2.3% (Table 5). All treatments provided high levels of control of this low fruitworm population. In contrast, stink bug damage was relatively high, with 13.6% damage in the control (Table 6). The only treatments that significantly reduced damage below the control was the Warrior and Voliam Xpress treatments. Thrips damage was relatively low with only 3.9% of fruit exhibiting thrips oviposition or feeding scars, and there were no significant differences among treatments (Table 7).

Table 1. Mean twospotted spider mite populations on tomatoes treated with various insecticides. Fletcher, NC 2008

Treatment	Rate/A	Applic. Date	Mites/leaflet 7/30	8/6	8/12	8/19	8/28	9/9	Cumul. mite-days
Synapse 24WG	2 oz	6/27, 7/3, 7/14, 8/1, 7/24, 8/8, 8/15, 9/1	0.1a	0.8a	0.9a	0.6a	2.4a	25.6ab	193.6abc
+ Induce	0.25%								
Movento 2SC	4 oz	8/8, 9/1							
Synapse 24WG	2 oz	6/27, 7/3, 7/14, 7/24, 8/1, 8/8, 8/15, 9/1	0.1a	0.5a	0.1a	1.2a	3.3ab	18.9a	161.7a
+ MSO	0.25%								
Movento 2SC	4 oz	8/8, 9/1							
Synapse 24WG	3 oz	6/27, 7/3, 7/14, 7/24, 8/1, 8/8, 8/15, 9/1	0.0a	0.8a	0.1a	1.1a	2.4a	20.7a	163.4ab
+Induce	0.25%								
Movento 2SC	4 oz	8/8, 9/1							
Synapse 24WG	3 oz	6/27, 7/3, 7/14, 7/24, 8/1, 8/8, 8/15, 9/1	0.2a	0.4a	0.3a	1.3a	2.1a	18.6a	148.6a
+ MSO	0.25%								
Movento 2SC	4 oz	8/8, 9/1							
Rimon 0.83EC	12 oz	7/3, 7/24, 8/8	0.0a	1.6a	2.1a	3.1a	5.5ab	42.2cd	359.0cd
Provado 1.6F	4 oz	8/8, 9/1							
Rimon 0.83EC	12 oz	6/27, 7/3, 7/14, 7/24, 8/1, 8/8, 8/15, 9/1	0.3a	1.9a	1.8a	6.1a	9.0bcd	54.2d	492.0d
Provado 1.6F	4 oz	8/8, 9/1							
Rimon 0.83EC	12 oz	6/27, 7/14, 8/1, 8/15	0.0a	0.0a	0.5a	0.7a	3.9ab	30.8abc	233.6abc
Coragen 1.67SC	5 oz	7/3, 7/24, 8/8, 9/1							
Provado 1.6F	4 oz	8/8, 9/1							
Rimon 0.83EC	12 oz	6/27, 7/14, 8/1, 8/15	1.7a	1.0a	0.7a	7.8a	13.2d	32.8abc	413.7d
Radiant 1SC	6 oz	7/3, 7/24, 8/8, 9/1							
Provado 1.6F	4 oz	8/8, 9/1							
Radiant 1SC	6 oz	6/27,	0.2a	0.9a	1.6a	4.0a	12.1cd	51.7d	485.7d
Voliam Xpress 150ZC	7 oz	7/3, 7/14, 8/1, 8/15							
Coragen 1.67SC	5 oz	7/24, 8/8, 9/1							
Radiant 1SC	6 oz	6/27, 7/3,	0.1a	0.5a	0.3a	1.6a	6.7abc	41.5bcd	337.4bcd
Voliam Flexi 40WG	4 oz	7/14, 8/1, 8/15							
Coragen 1.67SC	5 oz	7/24, 8/8, 9/1							
Dimethoate 4EC	1 pt	6/27	0.1a	0.5a	1.0a	4.5a	5.3ab	45.5cd	374.6cd
Warrior 1CS	3 oz	7/3, 7/14, 8/1, 7/24, 8/8, 8/15, 9/1							
Control			0.2a	1.0a	0.9a	2.2a	3.8ab	22.3a	203.1abc

Means in the same column followed by the same letter are not significantly different by LSD (p=0.05).

Table 2. Mean potato aphid infested leaves on tomatoes treated with various insecticides. Fletcher, NC 2008

			Percentage potato-aphid infested leaves						
Treatment	Rate/A	Applic. Date	7/25	7/30	8/6	8/12	8/19	8/28	9/9
Synapse 24WG + Induce Movento 2SC	2 oz 0.25% 4 oz	6/27, 7/3, 7/14, 8/1, 7/24, 8/8, 8/15, 9/1 8/8, 9/1	20.0a	32.5a	42.5c	45.0e	65.0cde	40.0bcd	52.5bc d
Synapse 24WG + MSO Movento 2SC	2 oz 0.25% 4 oz	6/27, 7/3, 7/14, 7/24, 8/1, 8/8, 8/15, 9/1 8/8, 9/1	5.0a	27.5a	37.5bc	37.5de	35.0abc	42.5cd	52.5bc d
Synapse 24WG +Induce Movento 2SC	3 oz 0.25% 4 oz	6/27, 7/3, 7/14, 7/24, 8/1, 8/8, 8/15, 9/1 8/8, 9/1	7.5a	22.5a	37.5bc	12.5abc	25.0ab	22.5abc	32.5ab c
Synapse 24WG + MSO Movento 2SC	3 oz 0.25% 4 oz	6/27, 7/3, 7/14, 7/24, 8/1, 8/8, 8/15, 9/1 8/8, 9/1	12.5a	2.5a	35.0bc	32.5cde	47.5bcde	32.5abc	25.0ab
Rimon 0.83EC Provado 1.6F	12 oz 4 oz	7/3, 7/24, 8/8 8/8, 9/1	2.5a	12.5a	30.0bc	17.5abcd	37.5abcd	27.5abc	17.5a
Rimon 0.83EC Provado 1.6F	12 oz 4 oz	6/27, 7/3, 7/14, 7/24, 8/1, 8/8, 8/15, 9/1 8/8, 9/1	12.5a	32.5a	40.0c	27.5bcde	47.5bcde	47.5cd	55.0cd
Rimon 0.83EC Coragen 1.67SC Provado 1.6F	12 oz 5 oz 4 oz	6/27, 7/14, 8/1, 8/15 7/3, 7/24 8/8, 9/1	25.0a	27.5a	42.5c	50.0e	70.0e	67.5de	90.0e
Rimon 0.83EC Radiant 1SC Provado 1.6F	12 oz 6 oz 4 oz	6/27, 7/14, 8/1, 8/15 7/3, 7/24 8/8, 9/1	7.5a	15.0a	20.0abc	10.0abc	37.5abcd	22.5abc	70.0de
Radiant 1SC Voliam Xpress 150ZC Coragen 1.67SC	6 oz 7 oz 5 oz	6/27, 7/3, 7/14, 8/1, 8/15 7/24, 8/8, 9/1	0.0a	10.0a	2.5a	2.5a	15.0a	12.5ab	17.5a
Radiant 1SC Voliam Flexi 40WG Coragen 1.67SC	6 oz 4 oz 5 oz	6/27, 7/3, 7/14, 8/1, 8/15 7/24, 8/8, 9/1	2.5a	5.0a	12.5ab	7.5ab	15.0a	32.5abc	12.5a
Dimethoate 4EC Warrior 1CS	1 pt 3 oz	6/27 7/3, 7/14, 8/1, 7/24, 8/8, 8/15, 9/1	0.0a	0.0a	12.5ab	2.5a	10.0a	5.0a	7.5a
Control			15.0a	17.5a	30.0bc	40.0de	67.5de	82.5e	92.5e

Means in the same column followed by the same letter are not significantly different by LSD (p=0.05)

Table 3. Mean western flower thrips populations on tomatoes treated with various insecticides. Fletcher, NC 2008

			Thrips per 10 leaflets										Cumul.
Treatment	Rate/A	Applic. Date	6/25	7/2	7/9	7/16	7/23	7/30	8/6	8/12	8/19	9/9	thrips-days
Synapse 24WG + Induce Movento 2SC	2 oz 0.25% 4 oz	6/27, 7/3, 7/14, 8/1, 7/24, 8/8, 8/15, 9/1 8/8, 9/1	1.3a	14.3a	0.0a	1.8a	0.5a	0.3a	1.3a	0.0a	0.8abc	7.5a	220.0bcde
Synapse 24WG + MSO Movento 2SC	2 oz 0.25% 4 oz	6/27, 7/3, 7/14, 7/24, 8/1, 8/8, 8/15, 9/1 8/8, 9/1	3.0a	5.0a	1.8a	6.8a	4.0a	2.3a	1.8a	1.5a	2.3e	2.0a	282.9de
Synapse 24WG +Induce Movento 2SC	3 oz 0.25% 4 oz	6/27, 7/3, 7/14, 7/24, 8/1, 8/8, 8/15, 9/1 8/8, 9/1	2.3a	4.5a	0.3a	0.8a	6.0a	1.8a	2.3a	3.3a	1.0bc	5.5a	290.6e
Synapse 24WG + MSO Movento 2SC	3 oz 0.25% 4 oz	6/27, 7/3, 7/14, 7/24, 8/1, 8/8, 8/15, 9/1 8/8, 9/1	11.5a	4.0a	0.8a	2.5a	2.0a	0.8a	0.0a	1.3a	0.3a	2.8a	259.5de
Rimon 0.83EC Provado 1.6F	12 oz 4 oz	7/3, 7/24, 8/8 8/8, 9/1	7.8a	3.0a	0.3a	0.8a	0.0a	1.0a	0.3a	0.5a	1.8de	1.0a	149.6abcd
Rimon 0.83EC Provado 1.6F	12 oz 4 oz	6/27, 7/3, 7/14, 7/24, 8/1, 8/8, 8/15, 9/1 8/8, 9/1	3.0a	1.8a	0.3a	0.0a	0.0a	0.0a	0.0a	0.0a	0.5ab	1.8a	56.6a
Rimon 0.83EC Coragen 1.67SC Provado 1.6F	12 oz 5 oz 4 oz	6/27, 7/14, 8/1, 8/15 7/3, 7/24, 8/8, 9/1 8/8, 9/1	11.0a	2.3a	0.3a	0.3a	0.0a	0.0a	0.0a	0.5a	0.5ab	6.3a	165.3abcde
Rimon 0.83EC Radiant 1SC Provado 1.6F	12 oz 6 oz 4 oz	6/27, 7/14, 8/1, 8/15 7/3, 7/24, 8/8, 9/1 8/8, 9/1	9.0a	0.8a	0.0a	0.0a	0.3a	0.8a	0.3a	0.0a	1.3cd	0.0a	119.5abc
Radiant 1SC Voliam Xpress 150ZC Coragen 1.67SC	6 oz 7 oz 5 oz	6/27, 7/3, 7/14, 8/1, 8/15 7/24, 8/8, 9/1	6.8a	1.3a	0.3a	0.0a	0.0a	1.0a	0.0a	0.0a	0.5ab	1.0a	117.4ab
Radiant 1SC Voliam Flexi 40WG Coragen 1.67SC	6 oz 4 oz 5 oz	6/27, 7/3, 7/14, 8/1, 8/15 7/24, 8/8, 9/1	6.0a	0.8a	0.3a	0.0a	0.3a	0.0a	0.0a	0.5a	1.8de	5.3a	161.1abcde
Dimethoate 4EC Warrior 1CS	1 pt 3 oz	6/27 7/3, 7/14, 8/1, 7/24, 8/8, 8/15, 9/1	3.8a	6.5a	0.5a	0.5a	1.3a	1.0a	0.5a	0.3a	8.3f	6.0a	256.9cde
Control			9.3a	3.5a	1.5a	0.0a	6.5a	0.8a	0.3a	2.3a	1.3cd	3.5a	263.3de

Means in the same column followed by the same letter are not significantly different by LSD (p=0.05).

Table 4. Mean thrips populations in tomato flowers on tomatoes treated with various insecticides. Fletcher, NC 2008

Treatment	Rate/A	Applic. Date	Thrips per 10 flowers 7/2	7/9	7/16	7/22	7/30	Season Total
Synapse 24WG	2 oz	6/27, 7/3, 7/14, 8/1, 7/24, 8/8, 8/15, 9/1	20.8a	20.5e	22.8bc	9.3c	18.5bcd	91.8defg
+ Induce	0.25%							
Movento 2SC	4 oz	8/8, 9/1						
Synapse 24WG	2 oz	6/27, 7/3, 7/14, 7/24, 8/1, 8/8, 8/15, 9/1	23.3a	20.8e	45.0d	7.0abc	17.3abcd	113.3g
+ MSO	0.25%							
Movento 2SC	4 oz	8/8, 9/1						
Synapse 24WG	3 oz	6/27, 7/3, 7/14, 7/24, 8/1, 8/8, 8/15, 9/1	14.5a	19.5e	19.5bc	15.0d	26.3d	94.8defg
+Induce	0.25%							
Movento 2SC	4 oz	8/8, 9/1						
Synapse 24WG	3 oz	6/27, 7/3, 7/14, 7/24, 8/1, 8/8, 8/15, 9/1	21.3a	17.3e	46.0d	9.3c	13.3abc	107.0fg
+ MSO	0.25%							
Movento 2SC	4 oz	8/8, 9/1						
Rimon 0.83EC	12 oz	7/3, 7/24, 8/8	14.3a	19.0e	24.3bc	7.8abc	15.3abcd	80.5cdef
Provado 1.6F	4 oz	8/8, 9/1						
Rimon 0.83EC	12 oz	6/27, 7/3, 7/14, 7/24, 8/1, 8/8, 8/15, 9/1	18.3a	16.5de	17.0ab	6.8abc	10.3ab	68.8bcde
Provado 1.6F	4 oz	8/8, 9/1						
Rimon 0.83EC	12 oz	6/27, 7/14, 8/1, 8/15	18.0a	13.5bcde	19.5bc	6.0abc	9.3ab	66.3bcd
Coragen 1.67SC	5 oz	7/3, 7/24, 8/8, 9/1						
Provado 1.6F	4 oz	8/8, 9/1						
Rimon 0.83EC	12 oz	6/27, 7/14, 8/1, 8/15	15.3a	7.3abc	21.3bc	6.5abc	7.3a	57.5abc
Radiant 1SC	6 oz	7/3, 7/24, 8/8, 9/1						
Provado 1.6F	4 oz	8/8, 9/1						
Radiant 1SC	6 oz	6/27,	15.5a	3.8a	2.0a	3.5a	9.5ab	34.3a
Voliam Xpress 150ZC	7 oz	7/3, 7/14, 8/1, 8/15						
Coragen 1.67SC	5 oz	7/24, 8/8, 9/1						
Radiant 1SC	6 oz	6/27, 7/3,	13.3a	8.5abcd	12.0ab	7.8abc	12.3ab	53.8abc
Voliam Flexi 40WG	4 oz	7/14, 8/1, 8/15						
Coragen 1.67SC	5 oz	7/24, 8/8, 9/1						
Dimethoate 4EC	1 pt	6/27	14.3a	6.0ab	9.3ab	4.3ab	11.8ab	45.5ab
Warrior 1CS	3 oz	7/3, 7/14, 8/1, 7/24, 8/8, 8/15, 9/1						
Control			14.3a	15.3cde	33.8cd	9.0bc	24.0cd	96.3efg

Means in the same column followed by the same letter are not significantly different by LSD (p=0.05).

Table 5. Mean lepidopterous damage to tomatoes treated with various insecticides. Fletcher, NC 2008.

Treatment	Rate/A	Applic. Date	Percent damaged fruit				
			8/6	8/21	9/4	9/18	Total
Synapse 24WG	2 oz	6/27, 7/3, 7/14, 8/1, 7/24, 8/8, 8/15, 9/1	0.4a	0.0a	1.5a	2.6a	1.0a
+ Induce	0.25%						
Movento 2SC	4 oz	8/8, 9/1					
Synapse 24WG	2 oz	6/27, 7/3, 7/14, 7/24, 8/1, 8/8, 8/15, 9/1	0.4a	0.2a	0.0a	1.9a	0.3a
+ MSO	0.25%						
Movento 2SC	4 oz	8/8, 9/1					
Synapse 24WG	3 oz	6/27, 7/3, 7/14, 7/24, 8/1, 8/8, 8/15, 9/1	0.3a	0.4a	0.9a	1.2a	0.8a
+Induce	0.25%						
Movento 2SC	4 oz	8/8, 9/1					
Synapse 24WG	3 oz	6/27, 7/3, 7/14, 7/24, 8/1, 8/8, 8/15, 9/1	0.0a	0.4a	0.2a	0.9a	0.3a
+ MSO	0.25%						
Movento 2SC	4 oz	8/8, 9/1					
Rimon 0.83EC	12 oz	7/3, 7/24, 8/8	2.1ab	1.1a	0.6a	1.0a	0.9a
Provado 1.6F	4 oz	8/8, 9/1					
Rimon 0.83EC	12 oz	6/27, 7/3, 7/14, 7/24, 8/1, 8/8, 8/15, 9/1	0.8ab	0.7a	0.4a	3.0a	0.8a
Provado 1.6F	4 oz	8/8, 9/1					
Rimon 0.83EC	12 oz	6/27, 7/14, 8/1, 8/15	0.6ab	0.2a	0.2a	1.0a	0.4a
Coragen 1.67SC	5 oz	7/3, 7/24, 8/8, 9/1					
Provado 1.6F	4 oz	8/8, 9/1					
Rimon 0.83EC	12 oz	6/27, 7/14, 8/1, 8/15	0.0a	0.2a	0.7a	1.7a	0.5a
Radiant 1SC	6 oz	7/3, 7/24, 8/8, 9/1					
Provado 1.6F	4 oz	8/8, 9/1					
Radiant 1SC	6 oz	6/27,	0.0a	0.0a	0.2a	1.9a	0.3a
Voliam Xpress 150ZC	7 oz	7/3, 7/14, 8/1, 8/15					
Coragen 1.67SC	5 oz	7/24, 8/8, 9/1					
Radiant 1SC	6 oz	6/27, 7/3,	0.5ab	0.0a	0.2a	0.8a	0.3a
Voliam Flexi 40WG	4 oz	7/14, 8/1, 8/15					
Coragen 1.67SC	5 oz	7/24, 8/8, 9/1					
Dimethoate 4EC	1 pt	6/27	2.7b	0.0a	0.2a	1.0a	0.9a
Warrior 1CS	3 oz	7/3, 7/14, 8/1, 7/24, 8/8, 8/15, 9/1					
Control			5.4c	0.9a	1.7a	3.9a	2.3b

Means in the same column followed by the same letter are not significantly different by LSD (p=0.05).

Table 6. Mean stinkbug damage to tomatoes treated with various insecticides. Fletcher, NC 2008.

			Percent damaged fruit				
Treatment	Rate/A	Applic. Date	8/6	8/21	9/4	9/18	Total
Synapse 24WG	2 oz	6/27, 7/3, 7/14, 8/1, 7/24, 8/8, 8/15, 9/1	4.1a	6.0a	20.1cdef	24.3abcd	13.0bc
+ Induce	0.25%						
Movento 2SC	4 oz	8/8, 9/1					
Synapse 24WG	2 oz	6/27, 7/3, 7/14, 7/24, 8/1, 8/8, 8/15, 9/1	6.2a	7.7a	11.6abc	30.1cde	12.5bc
+ MSO	0.25%						
Movento 2SC	4 oz	8/8, 9/1					
Synapse 24WG	3 oz	6/27, 7/3, 7/14, 7/24, 8/1, 8/8, 8/15, 9/1	5.5a	5.7a	28.1f	42.4e	21.7d
+Induce	0.25%						
Movento 2SC	4 oz	8/8, 9/1					
Synapse 24WG	3 oz	6/27, 7/3, 7/14, 7/24, 8/1, 8/8, 8/15, 9/1	5.3a	8.4a	19.5cdef	20.2abc	14.2c
+ MSO	0.25%						
Movento 2SC	4 oz	8/8, 9/1					
Rimon 0.83EC	12 oz	7/3, 7/24, 8/8	3.8a	9.2a	20.6def	17.1abc	14.1c
Provado 1.6F	4 oz	8/8, 9/1					
Rimon 0.83EC	12 oz	6/27, 7/3, 7/14, 7/24, 8/1, 8/8, 8/15, 9/1	5.0a	9.4a	14.4abcd	20.3abc	11.6bc
Provado 1.6F	4 oz	8/8, 9/1					
Rimon 0.83EC	12 oz	6/27, 7/14, 8/1, 8/15	5.8a	0.9a	19.0bcde	27.0bcde	12.9bc
Coragen 1.67SC	5 oz	7/3, 7/24, 8/8, 9/1					
Provado 1.6F	4 oz	8/8, 9/1					
Rimon 0.83EC	12 oz	6/27, 7/14, 8/1, 8/15	4.5a	3.3a	23.7ef	40.8de	14.8c
Radiant 1SC	6 oz	7/3, 7/24, 8/8, 9/1					
Provado 1.6F	4 oz	8/8, 9/1					
Radiant 1SC	6 oz	6/27,	7.4a	3.6a	10.4ab	11.3ab	7.4ab
Voliam Xpress 150ZC	7 oz	7/3, 7/14, 8/1, 8/15					
Coragen 1.67SC	5 oz	7/24, 8/8, 9/1					
Radiant 1SC	6 oz	6/27, 7/3,	7.1a	6.3a	17.0abcde	11.9a	11.4bc
Voliam Flexi 40WG	4 oz	7/14, 8/1, 8/15					
Coragen 1.67SC	5 oz	7/24, 8/8, 9/1					
Dimethoate 4EC	1 pt	6/27	2.4a	4.4a	9.3a	7.7a	5.5a
Warrior 1CS	3 oz	7/3, 7/14, 8/1, 7/24, 8/8, 8/15, 9/1					
Control			6.4a	10.9a	19.1bcde	9.7a	13.6c

Means in the same column followed by the same letter are not significantly different by LSD (p=0.05).

Table 7. Mean thrips damage to tomatoes treated with various insecticides. Fletcher, NC 2008.

Treatment	Rate/A	Applic. Date	Percent damaged fruit				
			8/6	8/21	9/4	9/18	Total
Synapse 24WG	2 oz	6/27, 7/3, 7/14, 8/1, 7/24, 8/8, 8/15, 9/1	6.1a	5.9a	3.2a	0.6a	4.1a
+ Induce	0.25%						
Movento 2SC	4 oz	8/8, 9/1					
Synapse 24WG	2 oz	6/27, 7/3, 7/14, 7/24, 8/1, 8/8, 8/15, 9/1	4.8a	8.0a	2.5a	1.2a	4.6a
+ MSO	0.25%						
Movento 2SC	4 oz	8/8, 9/1					
Synapse 24WG	3 oz	6/27, 7/3, 7/14, 7/24, 8/1, 8/8, 8/15, 9/1	4.1a	3.9a	3.5a	2.6a	3.5a
+Induce	0.25%						
Movento 2SC	4 oz	8/8, 9/1					
Synapse 24WG	3 oz	6/27, 7/3, 7/14, 7/24, 8/1, 8/8, 8/15, 9/1	4.9a	9.0a	0.9a	0.9a	3.9a
+ MSO	0.25%						
Movento 2SC	4 oz	8/8, 9/1					
Rimon 0.83EC	12 oz	7/3, 7/24, 8/8	5.7a	8.6a	2.3a	3.0a	4.5a
Provado 1.6F	4 oz	8/8, 9/1					
Rimon 0.83EC	12 oz	6/27, 7/3, 7/14, 7/24, 8/1, 8/8, 8/15, 9/1	6.2a	9.1a	2.2a	1.1a	4.9a
Provado 1.6F	4 oz	8/8, 9/1					
Rimon 0.83EC	12 oz	6/27, 7/14, 8/1, 8/15	7.7a	6.0a	2.7a	5.7a	5.0a
Coragen 1.67SC	5 oz	7/3, 7/24, 8/8, 9/1					
Provado 1.6F	4 oz	8/8, 9/1					
Rimon 0.83EC	12 oz	6/27, 7/14, 8/1, 8/15	4.8a	6.4a	3.6a	1.4a	4.2a
Radiant 1SC	6 oz	7/3, 7/24, 8/8, 9/1					
Provado 1.6F	4 oz	8/8, 9/1					
Radiant 1SC	6 oz	6/27,	4.1a	5.7a	2.1a	1.4a	3.5a
Voliam Xpress 150ZC	7 oz	7/3, 7/14, 8/1, 8/15					
Coragen 1.67SC	5 oz	7/24, 8/8, 9/1					
Radiant 1SC	6 oz	6/27, 7/3,	5.0a	7.4a	5.6a	2.4a	5.9a
Voliam Flexi 40WG	4 oz	7/14, 8/1, 8/15					
Coragen 1.67SC	5 oz	7/24, 8/8, 9/1					
Dimethoate 4EC	1 pt	6/27	5.5a	5.6a	1.7a	1.1a	3.9a
Warrior 1CS	3 oz	7/3, 7/14, 8/1, 7/24, 8/8, 8/15, 9/1					
Control			5.1a	7.3a	1.5a	2.3a	3.9a

Means in the same column followed by the same letter are not significantly different by LSD (p=0.05)

Tomato Chemigation Study – 2008

TOMATO, *Lycopersicon esculentum* Mill. 'Mountain Fresh Plus'

Potato aphid, *Macrosiphum euphorbiae* (Thomas)
Western flower thrips, *Frankliniella occidentalis* (Pergande)
Flower thrips, *Frankliniella tritici* (Fitch)
Tomato fruitworm, *Helicoverpa zea* (Boddie)
Stink bugs: *Euschistus servus* (Say) and *Acrosternum hilare* (Say)

The study was conducted at the Mountain Horticultural Crops Research Station in Mills River, NC. Five-wk-old 'Mountain Fresh Plus' tomato transplants were set on 2 June on black plastic mulch with drip irrigation. Plots consisted of single 25-ft long rows, with plants spaced 1.5 ft within rows and rows spaced 5 ft apart, and each treatment was replicated four times in a RCBD. Tomatoes were staked and strung as needed and sprayed with a standard fungicide program. No foliar insecticides were applied. Insecticides were injected into drip lines via a CO_2-powered injection system, and treatments and rates are listed in the tables. Potato aphid and foliar thrips populations were sampled at weekly intervals by recording the number of aphid-infested leaves per 10 leaves and the number of thrips per 10 leaflets. Vine-ripe fruit were harvested at 2-wk intervals from 31 July to 25 September, and the number of fruit, as well as the number damaged by lepidopterous insects, stinkbugs, and thrips, were recorded. All data were subjected to two-way ANOVA and means were separated by LSD (P = 0.05).

In general, foliar insect pest populations were of moderate intensity. Potato aphid populations were quite low until mid August, and by late August approximately 70% of plants were infested. Those treatments that included at least one application of the neonicotinoid immidacloprid (i.e., Admire) or thiamethoxam (i.e., Platinum and Voliam Durivo) provided the highest levels of aphid control (Table 1). The high rate (0.136 lb ai/A) of HGW86 was the only other treatment to significant reduce populations below the control. Foliar populations of western flower thrips reached their highest densities in late August, when counts in the control averaged 15.5 thrips per 10 leaflets (Table 2). However, the 9 September sample date was the only date that significant differences existed among treatments. Although none of the treatments significantly reduced counts below the control, the low rate of Coragen and the Admire did have counts significantly higher than the control. Counts were slightly elevated over the control, although not significantly, in all treatments that included a neonicotinoid insecticide. Populations of thrips infesting flowers in the control ranged from a low of 4.3/10 flowers 25 June to a high of 25/10 flowers on 8 July (Table 3). None of the treatments significantly affected flower populations of thrips. Fruit damage caused by lepidopterous larvae, principally tomato fruitworm, were low in this trial, with season average damage in the control only 4.1% (Table 4). Fruitworm damage was highest during early harvests in late July and early August, and declined as the season progressed to only about 2% damage in the control in September. With the exception of the Admire only treatment, all treatments significantly reduced damage below the control. All Coragen treatments, regardless of rate, were highly effective in suppressing fruitworm damage, as was Voliam Durivo, which also contains chlorantraniliprole, the same active ingredient in Coragen. Among the HGW86 treatments, damage in the higher rate treatments (0.088 and 0.134 lb ai/A) was lower during early harvests when fruitworm pressure was at its highest, but overall seasonal damage did not differ among the rates. Stinkbug damage was high in this trial, with 12.2% of fruit damage in the control (Table 5). None of the treatments significantly reduced damage below the control on any harvest date. However, overall damage was lower in those treatments that included wither Admire or Venom compared to all other treatments. The absence of significant differences in damage among these treatments is not surprising in that stink bugs were immigrating from surrounding vegetation, and rapid knockdown is through contact activity is usually required to kill these insects. Thrips damaged fruit was high on the first harvest date (31 July), when about 18% of fruit exhibited thrips feeding or oviposition scars, but declined to low levels thereafter (Table 6). There were no differences among treatments on any sample date, which reflects trends of thrips populations in flowers.

Table 1. Mean potato aphids on tomato foliage treated with various insecticides applied through the drip irrigation system. Fletcher, NC 2008

			% aphid-infested leaves					
Insecticide	Lb ai/A	Application date	7/30	8/6	8/12	8/19	8/28	9/9
HGW86 1.67SC	0.044	17 June, 1 July	2.5a	22.5bcd	17.5abcd	27.5bcde	45.0bcd	62.5cde
HGW86 1.67SC	0.066	17 June, 1 July	5.0a	27.5cde	25.0cde	37.5def	47.5cde	55.0cd
HGW86 1.67SC	0.088	17 June, 1 July	2.5a	17.5abcd	20.0bcde	32.5cdef	55.0def	55.0cd
HGW86 1.67SC	0.134	17 June, 1 July	10.0a	12.5abc	7.5abc	22.5abcd	25.0abc	37.5bc
Coragen 1.67SC	0.044	17 June, 1 July	7.5a	22.5bcd	27.5de	32.5cdef	60.0def	80.0de
Coragen 1.67SC	0.066	17 June, 1 July	15.0a	42.5e	60.0f	72.5g	75.0f	85.0e
Coragen 1.67SC	0.088	17 June	5.0a	12.5abc	20.0bcde	32.5cdef	52.5def	70.0de
Coragen 1.67SC + Platinum 2SL	0.066 0.078	17 June, 1 July 17 June	2.5a	7.5ab	2.5ab	10.0ab	12.5a	2.5a
Coragen 1.67SC + Admire Pro 4.6SC	0.066 0.25	17 June, 1 July 17 June	0.0a	0.0a	0.0a	2.5a	7.5a	2.5a
Admire Pro 4.6SC	0.25	17 June, 1 July	0.0a	7.5ab	2.5ab	15.0abc	22.5ab	2.5a
Venom 20SG	0.25	17 June, 1 July	20.0a	32.5de	37.5e	47.5ef	55.0def	82.5de
Coragen 1.67SC + AdmirePro Venom 20SG	0.066 0.25 0.25	17 June, 1 July 17 June 15 July	5.0a	2.5a	7.5abc	17.5abcd	10.0a	5.0a
Voliam Durivo	12.0 oz (form.)	17 June	5.0a	10.0abc	0.0a	10.0ab	22.5ab	12.5ab
Control	–	–	12.5a	15.0abcd	15.0abcd	50.0f	70.0ef	62.5cde

Means in the same column followed by the same letter are not significantly different by LSD (p=0.05).

Table 2. Mean western flower thrips on tomato foliage treated with various insecticides applied through the drip irrigation system. Fletcher, NC 2008

			Thrips per 10 leaflets					
Insecticide	Lb ai/A	Application date	7/30	8/6	8/12	8/19	8/28	9/9
HGW86 1.67SC	0.044	17 June, 1 July	1.8a	7.0a	2.5a	11.5a	12.8a	11.3a
HGW86 1.67SC	0.066	17 June, 1 July	3.5a	2.5a	12.5a	3.8a	9.3a	6.0a
HGW86 1.67SC	0.088	17 June, 1 July	0.8a	5.3a	1.8a	7.0a	6.8a	4.0a
HGW86 1.67SC	0.134	17 June, 1 July	0.5a	5.3a	0.5a	5.0a	9.8a	16.5abc
Coragen 1.67SC	0.044	17 June, 1 July	2.8a	4.3a	4.5a	3.8a	10.3a	34.3bc
Coragen 1.67SC	0.066	17 June, 1 July	1.3a	2.0a	2.3a	5.0a	3.3a	10.8a
Coragen 1.67SC	0.088	17 June	7.8a	5.3a	8.0a	10.5a	16.0a	7.8a
Coragen 1.67SC + Platinum 2SL	0.066 0.078	17 June, 1 July 17 June	4.3a	6.5a	6.0a	5.8a	14.8a	18.0abc
Coragen 1.67SC + Admire Pro 4.6SC	0.066 0.25	17 June, 1 July 17 June	8.8a	1.3a	5.3a	5.8a	11.5a	20.3abc
Admire Pro 4.6SC	0.25	17 June, 1 July	9.5a	4.8a	8.0a	8.0a	17.3a	35.0c
Venom 20SG	0.25	17 June, 1 July	2.0a	6.3a	20.0a	9.3a	12.3a	16.0ab
Coragen 1.67SC + AdmirePro Venom 20SG	0.066 0.25 0.25	17 June, 1 July 17 June 15 July	6.5a	5.0a	3.8a	10.3a	19.8a	13.8a
Voliam Durivo	12.0 oz (form.)	17 June	2.5a	4.0a	8.0a	4.3a	11.3a	13.5a
Control	–	–	6.0a	3.8a	2.8a	11.5a	15.5a	7.3a

Means in the same column followed by the same letter are not significantly different by LSD (p=0.05).

Table 3. Mean number of thrips (mixture of western flower thrips, flower thrips, and tobacco thrips) infesting flowers of tomatoes treated with various insecticides applied through the drip irrigation system. Fletcher, NC 2008

			Thrips per 10 flowers					
Insecticide	Lb ai/A	Application date	6/25	7/2	7/8	7/16	7/22	7/30
HGW86 1.67SC	0.044	17 June, 1 July	16.0	17.8	29.8	20.0	13.0	11.0
HGW86 1.67SC	0.066	17 June, 1 July	8.5	20.0	15.5	14.3	15.0	13.5
HGW86 1.67SC	0.088	17 June, 1 July	8.3	12.3	19.3	10.8	12.3	12.3
HGW86 1.67SC	0.134	17 June, 1 July	4.5	13.5	22.3	16.0	11.3	11.5
Coragen 1.67SC	0.044	17 June, 1 July	9.3	25.3	19.0	12.5	14.0	14.8
Coragen 1.67SC	0.066	17 June, 1 July	5.8	11.0	29.5	11.0	13.5	12.8
Coragen 1.67SC	0.088	17 June	8.8	19.0	27.3	16.5	13.8	19.0
Coragen 1.67SC + Platinum 2SL	0.066 0.078	17 June, 1 July 17 June	4.8	13.5	21.3	12.0	9.8	17.3
Coragen 1.67SC + Admire Pro 4.6SC	0.066 0.25	17 June, 1 July 17 June	9.5	23.0	23.5	17.8	10.8	20.3
Admire Pro 4.6SC	0.25	17 June, 1 July	8.0	8.3	23.8	14.5	10.3	11.8
Venom 20SG	0.25	17 June, 1 July	3.8	15.0	23.0	15.0	13.8	11.3
Coragen 1.67SC + AdmirePro Venom 20SG	0.066 0.25 0.25	17 June, 1 July 17 June 15 July	4.0	11.0	29.0	10.3	13.0	16.8
Voliam Durivo	12.0 oz (form.)	17 June	6.5	17.5	21.8	15.0	15.5	10.8
Control	–	–	4.3	18.3	25.0	14.0	9.5	11.8

Means in the same column followed by different letters are significantly different by LSD ($p=0.05$).

Table 4. Mean tomato fruitworm damage to tomatoes treated with various insecticides applied through the drip irrigation system. Fletcher, NC 2008

			Percentage damage per harvest date					
Insecticide	Lb ai/A	Application date	7/31	8/14	8/28	9/11	9/25	Total
HGW86 1.67SC	0.044	17 June, 1 July	1.4a	3.8ab	2.4ab	1.1abc	1.6a	1.8cd
HGW86 1.67SC	0.066	17 June, 1 July	1.0a	1.6ab	2.8abc	1.0abc	0.0a	1.4bc
HGW86 1.67SC	0.088	17 June, 1 July	1.1a	0.7a	2.8abc	0.2a	0.6a	1.0abc
HGW86 1.67SC	0.134	17 June, 1 July	0.8a	2.0ab	0.3a	0.7a	0.0a	0.8abc
Coragen 1.67SC	0.044	17 June, 1 July	0.4a	2.0ab	0.3a	0.4a	0.0a	0.4ab
Coragen 1.67SC	0.066	17 June, 1 July	0.4a	0.0a	0.0a	0.2a	1.8a	0.2a
Coragen 1.67SC	0.088	17 June	2.6a	0.9ab	0.6a	0.8ab	3.1a	1.2abc
Coragen 1.67SC + Platinum 2SL	0.066 0.078	17 June, 1 July 17 June	0.8a	0.0a	0.3a	0.4a	3.6a	0.5ab
Coragen 1.67SC + Admire Pro 4.6SC	0.066 0.25	17 June, 1 July 17 June	0.4a	0.5a	0.0a	0.6a	2.4a	0.5ab
Admire Pro 4.6SC	0.25	17 June, 1 July	3.6ab	4.9b	5.3c	2.1c	9.3a	3.6ef
Venom 20SG	0.25	17 June, 1 July	3.2ab	2.1ab	5.0bc	2.0bc	1.7a	2.8de
Coragen 1.67SC + AdmirePro Venom 20SG	0.066 0.25 0.25	17 June, 1 July 17 June 15 July	0.3a	0.0a	0.0a	0.6a	0.8a	0.4ab
Voliam Durivo	12.0 oz (form.)	17 June	2.1a	1.3ab	0.9a	0.9abc	0.0a	1.1abc
Control	–	–	6.5b	9.7c	4.8bc	2.1c	1.9a	4.1f

Means in the same column followed by the same letter are not significantly different by LSD (p=0.05).

Table 5. Mean stinkbug damage to tomatoes treated with various insecticides applied through the drip irrigation system. Fletcher, NC 2008

			Percentage damage per harvest date					
Insecticide	Rate/A	Application date	7/31	8/14	8/28	9/11	9/25	Total
HGW86 1.67SC	0.044	17 June, 1 July	3.4a	3.6abc	8.0ab	20.8a	24.2a	12.7a
HGW86 1.67SC	0.066	17 June, 1 July	4.7a	14.2d	6.7ab	21.4a	3.6a	12.7a
HGW86 1.67SC	0.088	17 June, 1 July	3.8a	9.2bcd	8.8ab	19.1a	28.0a	12.9a
HGW86 1.67SC	0.134	17 June, 1 July	5.3a	7.2abc	7.4ab	24.8a	28.3a	15.9a
Coragen 1.67SC	0.044	17 June, 1 July	3.5a	7.2abc	8.9ab	14.5a	37.8a	11.6a
Coragen 1.67SC	0.066		3.6a	5.0abc	3.7ab	19.6a	47.2a	13.5a
Coragen 1.67SC	0.088	17 June	4.7a	4.9abc	7.1ab	11.7a	14.6a	9.0a
Coragen 1.67SC + Platinum 2SL	0.066 0.078	17 June, 1 July 17 June	3.6a	9.8cd	8.1ab	16.1a	24.7a	12.4a
Coragen 1.67SC + Admire Pro 4.6SC	0.066 0.25	117 June, 1 July 17 June	4.9a	2.8ab	3.2a	17.5a	12.3a	9.9a
Admire Pro 4.6SC	0.25	17 June, 1 July	1.1a	3.4abc	3.2a	14.3a	14.2a	8.2a
Venom 20SG	0.25	17 June, 1 July	3.7a	1.0a	5.8ab	7.1a	13.3a	6.0a
Coragen 1.67SC + AdmirePro Venom 20SG	0.066 0.25 0.25	17 June, 1 July 17 June 15 July	5.2a	5.8abc	6.0ab	15.1a	23.3a	11.1a
Voliam Durivo	12.0 oz (form.)	17 June	7.4a	4.1abc	9.8b	18.4a	40.8a	14.1a
Control	–	–	3.8a	4.5abc	8.3ab	19.1a	13.2a	12.2a

Means in the same column followed by the same letter are not significantly different by LSD (p=0.05).

Table 6. Mean thrips damage to tomatoes treated with various insecticides applied through the drip irrigation system. Fletcher, NC 2008

			Percentage damage per harvest date					
Insecticide	Rate/A	Application date	7/31	8/14	8/28	9/11	9/25	Total
HGW86 1.67SC	0.044	17 June, 1 July	8.6a	1.9a	1.9a	0.6a	1.2a	2.6a
HGW86 1.67SC	0.066	17 June, 1 July	10.5a	1.9a	1.9a	2.4a	1.3a	3.6a
HGW86 1.67SC	0.088	17 June, 1 July	4.7a	3.3a	2.6a	0.7a	0.0a	2.0a
HGW86 1.67SC	0.134	17 June, 1 July	9.4a	4.6a	1.6a	0.7a	0.3a	2.7a
Coragen 1.67SC	0.044	17 June, 1 July	6.7a	0.6a	2.2a	0.2a	2.6a	2.0a
Coragen 1.67SC	0.066		7.6a	1.9a	3.4a	0.6a	1.5a	2.2a
Coragen 1.67SC	0.088	17 June	12.1a	3.3a	2.0a	0.5a	2.3a	3.4a
Coragen 1.67SC + Platinum 2SL	0.066 0.078	17 June, 1 July 17 June	9.2a	3.8a	2.0a	0.3a	3.0a	2.8a
Coragen 1.67SC + Admire Pro 4.6SC	0.066 0.25	117 June, 1 July 17 June	3.5a	3.5a	0.5a	1.0a	3.4a	1.8a
Admire Pro 4.6SC	0.25	17 June, 1 July	9.0a	3.9a	1.9a	0.6a	0.0a	2.4a
Venom 20SG	0.25	17 June, 1 July	5.5a	6.0a	3.1a	1.0a	0.0a	2.5a
Coragen 1.67SC + AdmirePro Venom 20SG	0.066 0.25 0.25	17 June, 1 July 17 June 15 July	7.4a	4.3a	2.6a	1.0a	4.2a	2.7a
Voliam Durivo	12.0 oz (form.)	17 June	9.0a	1.3a	2.1a	0.6a	1.4a	2.3a
Control	–	–	18.6a	1.8a	1.6a	1.0a	5.8a	3.2a

Means in the same column followed by the same letter are not significantly different by LSD (p=0.05).

Pepper Chemigation Study – 2008

PEPPER, *Capsicum annuum* 'Aristotle X3R'

Green peach aphid, *Myzus persicae* (Sulzer)
Western flower thrips, *Frankliniella occidentalis* (Pergande)
Flower thrips, *Frankliniella tritici* (Fitch)
Insidious flower bug, *Orius insidiosus* (Say)
Tomato fruitworm, *Helicoverpa zea* (Boddie)
European corn borer, *Ostrinia numilalis* (Hübner)

The study was conducted at the Mountain Horticultural Crops Research Station in Mills River, NC. 6-wk-old 'Aristotle X3R' pepper transplants were set on 3 June on black plastic mulch with drip irrigation. Plots consisted of single 25-ft long rows, and treatment rows were planted on 5-ft centers. Each 25-ft long plot was planted with double rows of peppers spaced 1.5 ft apart within rows and rows were separated by 1 ft. Each treatment was replicated four times and arranged in a RCBD. Peppers were staked and strung as needed and sprayed with a standard fungicide program. For soil applied insecticide treatments, insecticides were injected into drip lines via a CO_2-powered injection system. Only one treatment received insecticides via foliar sprays, and these were applied with a backpack sprayer delivering 50 GPA. Green peach aphid populations were sampled at weekly intervals by recording the number of aphids observed on 20 mid- to lower-plant leaves (sample size was reduced to 10 leaves on the final three dates). Thrips and insidious flower bugs were monitored by removing 10 flowers per plot, placing them in a vial of 50% ETOH, and counting dislodged insects under a stereomicroscope. Mature fruit was harvested at 2-wk intervals from 28 Jul until 23 Sep. The number of fruit, as well as the number damaged by tomato fruitworm, European corn borer, and stinkbug, were recorded. All data were subjected to two-way ANOVA and means were separated by LSD ($P = 0.05$).

Overall, insect pressure was very low in this trial. Green peach aphid populations began to build in mid August, but counts remained low the remainder of the season (Table 1). Aphid counts in insecticide treatments were not significantly reduced below the control, although season total cumulative aphid-days were numerically lowest in the drip-applied Admire/Coragen and high rate of HGW86 (0.134 lb AI/A). Populations of thrips in flowers (predominately western flower thrips) were relatively low and peaked on 23 July, when counts ranged from a low of about 1 per flower in the Admire/Coragen treatment to a high of 2.7 per flower in the 0.066 rate of HGW86, but these differences were not significant (Table 2). Thrips numbers did differ significantly on 1 and 7 August, but there were no clear trends in terms of treatment effects. Populations of the thrips predator insidious flower bug were also low, with the highest numbers (2.5 per 10 flowers) observed in the control 1 August, but there were no differences among treatments (Table 3). Direct damage to fruit was very low, with a total of only 5% of non-treated fruit damage by all insects (Table 4). The only insect that resulted in significant differences in fruit damage was European corn borer, but damage in the control was only 1.5%.

Table 1. Mean potato aphids on pepper foliage treated with various insecticides applied through the drip irrigation system (D) or foliar application (F). Mills River, NC. 2008.

Insecticide	Applic. method	Lb ai/A	Application date	aphids/leaf					Cumulative aphid-days
				8/6	8/12	8/19	8/28	9/4	
Control	—	—	—	0.0a	0.1a	1.1a	1.8ab	0.2a	24.9abc
HGW86 20SC	D	0.044	6/24, 7/8	0.1a	0.3b	1.8a	4.3bc	0.0a	51.9cde
HGW86 20SC	D	0.066	6/24, 7/8	0.0a	0.1a	1.2a	3.0abc	0.2a	36.6bcd
HGW86 20SC	D	0.088	6/24, 7/8	0.0a	0.1a	1.1a	2.3ab	0.4a	29.9abc
HGW86 20SC	D	0.134	6/24, 7/8	0.0a	0.1a	0.4a	1.5a	0.1a	16.0ab
Coragen 1.67SC	D	0.066	6/24, 7/8	0.1a	0.1a	1.3a	4.3bc	0.3a	47.2ab
Vydate 2L	D	0.75	6/24, 7/8	0.1a	0.2a	1.9a	5.9c	0.2a	65.0cde
Venom 20SG	D	0.25	6/24, 7/8	0.0a	0.1a	0.9a	2.0ab	0.1a	24.1abc
AdmirePro 4.6 Coragen 1.67SC	D D	0.36 0.066	6/24, 7/8	0.0a	0.0a	0.0a	0.2a	0.0a	2.5a
Radiant Coragen 1.67SC Provado 1.6F Actara 25WDG	F F F F	0.047 0.066 0.05 0.05	6/24,7/3,7/15, 8/4, 8/22 7/25, 8/15 8/15 8/22	0.3b	0.3b	2.8a	4.3bc	0.6a	66.2e

Means in the same column followed by different letters are significantly different by LSD (p=0.05).

Table 2. Mean western flower thrips in pepper flowers treated with various insecticides applied through the drip irrigation system (D) or foliar application (F). Mills River, NC. 2008.

				Thirps per 10 flowers							
Insecticide	Applic. method	Lb a.i./A	Applic. dates	7/2	7/8	7/17	7/23	8/1	8/7	8/12	Season Total
Control	—	—	—	1.5a	3.0a	6.0a	17.0a	7.5abc	6.3bcd	7.5a	48.8a
HGW86 20SC	D	0.044	6/24, 7/8	3.8a	3.8a	4.3a	18.3a	13.3cd	8.0cd	7.0a	58.3a
HGW86 20SC	D	0.066	6/24, 7/8	4.0a	4.3a	8.3a	27.3a	9.0abc	3.8ab	6.3a	62.8a
HGW86 20SC	D	0.088	6/24, 7/8	4.3a	3.5a	4.5a	20.0a	7.0abc	2.8a	11.5a	53.5a
HGW86 20SC	D	0.134	6/24, 7/8	4.5a	4.8a	6.0a	18.8a	11.5bcd	4.0ab	7.8a	57.3a
Coragen 1.67SC	D	0.066	6/24, 7/8	1.8a	3.8a	4.3a	18.3a	6.5ab	5.8abcd	4.0a	44.3a
Vydate 2L	D	0.75	6/24, 7/8	3.5a	4.0a	7.5a	19.0a	3.0a	5.0abc	10.3a	52.3a
Venom 20SG	D	0.25	6/24, 7/8	3.8a	8.5a	8.8a	23.0a	6.8abc	8.5d	8.0a	67.3a
AdmirePro 4.6SC Coragen 1.67SC	D D	0.36 0.066	6/24, 7/8	2.3a	8.0a	5.5a	11.8a	15.8d	4.8abc	8.5a	56.5a
Radiant Coragen 1.67SC Provado 1.6F Actara 25WDG	F F F F	0.047 0.066 0.05 0.05	6/24,7/3,7/15, 8/4, 8/22 7/25, 8/15 8/15 8/22	2.8a	5.0a	6.0a	12.5a	15.8d	3.5ab	8.0a	53.5a

* D = drip application; F = foliar application
Means in the same column followed by different letters are significantly different by LSD (p=0.05).

Table 3. Mean insidious flower bugs in pepper flowers treated with various insecticides applied through the drip irrigation system (D) or foliar application (F). Mills River, NC. 2008.

Insecticide	Applic. method	Lb a.i./A	Applic. dates	Bugs per 10 flowers 7/17	7/23	8/1	8/12
Control	—	—	—	0.8	1.3	2.5	1.0
HGW86 20SC	D	0.044	6/24, 7/8	1.0	0.5	2.0	1.5
HGW86 20SC	D	0.066	6/24, 7/8	0.8	0.8	1.0	1.3
HGW86 20SC	D	0.088	6/24, 7/8	0.5	1.8	1.0	0.8
HGW86 20SC	D	0.134	6/24, 7/8	1.3	1.3	1.8	1.3
Coragen 1.67SC	D	0.066	6/24, 7/8	1.0	1.0	1.8	1.5
Vydate 2L	D	0.75	6/24, 7/8	0.5	1.5	1.8	2.5
Venom 20SG	D	0.25	6/24, 7/8	0.5	1.3	2.0	2.8
AdmirePro 4.6SC Coragen 1.67SC	D D	0.36 0.066	6/24, 7/8	0.8	2.3	1.5	2.0
Radiant Coragen 1.67SC Provado 1.6F Actara 25WDG	F F F F	0.047 0.066 0.05 0.05	6/24,7/3,7/15, 8/4, 8/22 7/25, 8/15 8/15 8/22	0.5	1.3	2.3	2.3

Means in the same column followed by different letters are significantly different by LSD (p=0.05).

Table 4. Mean season total damage caused by tomato fruitworm, European corn bore and stink bugs on peppers treated with various insecticides applied through the drip irrigation system (D) or foliar application (F). Mills River, NC. 2008.

Insecticide	Applic. method	Lb a.i./A	Applic. dates	Percent fruit damage: Fruitworm	European corn borer	Stink bug	Total
Control	—	—	—	1.3	1.5cd	2.1	5.0a
HGW86 20SC	D	0.044	6/24, 7/8	1.0	1.3bcd	2.0	4.4a
HGW86 20SC	D	0.066	6/24, 7/8	1.1	0.9abc	2.2	4.2a
HGW86 20SC	D	0.088	6/24, 7/8	0.6	1.0abc	2.0	3.7a
HGW86 20SC	D	0.134	6/24, 7/8	0.8	1.2abcd	0.9	2.8a
Coragen 1.67SC	D	0.066	6/24, 7/8	0.7	0.6ab	1.8	3.1a
Vydate 2L	D	0.75	6/24, 7/8	0.8	0.9abc	1.6	3.3a
Venom 20SG	D	0.25	6/24, 7/8	0.5	1.9d	0.7	3.1a
AdmirePro 4.6SC Coragen 1.67SC	D D	0.36 0.066	6/24, 7/8	0.5	1.1abgcd	2.6	4.3a
Radiant Coragen 1.67SC Provado 1.6F Actara 25WDG	F F F F	0.047 0.066 0.05 0.05	6/24,7/3,7/15, 8/4, 8/22 7/25, 8/15 8/15 8/22	0.8	0.4a	1.1	2.4a

Means in the same column followed by different letters are significantly different by LSD (p=0.05).

Twospotted Spider Mite Control on Tomatoes – 2008

TOMATO: *Lycoperiscon esculentum* Miller 'Crista'

Two-spotted spider mite (TSSM): *Tetranychus urticae* (Koch)
Western flower thrips (WFT): *Frankliniella occidentalis* (Pergande)

Five-wk-old 'Crista' tomato transplants were set on black plastic mulch on 5 June in single-row, 20-ft long plots. Plants were set 1.5 ft apart within rows, and rows were on 10-ft centers. Each treatment was replicated four times in a RCBD. Plants were supplied water via drip irrigation as needed, and plants were staked and strung as needed during the season. One wk before field planting, transplants were infested with TSSM from a laboratory colony maintained on bush beans. To encourage mite populations to build up in tomato plots, all treatments including control were sprayed weekly during the first three weeks after planting with Sevin XLR (1 qt/acre). Treatments consisted of weekly interval applications of QRD-416 at 2 or 3 qt/acre, QRD-416 applied weekly but supplemented with an application of Agri-Mek 0.15EC (10 fl oz/acre), and applications of Acramite 50WS (16 oz/acre), Acramite 4SC (16 fl oz/acre), Oberon 2SC (8 fl oz/acre), Agri-Mek 0.15EC (10 fl oz/acre), and a non-treated control. QRD-416 applications were applied preventively on 27 June, 3, 10, 17, and 22 July, 1 and 5 August, and 2 September. All other treatments were applied as curative applications on 22 Jul and 5 August. All applications were applied with a tractor-mounted boom sprayer delivering 114 GPA through 7 hollow-cone nozzles (3 per side and 1 overhead). In addition, all treatments were treated with drip irrigation applications of Coragen 1.67SC (3.5 oz/acre) and Admire Pro 4.6 (10 oz/acre) on 26 June, and Coragen (3.5 oz/acre) alone on 10 July. TSSM populations were monitored by observing 10 terminal leaflets (from the most recently expanded leaf) per plot and recording the number of motile TSSM. To assess the population age structure of mite populations on tomato treatments, 10 leaflets per plot were also returned to the laboratory, a single 1.8-cm diameter disk punched from each leaflet, and the number of TSSM adults, immatures and eggs counted under a stereomicroscope. WFT populations were monitored both on foliage and in flowers; on foliage, immatures were counted on 10 leaflets per plot (from a mid-plant leaf), and in flowers, 10 flowers were removed and placed in 50% ETOH to dislodge thrips, which were then counted under a stereomicroscope. Season total cumulative TSSM days and WFT days were calculated by multiplying the mean population of two successive sample dates by the sampling interval (days), and cumulating mite and thrips days for successive sample dates. All data were subjected to two-way ANOVA and means were separated by LSD ($P = 0.05$).

TSSM populations remained low through June and early July, and began to increase in mid July. Populations peaked in mid to late August, when counts in the control averaged about 100 mites per leaflet. On 21 July, the sample date before the first application of curative treatments, mites averaged about 7 per leaflet in the control. Preventive, weekly applications of QRD-416 before this time did not suppress mite densities compared with the control (Table 1). On 24 July, 3 days after application of all treatments, mite densities were significantly reduced below the control all treatments except those preventively sprayed with QRD-416. By 4 Aug, 13 days after the 22 July application, mite populations increased to >8 mites per leaflet (our provisional economic threshold level) in all treatments, with the two Acramite treatments and the Agri-Mek + QRD-416 treatments the only ones with densities significantly lower than the control. Because of these high densities, a second application of treatments was applied on 5 August, and none of the treatments were highly effective in suppressing populations at this time. Leaf-disk counts of TSSM were highly variable, although the trends of number of eggs and immatures followed field visor lens counts (Table 2). It is noteworthy that while field counts indicated that QRD-416 did not suppress mite populations, they did significantly reduce egg densities below the control on 4 and 11 August. Thrips populations were of low to moderate intensity, and none of the treatments significantly reduced flower or foliar populations of thrips below the control (Table 3).

Table 1. Mean twospotted spider mite counts on tomatoes treated with different acaracides. Mills River, NC. 2008

Treatment[1]	Rate/A	Mites per leaflet										Cummul
		7/16	7/21	7/24	7/29	8/4	8/11	8/18	8/27	9/4	9/10	mite-days
QRD 416	2 qt	2.7	5.5	8.4	9.5bc	37.6bcd	13.4bc	42.5ab	60.7	29.7	39.1	1632.9cd
QRD 416	3 qt	2.1	10.6	5.1	6.1abc	57.2d	17.3c	89.7bc	43.7	42.9	45.4	2119.6de
QRD 416 Agri-Mek 0.15EC	3 qt 10 fl oz	0.5	1.9	1.6	1.8a	9.5a	6.4a	29.8a	30.4	26.5	56.8	983.7ab
Acramite 50WS	16 oz	1.9	6.8	5.6	3.6a	14.6ab	10.5ab	22.9a	30.8	30.1	51.4	1051.4ab
Acramite 4SC	16 fl oz	1.2	4.0	2.6	2.8a	11.0a	6.5a	22.6a	21.0	26.6	38.6	821.7a
Oberon 2SC	8 fl oz	2.7	6.6	5.1	4.1ab	20.9abc	10.5ab	30.9a	35.1	35.1	42.3	1202.9bc
Agri-Mek 0.15EC	10 fl oz	1.9	9.7	6.1	4.0ab	21.7abc	10.7ab	51.5abc	22.9	30.3	42.2	1249.9b
Control	—	2.3	6.7	11.2	10.8c	42.0cd	8.1ab	99.9c	99.9	29.9	35.3	2429.0e

Means within columns followed by different letters are significantly different by LSD (P = 0.05). In those columns with no letters, ANOVA were not significant.

[1]QRD-416 applications were made on 27 June, 3, 10, 17, and 22 July, 1 and 5 August, and 2 September. All other treatments were applied on 22 July and 5 August.

Table 2. Mean number of twospotted spider mite adults, immatures and eggs per 2-cm diameter leaf disk removed from leaflets of tomatoes treated with various acaricides. Mills River, NC. 2008

		7/21			7/24			7/29			8/4		
Treatment	Rate/A	Aldt	Immat	Eggs	Aldt	Immat	Eggs	Aldt	Immat	Eggs	Aldt	Immat	Eggs
QRD 416	2 qt	1.0	3.6	10.7	1.4	5.5	30.8	1.8	10.3	15.8ab	5.8	10.9bc	44.2cd
QRD 416	3 qt	1.4	2.6	9.5	1.4	3.7	21.2	1.8	9.2	12.7ab	5.1	5.5abc	58.4d
QRD 416 Agri-Mek 0.15EC	3 qt 10 fl oz	0.4	0.1	2.3	0.2	4.8	5.1	0.1	1.8	1.6a	1.7	0.9a	4.6a
Acramite 50WS	16 oz	1.2	3.3	7.2	1.0	12.8	18.7	0.5	6.3	7.4ab	2.4	1.4a	21.2ab
Acramite 4SC	16 fl oz	0.5	1.1	5.2	0.5	1.3	8.4	0.5	3.3	7.9ab	1.8	2.0a	12.9ab
Oberon 2SC	8 fl oz	1.6	2.3	11.8	0.5	2.6	14.5	0.4	2.7	8.3ab	2.6	3.5ab	30.8bc
Agri-Mek 0.15EC	10 fl oz	2.5	4.5	21.4	1.2	4.0	28.4	1.0	9.5	6.2ab	3.5	3.9ab	15.6ab
Control	—	1.6	2.5	17.0	1.8	4.4	24.6	2.2	7.5	23.1b	4.8	15.6c	77.6e

Means within columns followed by different letters are not significantly different by LSD (P = 0.05). In those columns with no letters, ANOVA were not significant.

[1]QRD-416 applications were made on 27 June, 3, 10, 17, and 22 July, 1 and 5 August, and 2 September. All other treatments were applied on 22 July and 5 August.

Table 2. Continued.

Treatment	Rate/A	8/11 Aldt	8/11 Immat	8/11 Eggs	8/18 Aldt	8/18 Immat	8/18 Eggs	8/27 Aldt	8/27 Immat	8/27 Eggs
QRD 416	2 qt	4.4	12.9ab	16.6a	1.3	18.6ab	34.7b	4.2	15.7bc	6.1
QRD 416	3 qt	4.8	17.3bc	18.6a	1.9	19.3ab	58.8b	2.1	19.8c	18.1
QRD 416 Agri-Mek 0.15EC	3 qt 10 fl oz	1.6	4.4a	5.8a	2.8	2.8a	8.5a	1.5	3.8a	6.8
Acramite 50WS	16 oz	2.8	6.1a	16.9a	2.6	3.6a	9.6a	2.6	10.5ab	14.0
Acramite 4SC	16 fl oz	1.8	5.6a	6.9a	0.2	5.2a	20.2a	1.3	4.3a	6.6
Oberon 2SC	8 fl oz	3.6	5.4a	18.2a	1.8	10.1a	30.3b	1.6	6.7a	6.4
Agri-Mek 0.15EC	10 fl oz	2.0	9.6ab	11.6a	1.7	14.0a	11.0a	1.6	12.4abc	8.3
Control	—	2.8	26.0c	39.0b	5.1	35.8b	10.6a	7.4	11.0abc	6.3

Means within columns followed by different letters are not significantly different by LSD (P = 0.05). In those columns with no letters, ANOVA were not significant.

[1]QRD-416 applications were made on 27 June, 3, 10, 17, and 22 July, 1 and 5 August, and 2 September. All other treatments were applied on 22 July and 5 August.

Table 3. Mean thrips populations in tomato flowers, and on foliage treated with various acaricides. CTD is cumulative thrips days on foliage.
Mills River, NC. 2008

		Thrips per 10 flowers				Thrips per 10 leaflets						
Treatment	Rate/A	7/8	7/15	7/24	8/1	6/18	6/25	7/2	7/9	7/19	7/24	CTD
QRD 416	2 qt	39.8	9.8	15.3	13.5	5.0	3.8	1.3	0.0	2.5	0.8a	74.3
QRD 416	3 qt	40.0	10.8	14.0	15.5	5.8	2.3	0.5	0.0	2.0	0.8a	57.4
QRD 416 Agri-Mek 0.15EC	3 qt 10 fl oz	39.8	9.3	14.3	18.8	4.0	3.3	0.5	0.3	0.8	0.8a	50.6
Acramite 50WS	16 oz	43.3	9.8	18.5	17.3	3.0	11.5	1.5	0.3	0.5	1.5a	113.0
Acramite 4SC	16 fl oz	44.8	12.3	16.0	20.0	4.0	4.3	1.3	0.3	0.8	1.0a	63.9
Oberon 2SC	8 fl oz	42.3	12.5	18.8	22.8	1.5	4.0	1.0	0.8	1.0	3.8ab	68.0
Agri-Mek 0.15EC	10 fl oz	37.5	13.5	14.3	23.0	4.3	6.8	0.8	1.0	0.8	2.0a	88.0
Control	—	35.0	17.0	25.3	14.3	4.8	1.5	1.0	1.0	1.0	6.5b	74.6

Means within columns followed by different letters are not significantly different by LSD (P = 0.05). In those columns with no letters, ANOVA were not significant.

[1]QRD-416 applications were made on 27 June, 3, 10, 17, and 22 July, 1 and 5 August, and 2 September. All other treatments were applied on 22 July and 5 August.

Peach Insecticide Trial – 2009

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PEACH, *Prunus persica* (L.)

Plum Curculio: *Conotrachelus nenuphar* (Herbst)
Stink bugs: *Euschistus servus* (Say) and *Acrosternum hilare* (Say)
Oriental fruit moth: *Grapholita molesta* (Busck)

The trial was conducted in a 7-yr-old, 2-acre peach block at the Mountain Horticultural Crops Research & Extension Center (Mills River, NC). The block was a cultivar trial consisting of 20 different varieties. Trees were spaced 15 ft within rows, and rows were on 20-ft centers. Plots consisted of 3 trees x 3 rows (0.06 acres), and each treatment was replicated three times in a RCBD. Applications of insecticide treatments (see table for treatments) were made with a tractor-mounted air-blast sprayer delivering 105 GPA. Early season fruit damage caused by plum curculio and stink bugs was evaluated on 1 June, and at harvest 100 fruit per plot were removed and evaluated for all insect damage. Because the study was in a variety trial, not all treatments were harvested at the same time; harvest extended from mid July through mid August. All data were subjected to two-way ANOVA and means were separated by LSD ($P = 0.05$).

There were no significant differences among treatments in the early season assessment damage assessment, with 2.0 and 3.3% plum curculio and stinkbug damage in the control, respectively (Table 1). At harvest, oriential fruit moth damage was the only pest categories that significantly differed. All treatments significantly reduced damage below the control. In addition, overall damage as reflected by percentage clean fruit also significantly differed. The only treatments with percentage of clean fruit that was not significantly higher than the control was standard (Asana and Imidan treatments) and the 0.044 lb AI/A of HGW86.

Table 1. Mean percent insect damage to peaches treated with different seasonal insecticide programs. Mills River, NC. 2008.

			1 June		Harvest Assessment					
Insecticide	Rate/A	Application date	Plum Curculio	Cat facing	Plum curculio	Cat facing	Stings	OFM entries	Surface scars	Clean fruit
Altacor 35WDG Avaunt	3.0 oz	4/21, 5/7, 6/30 6/18, 7/13, 7/29	1.3	3.3	6.7	5.3	4.7	1.3	3.7	78.3
HGW86 10SE	13.5 oz	4/21, 5/7, 5/25, 6/18, 7/13, 7/29	0.0	0.7	4.0	2.3	1.7	0.0	0.7	91.3
HGW86 10SE + MSO	13.5 oz 0.5%	4/21, 5/7, 5/25, 6/18, 7/13, 7/29	0.7	4.0	5.3	5.7	2.0	1.3	0.3	85.3
HG86W 10SE + MSO	20.5 oz 0.5%	4/21, 5/7, 5/25, 6/18, 7/13, 7/29	0.0	0.7	2.7	4.0	2.0	1.7	0.0	89.7
Asana XL Imidan 70WP	10 fl oz 3 lb	4/21, 5/25, 7/13, 7/29 5/7, 6/18	1.3	3.3	2.7	6.7	4.3	2.3	0.7	83.3
Control			1.3	3.3	9.7	7.0	5.0	17.0	2.0	59.3

European Red Mite Control on Apples – 2008

APPLE: *Malus domestica* Borkhauser 'Rome Beauty'

European red mite (ERM): *Panonychus ulmi* (Koch)
Predatory mite (NF): *Neoseiulus fallacis* (Garman)

This trial was originally established in a block of mature 'Delicious' trees at the Mountain Horticultural Crops Research Station (Mills River, NC). Despite multiple post-bloom applications of esfenvalerate (Asana XL) to test trees, mite populations remained very low and the trial was moved at a commercial orchard in Dana, Henderson County, NC. A mature block of 'Rome Beauty' apples was used, with plots consisting of block of trees 3 rows wide by 3 rows long, and each treatment was replicated four times in a RCBD. A single application of all treatments was made on 19 Jun. All treatments were sprayed with the same fungicide and insecticide program throughout the season. Beginning in early Jun, mite populations were monitored by removing 10 leaves per plot at 7-day intervals, placing leaves through a mite brushing machine, and counting the number of ERM adults, immatures, and eggs, as well as predatory mites (*Neoseiulus fallacies*), under a stereomicroscope. Cumulative mite days were calculated by multiplying the mean mite population of two successive sample dates by the sampling interval (days), and cumulating mite days for successive sample dates. All data were subjected to two-way ANOVA and means were separated by LSD ($P < 0.05$).

On 18 June, the day before application of treatments on 19 June, mite densities averaged 14.5 motiles (adults + immatures) per leaf across all treatments (Table 1); there were no differences among treatments on this date. At this time, mmatures out numbered adults by about 3-fold, with means of 3.3 adults (Table 2) and 11.2 immatures (Table 3) per leaf. At 7 days after treatment applications, mite populations in the control increased by 2.2-fold compared with pre-treatment counts. Although all treatments except Nexter reduced mite counts below the control, overall densities remained high and there were no significant differences among treatments. On 3 July, 14-days after treatment, mite populations were beginning to naturally decline, but differences in efficacy were apparent. The most efficacious treatments were Kanemite, Apollo + Kanemite and Apollo + FujiMite, while Apollo alone, Nexter and Acramite did not significantly reduce populations below the control. Mite densities naturally declined to <1 per leaf in all treatment s by 24 July. The relatively efficacy of treatments was reflected in seasonal mite-day accumulations, with only the Kanemite, FujiMite, and Apollo + Kanemite and Apollo + FujiMite treatments being significantly reduced below the control. Egg densities were not always reflective of the motile densities, with none of the treatments significantly reducing season total egg numbers below the control (Table 4). Predatory mite densities were of low to moderate intensity in this trial, peaking at only 0.5 *N. fallacies* per leaf in the control on 24 July.

Although Apollo appeared to perform poorly in this trial, it should be noted that treatment applications were higher than desirable for ovicidal products. Although the resistance status of this orchard mite population is unknown, populations resistant to Apollo and Nexter are know to exist in other orchards in Henderson County. Nonetheless, the addition of Apollo to products with known knockdown activity, did not appear to enhance the level of control. The natural crash of mite populations by mid July, and lack of resurgence thereafter, did not afford the opportunity to assess differences in residual activity. The natural decline of ERM observed in this study is consistent with what occurs in most years, i.e., ERM naturally decline in mid to late July.

Table 1. Mean ERM motiles (adults + immatures) on apples treated with various miticides on 19 June. Henderson County, NC. 2008.

		Mites per leaf							Cummulative
Treatment	Rate/A	6-18	6-26	7/3	7/10	7/17	7/24	7/31	mite-days
Apollo 4SC	4.0 oz	—	19.8a	14.4bc	2.9abc	1.0a	0.4a	0.2a	201.1bc
Apollo 4SC + Nexter 75WP	4.0 oz 4.4 oz	—	14.8a	7.7abc	1.6ab	1.1a	0.2a	0.1a	126.4abc
Apollo 4SC + Kanemite 1.25SC	4.0 oz 21.0 oz	—	25.7a	3.5a	0.6a	1.2a	0.0a	0.2a	129.3a
Apollo 4SC + FujiMite	4.0 oz 2.0 pts	—	26.3a	4.1a	0.6a	0.3a	0.1a	0.1a	127.9a
Nexter 75WP	4.4 oz	—	39.0a	15.8c	5.4c	4.7a	0.8a	0.6a	334.4c
Kanemite 1.25SC	21.0 oz	—	13.4a	1.5a	1.0ab	1.7a	0.2a	0.1a	77.7a
FujiMite 5EC	2.0 pts	—	27.6a	6.1ab	1.4ab	1.3a	0.3a	0.5a	164.6ab
Acramite 50WS	1.0 lb	—	30.0a	6.6abc	2.0ab	0.6a	0.1a	0.3a	172.3abc
Untreated control	-	14.5	32.4a	14.1bc	3.4bc	3.4a	0.0a	0.2a	261.2c

Means within the same column followed by the same letter are not significantly different by LSD (P = 0.05).

Table 2. Mean ERM adults on apples treated with various miticides on 19 June. Henderson County, NC. 2008.

		Adults per leaf							Cummulative
Treatment	Rate/A	6-18	6-26	7/3	7/10	7/17	7/24	7/31	mite-days
Apollo 4SC	4.0 oz	—	4.9ab	1.5bc	0.1a	0.0a	0.0a	0.0a	28.4bc
Apollo 4SC + Nexter 75WP	4.0 oz 4.4 oz	—	3.5a	0.4ab	0.1a	0.1a	0.1ab	0.0a	16.5ab
Apollo 4SC + Kanemite 1.25SC	4.0 oz 21.0 oz	—	3.1a	0.4ab	0.2a	0.1a	0.0a	0.0a	15.8ab
Apollo 4SC + FujiMite	4.0 oz 2.0 pts	—	2.7a	0.2a	0.1a	0.0a	0.0a	0.0a	11.4a
Nexter 75WP	4.4 oz	—	7.5bc	2.7c	0.3a	0.6b	0.5c	0.2a	58.1d
Kanemite 1.25SC	21.0 oz	—	2.4a	0.1a	0.1a	0.1a	0.1ab	0.0a	10.8a
FujiMite 5EC	2.0 pts	—	2.7a	0.5ab	0.1a	0.1a	0.2b	0.1a	17.0ab
Acramite 50WS	1.0 lb	—	4.8ab	0.1a	0.2a	0.0a	0.0a	0.0a	19.5ab
Untreated control	-	3.3	8.7c	2.1c	0.4a	0.3ab	0.0a	0.0a	49.7cd

Means within the same column followed by the same letter are not significantly different by LSD (P = 0.05).

Table 3. Mean total ERM immatures on apples treated with various miticides on 19 June. Henderson County, NC. 2008.

		Immatures per leaf							Cummulative
Treatment	Rate/A	6-18	6-26	7/3	7/10	7/17	7/24	7/31	mite-days
Apollo 4SC	4.0 oz	—	15.0	12.9c	2.8abc	1.0	0.3	0.2	172.7bc
Apollo 4SC + Nexter 75WP	4.0 oz 4.4 oz	—	11.2	7.3abc	1.5ab	1.1	0.2	0.1	109.8ab
Apollo 4SC + Kanemite 1.25SC	4.0 oz 21.0 oz	—	22.7	3.1a	0.4a	1.1	0.0	0.2	113.5ab
Apollo 4SC + FujiMite	4.0 oz 2.0 pts	—	23.5	4.0ab	0.6ab	0.3	0.0	0.1	116.6ab
Nexter 75WP	4.4 oz	—	31.5	13.2c	5.1c	4.1	0.4	0.4	276.3c
Kanemite 1.25SC	21.0 oz	—	11.1	1.4a	0.9ab	1.6	0.1	0.1	66.9a
FujiMite 5EC	2.0 pts	—	24.9	5.6abc	1.3ab	1.2	0.1	0.4	147.6ab
Acramite 50WS	1.0 lb	—	25.3	6.5abc	1.8ab	0.6	0.1	0.2	152.8abc
Untreated control	-	11.2	23.8	12.0bc	3.0bc	3.1	0.0	0.2	211.5bc

Means within the same column followed by the same letter are not significantly different by LSD (P = 0.05).

Table 4. Mean total ERM motiles eggs on apples treated with various miticides on 19 June. Henderson County, NC. 2008.

		Eggs per leaf								Season
Treatment	Rate/A	6-18	6-26	7/3	7/10	7/17	7/24	7/31	8/7	Total
Apollo 4SC	4.0 oz	—	42.0a	53.4c	27.9a	10.4a	16.6a	11.6bcd	7.4a	169.3c
Apollo 4SC + Nexter 75WP	4.0 oz 4.4 oz	—	37.9a	47.8abc	32.5a	17.6a	12.1a	20.5e	12.9a	181.1c
Apollo 4SC + Kanemite 1.25SC	4.0 oz 21.0 oz	—	49.4a	16.2a	16.5a	21.1a	10.0a	15.0de	11.9a	140.0bc
Apollo 4SC + FujiMite	4.0 oz 2.0 pts	—	44.3a	22.7ab	23.2a	21.0a	9.2a	12.3cd	17.7a	150.3bc
Nexter 75WP	4.4 oz	—	45.1a	47.2bc	14.4a	17.8a	11.0a	5.0abc	16.1a	156.6bc
Kanemite 1.25SC	21.0 oz	—	41.1a	21.0a	15.1a	6.8a	8.4a	9.4abcd	7.2a	108.8ab
FujiMite 5EC	2.0 pts	—	46.9a	18.8a	30.1a	17.6a	8.9a	7.6abcd	5.0a	134.8abc
Acramite 50WS	1.0 lb	—	29.0a	13.8a	12.0a	13.5a	3.6a	4.4ab	9.6a	85.8a
Untreated control	-	14.8	47.8a	24.6abc	14.8a	10.7a	8.5a	1.9a	1.8a	110.1ab

Means within the same column followed by the same letter are not significantly different by LSD (P = 0.05).

Table 5. Mean predatory mites (*Neoseiulus fallacis*) on apples treated with various miticides on 19 June. Henderson County, NC. 2008.

		Predatory mites per leaf							Cummulative
Treatment	Rate/A	6-26	7/3	7/10	7/17	7/24	7/31	8/7	mite-days
Apollo 4SC	4.0 oz	0.1a	0.1a	0.2a	0.1a	0.1a	0.1a	0.3a	5.0a
Apollo 4SC + Nexter 75WP	4.0 oz 4.4 oz	0.3a	0.1a	0.0a	0.0a	0.0a	0.1a	0.1a	2.4a
Apollo 4SC + Kanemite 1.25SC	4.0 oz 21.0 oz	0.1a	0.1a	0.1a	0.0a	0.2a	0.1a	0.1a	3.5a
Apollo 4SC + FujiMite	4.0 oz 2.0 pts	0.2a	0.1a	0.1a	0.1a	0.2a	0.1a	0.1a	3.9a
Nexter 75WP	4.4 oz	0.2a	0.2a	0.3a	0.2a	0.2a	0.3a	0.1a	9.5bc
Kanemite 1.25SC	21.0 oz	0.4a	0.2a	0.1a	0.4b	0.4a	0.3a	0.2a	10.5cd
FujiMite 5EC	2.0 pts	0.3a	0.3ab	0.0a	0.0a	0.1a	0.4a	0.3a	6.1ab
Acramite 50WS	1.0 lb	0.2a	0.5b	0.1a	0.1a	0.2a	0.3a	0.1a	6.5abc
Untreated control	-	0.2a	0.0a	0.2a	0.2ab	0.5a	0.4a	0.1a	13.7d

Means within the same column followed by the same letter are not significantly different by LSD (P = 0.05).

Control of Internal Lepidopteran Pests on Apple – 2008

APPLE, *Malus domestica* Borkhauser 'Golden Delicious'

Codling Moth: *Cydia pomonella* (L.)
Oriental Fruitmoth*Grapholita molesta* (Busck)
Leafrollers: *Platynota idaeusalis* (Walker)
Plum Curculio: *Conotrachelus nenuphar* (Herbst)
Plant bugs: *Lygus lineolaris* (Palisot de Beauvois)
Comstock Mealybug (CMB): *Pseudococcus comstockie* (Kuwana)
Green Apple Aphids (GAA): *Aphis pomi* De Geer and *A. spiraecola* Patch
European Red Mite (ERM): *Panonychus ulmi* (Koch)
Potato Leafhopper: Empoasca fabae (Harris)

This trial was conducted in a 29-yr-old block of 'Golden Delicious' apples with trees spaced 10-ft apart within rows and rows on 25-ft centers, and an estimate tree-row-volume of approximately 300 GPA. Plots consisted of 2 adjacent trees within a row, and each treatment was replicated 4 times and arranged in a RCBD. While the primary objective was to compare the efficacy of insecticides for control of first and second generation codling moth, early season insecticide programs also differed among treatments (see tables for treatments). Applications were made with a tractor-mounted air-blast sprayer delivering 100 gpa. Counts of European red mite (ERM), apples aphids (GAA) and potato leafhopper (PLH) were made on selected sample dates to coincide with peak densities of these pests. ERM were counted on 10 leaves per plot with a 10X visor lens, GAA populations were estimated recording the number of aphids on the most infested leaf of 10 aphid-infested terminal shoots per plot, and PLH were counted on 10 terminal shoots per plot. At harvest on 23 Sept, 100 fruit per plot were harvested and the number damaged by various insect pests was recorded. All data were subjected to a two-way ANOVA and means from significant ANOVAs were separated by LSD (P = 0.05).

Populations of indirect pest populations were low in this trial. At the time of the first GAA count on 12 June, aphid counts were lowest in the control and significantly higher in treatments previously sprayed on 3 June with Guthion and Voliam Xpress (Table 1). Populations declined in all treatments 7 and 13 days later, when no significant differences existed among treatments. PLH counts at 2 and 8 days after the 17 June application indicated that the only treatments that did not reduce counts below the control were those sprayed with the 6.0 oz rate of Movento; treatments sprayed with Provado, the 9.0 oz rate of Movento, Voliam Flexi and Voliam Xpress all had counts lower than the control. ERM populations were extremely low in this trial, with the highest counts observed on 25 June in the Voliam Xpress treatment (0.3 mites/leaf).

Overall direct damage was also low in this trial, with a total of only 15.2% of fruit damaged by all insects. It should be noted that this orchard had no fruit in 2007 due to an early season freeze, and this likely contributed to low insect pressure in 2008. In fact, the only pest classification with a significant ANOVA was internal lepidopterans, and only 5.8% of non-treated fruit were damage by leps. All treatments significantly reduced damage below the control, although damage in the Belt treatment was higher than all other insecticide treatments. Plum curculio was the only other insect pest of importance, damaging 7.5% of fruit. Although there were no significant differences among treatments in curculio damage, treatments sprayed at petal fall with Avaunt averaged 2.1%, with Movento 4.3%, and both Voliam Flexi and Xpress averaged 2.3% damage.

Table 1. Green apple aphid, potato leafhopper and European red mite populations on 'Golden Delicious' apples before and after insecticides applied on 17 June. Mills River, NC. 2008

				Aphids/most infested leaf			Leafhoppers/10 shoots		Mites/10 leaves	
TRT #	Treatment	Rate/A	Applic. date	6/12	6/19	6/25	6/19	6/25	6/12	6/25
1	Control			1.8a	0.6a	0.0	4.3bc	1.3a	0	0.8a
2	Actara 25WDG	4.5 oz	4/10	10.4c	5.7a	0.1a	0.5a	0.0a	0	0.0a
	Avaunt 30DG	5.0 oz	5/4							
	Guthion 50WP	2.0 lb	5/19, 6/3, 8/11							
	Provado 1.6F	4.0 oz	6/17							
	Imidan 70WP	3.5 lb	7/6							
3	Assail 70WP	4.0 oz	4/10	4.3ab	2.7a	1.3b	0.8a	0.3a	0	0.0a
	Avaunt 30DG	5.0 oz	5/4							
	Delegate 25WG	5.0 oz	5/19, 6/3							
	Provado 1.6F	4.0 oz	6/17							
	Altacor 35WG	3.0 oz	7/6, 8/11							
4	Assail 70WP	4.0	4/10	2.5ab	0.9a	0.2a	0.3a	0.3a	0	0.3a
	Avaunt 30DG	5.0 oz	5/4							
	Delegate 25WG	5 oz	5/19, 6/3							
	Provado 1.6F	4.0 oz	6/17							
	Altacor 35WG	3.0 oz	7/6, 8/11							
5	Movento 2SC + Oil	6.0 oz, 0.5%	5/4, 6/17	4.9ab	1.2a	0.3a	5.0c	0.3a	0	0.3a
	Delegate 25WG	5.0 oz	5/19, 6/3							
	HGW86 10SE	10.2 oz	7/6, 8/11							
6	Movento 2SC + Oil	9.0 oz, 0.5%	5/4, 6/17	3.8ab	0.3a	0.1a	2.0ab	1.0a	0	0.0a
	Delegate 25WG	5.0 oz	5/19, 6/3							
	HGW86 10SE	13.6 oz	7/6, 8/11							
7	Movento 2SC + Oil	9.0 oz, 0.5%	5/4, 6/17	2.0a	1.1a	0.0a	1.8a	0.8a	0	0.0a
	Belt 4SC + Induce	5.0 oz, 0.25%	5/19, 6/3, 7/6, 8/11							
8	Assail 70WP	4.0 oz	5/4	4.0ab	0.7a	0.0a	0.0a	0.0a	0	0.0a
	Voliam Flexi 40WG	4.0 oz	5/19, 6/3, 6/17							
	Delegate 25WG	5.0 oz	7/6, 8/11							
9	Actara 25WDG	4.5 oz	5/4	6.7bc	0.7a	0.3a	0.0a	0.0a	0	3.8b
	Voliam Xpress 150ZC	6.0 oz	5/19, 6/3, 6/17							
	Delegate 25WG	5.0 oz	7/6, 8/11							

Means followed by different letters are significantly different by LSD (P = 0.05).

Table 2. Insect damage to ‘Golden Delicious’ apples treated with various insecticide programs. Mills River, NC. 2008

TRT #	Treatment	Rate/A	Applic. date	Lep entries	Leafroller	Plum Curculio	Plant bug	Mealy bug	% clean fruit
1	Control			5.8c	0.3a	7.5a	1.8a	0.0a	84.8a
2	Actara 25WDG	4.5 oz	4/10	0.0a	0.0a	3.8a	1.3a	0.0a	95.0a
	Avaunt 30DG	5.0 oz	5/4						
	Guthion 50WP	2.0 lb	5/19, 6/3, 8/11						
	Provado 1.6F	4.0 oz	6/17						
	Imidan 70WP	3.5 lb	7/6						
3	Assail 70WP	4.0 oz	4/10	0.5a	0.0a	1.5a	0.8a	0.0a	97.3a
	Avaunt 30DG	5.0 oz	5/4						
	Delegate 25WG	5.0 oz	5/19, 6/3						
	Provado 1.6F	4.0 oz	6/17						
	Altacor 35WG	3.0 oz	7/6, 8/11						
4	Assail 70WP	4.0	4/10	0.8a	0.0a	1.0a	2.3a	0.0a	96.0a
	Avaunt 30DG	5.0 oz	5/4						
	Delegate 25WG	5 oz	5/19, 6/3						
	Provado 1.6F	4.0 oz	6/17						
	Altacor 35WG		7/6, 8/11						
5	Movento 2SC + Oil	6.0 oz, 0.5%	5/4, 6/17	1.8ab	0.0a	5.8a	2.0a	0.3a	90.3a
	Delegate 25WG	5.0 oz	5/19, 6/3						
	HGW86 10SE	10.2 oz	7/6, 8/11						
6	Movento 2SC + Oil	9.0 oz, 0.5%	5/4, 6/17	0.8a	0.0a	2.5a	2.0a	0.5a	94.3a
	Delegate 25WG	5.0 oz	5/19, 6/3						
	HGW86 10SE	13.6 oz	7/6, 8/11						
7	Movento 2SC + Oil	9.0 oz, 0.5%	5/4, 6/17	4.0b	0.3a	4.5a	1.8a	0.0a	89.5a
	Belt 4SC	5.0 oz, 0.25%	5/19, 6/3, 7/6, 8/11						
8	Assail 70WP	4.0 oz	5/4	0.0a	0.0a	2.3a	2.0a	0.0a	95.8a
	Voliam Flexi 40WG	4.0 oz	5/19, 6/3, 6/17						
	Delegate 25WG	5.0 oz	7/6, 8/11						
9	Actara 25WDG	4.5 oz	5/4	0.3a	0.0a	2.3a	1.8a	0.0a	95.8a
	Voliam Xpress 150ZC	6.0 oz	5/19, 6/3, 6/17						
	Delegate 25WG	5.0 oz	7/6, 8/11						

Means followed by different letters are significantly different by LSD (P = 0.05).

On-Farm Altacor – Delegate Rotation Trial

In recent years the codling moth has become the key pest of apples in NC, due in part to populations resistant to a diversity of insecticides, including organophosphates and insect growth regulators. The availability in 2008 of two new insecticides with excellent activity against codling moth, rynaxypyr (Altacor) and spinetoram (Delegate), provides growers with two new tools to improve codling moth control. For resistance management purposes, growers will be advised to rotate these products between first and second generation populations; i.e., do not treat the same generation with both compounds, and do not use the same product against successive generations. The purpose of this study was to compare the performance of Altacor and Delegate against first and second generation codling moth populations.

Materials & Methods

Five apple orchards were selected that all had moderate to high codling moth populations in 2007. At each study site, two treatments ranging in size from 5 to 10 acres were established. Treatments consisted of 1) Altacor applied against first generation and Delegate applied against second generation, and 2) Delegate applied against the first generation and Altacor applied against the second generation. For all applications, Altacor 35WDG was applied at 3.0 oz/acre, and Delegate 25WG was applied at 5.2 oz/acre. With the exception of the Lynch orchard, first generation sprays were applied at 1st and 2nd cover sprays. Due to communication problems, both treatments were sprayed with Delegate at the first cover spray at the Lynch orchard. For second generation applications, one or two applications were made, depending on the intensity of pheromone trap captures and harvest dates. All treatments at all locations were sprayed with Avaunt at petal fall, which occurred 10 to 14 days before first cover sprays. Additional insecticides applied to treatments are shown in Table 1. In most instances, these other insecticides were applied for summer aphids or apple maggot. Finally, pheromone-mediated mating disruption (Isomate TT CM/OFM at 200 dispensers per acre) was used at all study sites except the Nix orchard.

Codling moth and oriental fruit moth were monitored at all study sites using Delta traps baited with CM-L2 and OFM-L111 pheromone lures, respectively. Traps were placed at a density of about 1 CM trap/3 acres and 1 OFM trap/10 acres. Attractant lures were replaced every 12 weeks during the course of the season to ensure lure potency. Fruit damage assessments were conducted in treatment plots twice, once in late June (end of 1st CM generation) and consisted of 30 fruit/ tree from 20 trees/plot, and at harvest which consisted of destructively sampling 250 – 500 apples/plot (50% each from the upper and lower tree canopy). Apple damage was categorized as internal-feeding lepidopteran stings or entries, and fruit surface was also assessed for plum curculio and plant bug damage.

In mid June, abnormally high woolly apple aphid (WAA) populations were reported in a number of apple orchards in Henderson County where two to three Delegate applications were made. To determine if there was a relationship between WAA populations and Delegate sprays, treatments at all study sites were sampled in mid July/early August, and again in mid October. In each treatment, WAA populations were assessed by counting the number of WAA colonies on

21 trees per plot (each tree was searched for 2 min.). In three of these orchards, 50 WAA colonies were collected, individually placed in 50% ETOH, and returned to the laboratory. Each sample was observed under a dissecting microscope and the number of live aphids and aphids parasitized by the parasitoid *Aphelinus mali* was recorded.

Results

In the previous growing season (2007), codling moth damage was high (>5%) at the Barnwell, Lynch and Owensby sites, and relatively low (<1%) at Nix and Staton. Based on first generation codling moth trap captures, codling moth pressure was high at the Barnwell and Nix sites, and of low to moderate intensity at the remaining three sites (Fig. 1). Insecticides and dates of applications to the two treatments are shown in Table 1. While timing of the initial application of first generation treatments was targeted for 250 degree-days after biofix, it varied from 270 at Staton and Owensby to 350 at Barnwell. It should also be noted that due to communication problems, both treatments at the Lynch site were treated with Delegate at the initial spray against the first generation. Oriental fruit moth trap captures were extremely low at all sites; the Nix orchard was the only site where any OFM captured, and here a season total of only 7 were captured.

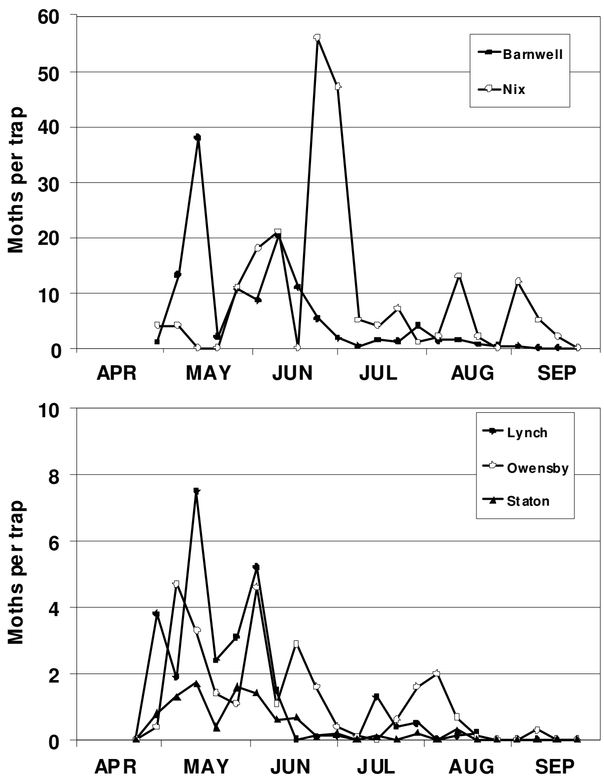


Fig. 1. Weekly codling moth pheromone trap captures at study sites used for Altacor-Delegate rotation study.

Damage assessments at the end June indicated that first generation damage codling moth was low in both treatments at all sites (Table 2). Averaged across the five study sites, codling moth damage averaged 0.1% in both treatments, with damage detected in only two of the 10 treatment blocks (0.3% in the Altacor treatment at the Lynch site and 0.7% in the Delegate treatment at Owensby).

The high level of first generation control achieved at all sites resulted in very low second generation pheromone trap captures. Pheromone traps at the Nix orchard, the only site that did not use mating disruption, captured 13 and 12 moths per trap on 12 August and 1 September (Fig. 1), respectively. It should be noted that this study site was adjacent to an orchard that had relatively high codling moth populations and a bin storage pile, which was the likely source of high moth captures in August and September. At no other sites did mean trap captures exceed 2 moths per trap (Fig. 1). Based on previous research, the ideal timing of insecticide sprays for second generation codling moth in NC is about 1400 DD after biofix, which in 2008 occurred from 12 – 15 July in Henderson County. Because of low trap captures and/or early havest dates, only one application of either Altacor of Delegate was made at the Nix, Staton and Lynch sites, while two were made at the Barnwell and Owensby sites. Considering the low second generation trap captures and the fact that mating disruption was used at Barnwell and Owensby, it is questionable whether either of these two applications were necessary. Nonetheless, harvest damage assessments indicated that codling moth damage was extremely low in both treatments at all test sites; among the 10 treatment sites, damage was detected in only one (0.4% damaged in the treatment sprayed with Altacor in the second generation at Lynch orchard).

Field assessments of woolly apple aphid populations (i.e., % WAA infested trees and WAA colonies/tree data categories in Table 3) were made on 11 July in all orchards, which occurred after first and before second generation treatment sprays were made (Table 1). At this time, WAA populations were higher in blocks sprayed with Delegate (TRT 2) compared with Altacor (TRT 1) during the first generation based on percentage of trees infested with WAA (50.5 vs. 29.5 %) and colonies per tree (8.5 vs. 0.7 colonies/tree). The Lynch orchard was the only site where the Altacor treatment had a higher percentage of trees infested than Delegate, but this was also the site where an application of Delegate was mistakenly made to the Altacor treatment during the first generation.

To assess average WAA colony size and parasitism, 50 colonies per treatment were collected from the Staton, Barnwell and Owensby sites. Unfortunately, aphid colonies were collected after the second generation sprays was made to treatments at all sites except Staton. Hence, Barnwell and Owensby treatments that were sprayed with Altacor during the first generation were also sprayed with one and two sprays of Delegate, respectively, before aphids were collected for colony size and parasitism. In these two orchards, both the number of aphids per colony and percent parasitism by *Aphelinus mali* were similar in both treatments (Table 3). In the Staton orchard, where second generation Altacor/Delegate sprays had not yet been made, colony size was lower and parasitism was higher in the Altacor compared with Delegate treatment.

A second assessment of WAA was made in mid October, which was more than two months after the last insecticide sprays were made and after both treatments had been sprayed with both Altacor and Delegate. When averaged across all study sites, the intensity of WAA populations and parasitism by *A. mali* were remarkably similar (Table 3). While there were differences in aphid densities and parasitism between treatments within orchards, there was no consistent trend among orchards.

Based on the results of this trial, two applications of either Altacor or Delegate provided outstanding control of first generation codling moth, even under high population pressure at the Barnwell and Nix sites. Because of the high level of control achieved against the first generation, second generation codling moth populations were very low, and there was minimal damage detected in any treatment at harvest. Preliminary evidence suggested that WAA populations were higher and parasitism was lower in blocks treated with Delegate compared with Altacor during the first generation. At the end of the year when both treatments had been sprayed with both insecticides, these differences were no longer apparent and WAA population density and levels of *A. mali* parasitism were essentially the same in both treatments. It should be noted that this trial was not designed to determine effects on WAA population dynamics, and further studies will be necessary to assess the impact of these insecticides on WAA.

Table 1. Cultivars, rootstocks and insecticides applied to treatments of Altacor-Delegate rotation study. CM DD refers to cumulative degree days from biofix for codling moth. 2008[1]

Cooperator	Cultivar	Rootstock(s)	TRT 1	TRT 2	CM DD
Nix	Gala	M.26	5/21 Altacor	5/21 Delegate	295
(Henderson Co)	Fuji		6/4 Altacor	6/4 Delegate	
			6/17 Intrepid (8 oz)	6/17 Intrepid (8 oz)	
			7/1 Calypso (6 oz)	7/1 Assail (4 oz)	
			7/16 Delegate	7/16 Alacor	1455
Lynch	Golden Delicious	Seedling	5/8 Delegate	5/8 Delegate	280
(Polk Co)			5/23 Altacor	5/23 Delegate	600
			6/5 Altacor	6/5 Delegate	
			6/19 Asana (6 oz)	6/19 Asana (6 oz)	1250
			7/13 Delegate	7/13 Altacor	1875
Barnwell	Deliciouis	M.26, M.7,	5/26 Altacor	5/26 Delegate	350
(Henderson Co)	Golden Delicious	M.9, and Bud.9	6/10 Altacor	6/10 Delegate	
	Jonathan		6/23 Assail (4 oz)	6/23 Assail (4 oz)	
			7/14 Delegate	7/14 Altacor	1410
			8/7 Delegate	8/7 Altacor	
Owensby	Rome Beauty	Seedling	5/19 Altacor	5/19 Delegate	270
(Henderson Co)			6/2 Altacor	6/2 Delegate	
			6/16 Intrepid (10 oz)	6/16 Intrepid (10 oz)	1435
			7/15 Delegate	7/15 Alacor	
			8/5 Delegate	8/5 Altacor	
Staton	Rome Beauty	Seedling and	5/19 Altacor	5/19 Delegate	270
(Henderson Co)		MM.111	6/2 Altacor	6/2 Delegate	
			7/17 Imidan (3 lb)	7/17 Imidan (3 lb)	1480
			8/1 Delegate	8/1 Altacor	1830

[1]All applications of Altacor 30WDG were made at 3 oz/acre, and all applications of Delegate 25WG were made at 5.2 oz/acre.

Table 2. Mean fruit damage by codling moth (CM), plum curculio (PC) and plant bugs (PB) at the end of first generation codling moth flight (late June) and at harvest in blocks of apples treated with Altacor for first generation and Delegate for second generation (TRT 1) or Delegate for first generation and Altacor for second generation (TRT 2). 2008

	Late June Assessment						Harvest Assessment[1]					
	TRT I (Altacor/Delegate)			TRT 2 (Delegate/Altacor)			TRT I (Altacor/Delegate)			TRT 2 (Delegate/Altacor)		
Orchard	CM	PC	PC	CM	PC	PC	CM	PC	PB	CM	PC	PB
Nix	0.0	0	0	0	0	0.3	0	0.2	0	0	1.7	0
Lynch	0.3	0	0	0	1.3	0	0	0.4	0	0.4	0	0.4
Barnwell	0.0	0	0	0	0	0.7	0	0.7	0	0	0.7	0.1
Owensby	0.0	0.7	0	0.7	0	0	0	0	0.8	0	0	0.8
Staton	0.0	0	0	0	0	0	0	0.7	2.0	0	0	0.7
Mean (±SEM)	0.1±0.1	0.1±0.1	0	0.1±0.1	0.3±0.3	0.2±0.1	0	0.4±0.1	0.6±0.4	0.1±0.1	0.5±0.3	0.4±0.1

[1]Harvest dates were: Nix 15 Sept; Lynch 8 Sept; Barnwell 3 Sept; Owensby 1 Oct; Staton 1 Oct.

Table 3. Woolly apple aphid populations and parasitzation by *Aphelinus mali* in blocks of apples treated with Altacor and Delegate. 2008

	TRT I (Altacor/Delegate)				TRT 2 (Delegate/Altacor)			
Orchard	% WAA infested trees	WAA colonies/tree	Aphids per colony	% parasitism	% WAA infested trees	WAA colonies/tree	Aphids per colony	% parasitism
				Jul/Aug Assessment[1]				
Nix	4.8	0.1	—	—	9.5	0.7	—	—
Lynch	42.9	1.0	—	—	33.3	1.9	—	—
Barnwell	28.6	1.6	11.4	60.3	90.5	23.7	12.8	54.8
Owensby	4.8	0.1	13.0	20.3	23.8	0.3	13.5	20.3
Staton	66.7	1.0	2.3	84.3	95.2	16.0	62.5	1.7
Mean (±SEM)	29.5±9.6	0.7±0.2	8.9±2.9	55.0±16.1	50.5±14.5	8.5±3.9	29.6±14.2	25.6±13.5
				October Assessment[2]				
Nix	61.9	2.2	—	—	47.6	1.0	—	—
Lynch	19.0	0.6	—	—	33.3	1.1	—	—
Barnwell	57.1	1.7	8.4	30.8	85.7	6.1	13.7	9.9
Owensby	81.0	3.6	20.3	23.3	90.5	3.4	16.3	70.0
Staton	81.0	4.4	9.1	24.8	47.6	1.4	15.2	7.1
Mean (±SEM)	60.0±9.3	2.5±0.6	12.6±3.3	26.6±2.0	61.0±9.3	2.6±0.8	15.1±0.7	29.0±17.8

[1]First assessment date for % infested trees and colonies per tree was 11 July in all orchards. Collection of colonies for assessment of aphids per colony and % parasitism occurred on 28 July at Staton, 4 August at Barnwell, and 8 August at Owensby.

[2] Second assessment date for all data categories was 13 October at Barnwell, Owensby, and Staton, and 21 October for Nix and Lynch.

Field Tests of Puffer and CheckMate Pheromone Dispensers

The projects completed this past summer sought to evaluate the efficacy of Sutera PUFFER® CM/OFM and Sutera CM/OFM CheckMate Duel, against the industry standard use of Isomate® CM/OFM TT for the management of the top two lepidopteron pests of eastern US apples; the codling moth, *Cydia pomonella* (L.) (Lepidoptera: Tortricidae) and the Oriental fruit moth, *Grapholita molesta* (Busck), Lepidoptera: Tortricidae. All mating disruption treatments were used as a complement to the growers' normal insecticide programs.

Materials & Methods

Pheromone Dispensing Systems

Puffer

In 2008, orchard I from 2007 was again used and a new orchard (Orchard III) replaced orchard II from 2007 (Fig. 1). Orchard III consisted of approximately 9.96ha of contiguous mixed 'Rome Beauty' and 'Golden Delicious' variety apple trees with tree size ranging from 2.44 – 4.57m. Puffer aerosol cans contained custom formulations of 24g of OFM and 55.45g of CM pheromones. Average weight (± SEM) of aerosol cans when placed into the Puffer cabinets prior to travel into the field was 416.78 ± 0.22g. In both orchards I & III, Puffers were placed every 50.29m in the second row of trees inside of the orchard perimeter in the top 1m of the tree canopy. Pheromone dispensers were placed in the outside perimeter of trees at a rate of 200/0.41ha of CM/OFM Isomate TT in the top 1m of the tree canopy. Orchard I (5.78ha) used a total of 18 Puffers and orchard III (4.67ha) used a total of 12 Puffers. At the end of the season Puffer cabinets were retrieved and the aerosol cans were removed and weighed to determine the total output in each apple orchard. Orchard I & III Puffers were in place for 183d and aerosol cans weighed an average of 139.88 ± 7.56 with a mean output of 276.80 ± 7.57g/aerosol can. Mean codling moth pheromone output for both orchards was 0.28 ± 0.00g ai/day which was sufficient coverage for 180d. Puffers were applied on 21 April.

Isomate TT

Twenty-one commercial apple orchards (1.62 – 42.09ha in size) were selected in 2008 for treatment with CM/OFM Isomate TT pheromone reservoir dispensers. In each of the orchards, tree density per unit area was determined to aid in the proper application rate of the reservoir dispensers to trees. Pheromone reservoir dispensers were applied at a rate of 200/0.41ha to the upper 1m of the tree canopy (58.88g* ai CM pheromone/0.41ha). Six non-mating disruption commercial apple orchards (5.26 – 17.40ha in size) were used as controls and received only insecticide applications for codling moth control. * Data obtained from the federal label.

Checkmate Duel

Four commercial apple orchards were selected in 2008 for a paired comparison of CM/OFM CheckMate Duel with CM/OFM Isomate TT pheromone reservoir dispensers (Fig. 2). In each of the orchards ≈ 1.62 – 2.02ha plots were established. In each of the treatment blocks, tree density per unit area was determined to aid in the proper application rate of the reservoir dispensers to trees. CheckMate pheromone reservoir dispensers were applied at a rate of 170/0.41ha to the upper 1m of the tree canopy (45.90g* ai CM pheromone/0.41ha). Isomate pheromone reservoir dispensers were applied at a rate of 200/0.41ha to the upper 1m of the tree canopy (58.88g ai CM pheromone/0.41ha). * Data obtained from the federal label.

Data from commercial apple orchards across Henderson County treated with CheckMate were also pooled to better assess the efficacy. Orchards treated with CM/OFM CheckMate Duel

(N = 7) were pooled to allow for the comparison of efficacy against CM/OFM Isomate TT (N = 14) and controls (N = 7) which received only insecticide applications for codling moth control. CheckMate pheromone reservoir dispenser treated apple orchards received between 150 - 212/0.41ha to the upper 1m of the tree canopy. Isomate pheromone reservoir dispensers were applied uniformly at a rate of 200/0.41ha to the upper 1m of the tree canopy.

A large commercial apple orchard was selected in 2008 for a paired comparison of CM/OFM CheckMate Duel pheromone reservoir dispensers at 150/0.41ha (N = 3) against CM/OFM CheckMate Duel 200/0.41ha (N = 3) (Fig. 3). The orchard was divided into ≈ 2.02ha blocks. In each of the treatment blocks, tree density per unit area was determined to aid in the proper application rate of the reservoir dispensers to trees. CheckMate dispensers were applied to the upper 1m of the tree canopy to their respective treatments at rates of 150/0.41ha (40.50g ai CM pheromone/0.41ha) and 200/0.41ha (54.00g ai CM pheromone/0.41ha).

Treatment Evaluation

Treatment efficacy was based on male moths captured in pheromone traps and damage to fruit by larvae. At all study sites, CM and OFM male moths were monitored with Delta traps baited with CM-L2 lures OFM-L111, respectively. Traps were placed in each treatment at a density of one CM trap/2.5 acres (trap placed in the upper canopy), and one OFM trap/10 acres (if plot size was <4 ha, only one OFM trap was used) at eye level. Attractant lures were replaced at 12-wk intervals to ensure lure potency. Traps were monitored weekly to record the number of moths captured and to clean and service traps. End of season damage assessments were made in all treatments by collecting a minimum of 5-10 samples per treatment (depending on plot size), with a sample consisting of 50 fruit (half from each the upper and lower canopy). Fruit were destructively sampled to detect larval tunnels and live worms.

Results & Discussion

Puffer

Codling moth pressure was high beginning in April across all orchards with CM seasonal trap counts ranging from 1 – 305 moths. Oriental fruit moth pressure was uniformly low across all treatments and resulted in no observable treatment differences and as a result was not included in the comparisons.

Puffer treated orchards at both sites (I & III) performed better in 2008 than in 2007 (Fig. 4). In 2007 little difference was detected between the Isomate TT treated blocks and Puffer treated blocks against the controls with less than 7.63 trapped CM between any of the treatments. In 2008, addition of the Isomate TT pheromone dispensers placed in trees adjacent to trees containing Puffer dispensers achieved greater suppression of CM (Fig. 4). End of season mean average of trapped CM was 122.50 ± 1.12 in controls compared to 33.21 ± 0.39 and 16.00 ± 0.31 in the Isomate TT and Puffer blocks respectively (Fig. 4). Differences between trapped CM in Puffer and Isomate TT blocks was not pronounced with the greatest differences found only on 2 sample dates of 1.13% on 118J and 1.87% on 209J (Fig. 4). Both Puffer and Isomate TT blocks suppressed CM numbers throughout the course of the season compared to the controls (Fig. 4). Nearby orchard blocks treated with CheckMate 170/0.41ha did not perform better than any other treatment and was most likely the result of the CheckMate blocks being in proximity to apple bin storage area at one of the sites which may have acted as a CM source of infestation (Fig. 4). Mean fruit damage (±SEM) in the Isomate TT treated orchards was 0.33 ± 0.20 %, which is 0.13% greater than orchards treated with Puffers with 0.20 ± 0.20 % damage (Table 1). Damaged fruit in CheckMate treated orchards was uniformly low with 0.13 ± 0.13% with only a

0.07% damage difference between Puffer blocks and 0.20% between Isomate TT blocks (Table 1).

Puffer aerosol dispenser can output for both orchards was 0.39 ± 0.00g ai/day in 2007 and 0.28 ± 0.00g ai/day in 2008 (see above) which was sufficient coverage for the 154 and 180d. (2007 and 2008 respectively) Puffers were used in the field. The single greatest advantage of using Puffers is that they automatically meter out uniform amounts of pheromone regardless of environmental conditions as compared to reservoir dispensers like Isomate TT and CheckMate Duel which release greater amounts of pheromone on hotter days than cooler days (temperature dependant).

Isomate TT

Use of CM/OFM Isomate TT compared to control blocks (without mating disruption) effectively suppressed populations during the first CM generation by -90.15% in the conventional insecticide (CNV) program + mating disruption using Isomate TT pheromone reservoir dispensers (Fig. 4). Use of reduced risk insecticide (RR) programs + Isomate TT was only 4.26% different with -86.25% trap shutdown compared to controls (Fig. 3). The peak of CM counts for the second generation occurred on 181J (Fig. 4). Conventional and RR insecticide programs + Isomate TT were -98.21% and -86.77% (respectively) less than controls (Fig. 4). Differences over the course of the season between CNV and RR insecticide programs never differed more than 11.44% which is an indication of an effective merging of the two insecticide programs that coincides with the introduction of newer RR products like Delegate and Altacor. Damaged fruit found in apple orchards treated with Isomate TT was not significantly less than damage found in conventionally managed orchards (Fig. 6).

CheckMate Duel

The use of CheckMate dispensers at 170/0.41ha suppressed first generation CM numbers by -48.88% on 122J compared to the control which was 21.42% less than Isomate TT with -48.56% (Fig. 7). Thereafter, CheckMate suppression of CM numbers were similar to the conventional controls with the exception of a single mean spike of 24.50 ± 18.25 moths on 167J (Fig. 7). Reasons for this point increase which exceeded all other treatments are unknown but may have been the influx of CM from outside of the orchards being monitored.

Pooled cumulative weekly moth counts from 28 orchards across Henderson County showed a similar trend of CheckMate dispensers at 170/0.41ha not performing as well as Isomate TT at suppressing CM numbers (Fig. 8). Differences in performance between CheckMate 170/0.41ha and Isomate 200/0.41ha are more pronounced when comparing cumulative weekly moth counts against mean weekly counts (Figs. 7 & 8).

Differences between the effectiveness of Isomate TT and CheckMate Duel dispensers may be the result of CM pheromone that they deliver to the orchards (see above). Isomate TT dispensers release approximately 58.88g ai CM pheromone/0.41ha into the orchard during every growing season which is a 1.3 fold increase over the amount that CheckMate released in the field with 45.90g ai CM pheromone/0.41ha (see above). This could explain the performance difference between Isomate TT and CheckMate Duel dispensers in the field on CM numbers.

Evaluation of CheckMate at field release rates of 150/0.41ha (40.50g ai CM pheromone/0.41ha) and 200/0.41ha (54.00g ai CM pheromone/0.41ha) in replicated experiments showed that there was little performance difference between the two rates (Fig. 7). The amount of pheromone present in the orchard at any one time supplied by the 150/0.41ha rate of

CheckMate may be adequate and the additional pheromone released by the 200/0.41ha may be unnecessary (Fig. 7). Destructive sampling of ≈ 250 apples from each of the replicated treatment blocks revealed 0.00 ± 0.00 damage due to codling moth. As a result, assessment of checkmate dispenser rate is difficult to assess in this 2008 experiment.

Summary

From the experiments presented here we can see a clear impact of pheromone delivery on the effectiveness of the product when used in the field to manage CM. The use of Puffers with an outer perimeter of Isomate TT provided effective CM suppression that was similar to Isomate TT used alone. The use of Isomate TT provided CM suppression that was better than all of the other treatments evaluated with greater than ≈ 86% trap shutdown. CheckMate performed better than Isomate TT at suppressing CM populations during the first generation but not for the second CM generation. Increasing the rate of CheckMate from150/0.41ha to 200/0.41ha rate did not improve CM suppression.

Fig. 1. Plot maps of Puffer treated orchards compared to orchards treated with 200/0.41ha CM/OFM Isomate TT in 2008

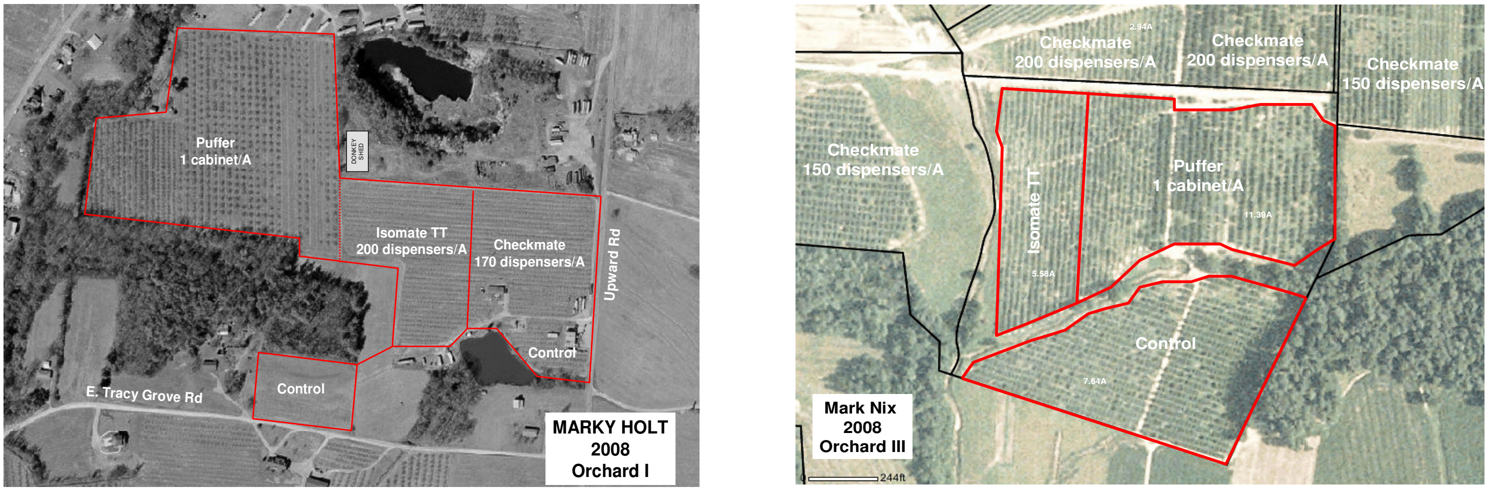


Fig. 2. Plot maps of CheckMate 170/0.41ha treated orchards compared to orchards treated with 200/0.41ha CM/OFM Isomate TT in 2008

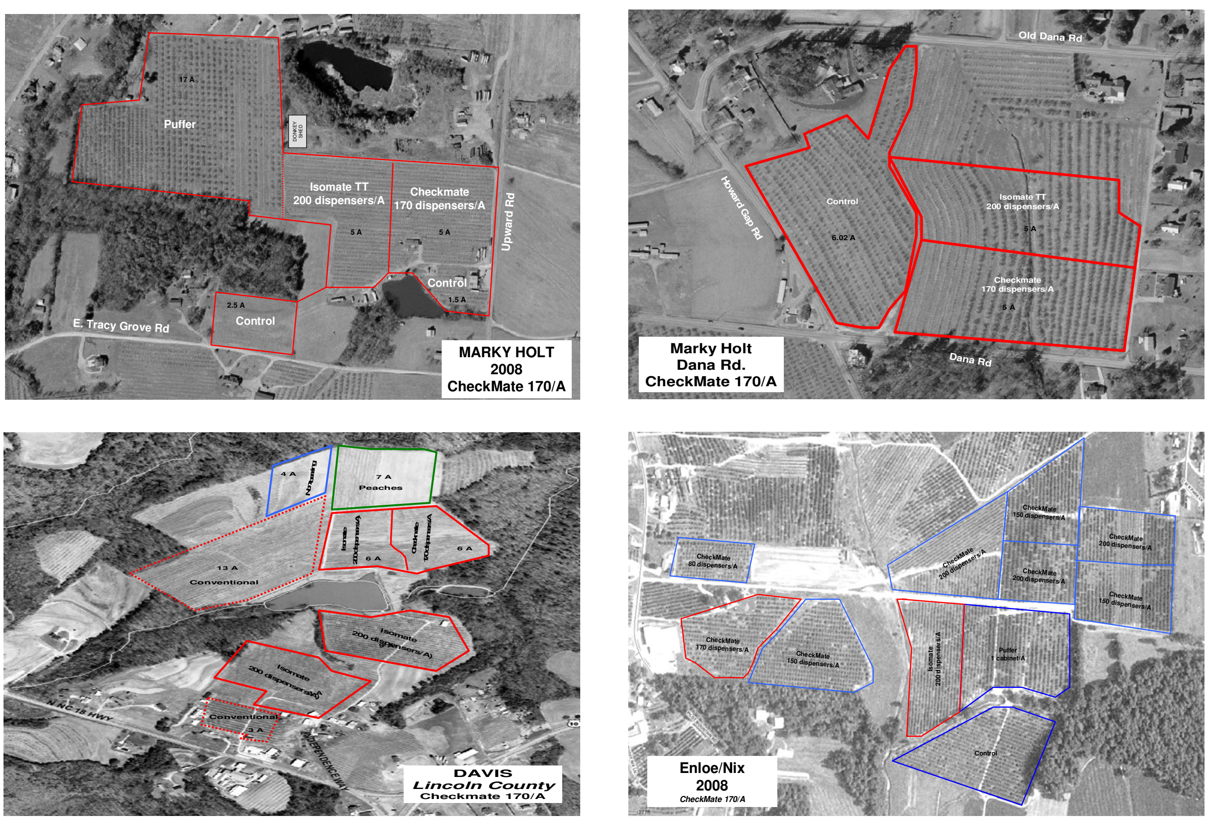


Fig. 3. Plot map of CheckMate 150/0.41ha treated orchards compared to orchards treated with CheckMate 200/0.41ha in 2008

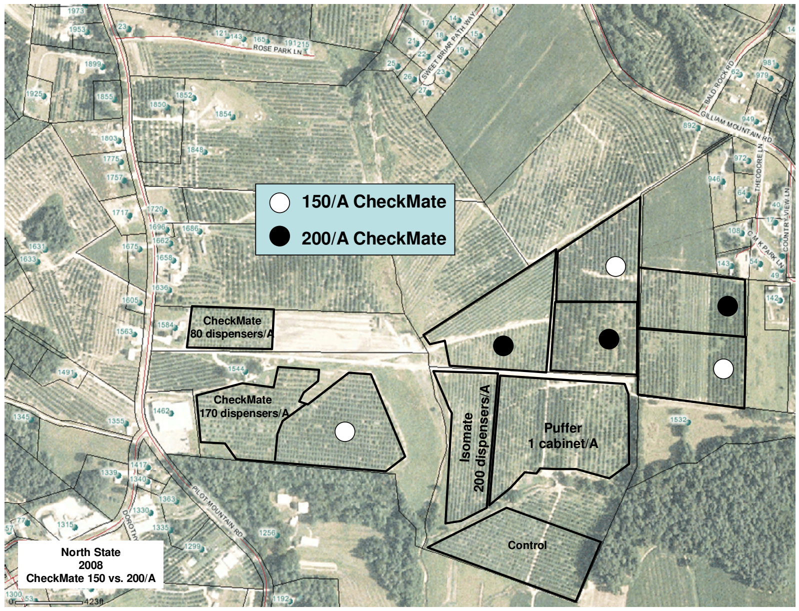


Fig. 4. Mean weekly trap captures of codling moth in Puffer pheromone dispenser treated orchards compared to Isomate CM/OFM TT treated orchards in 2008

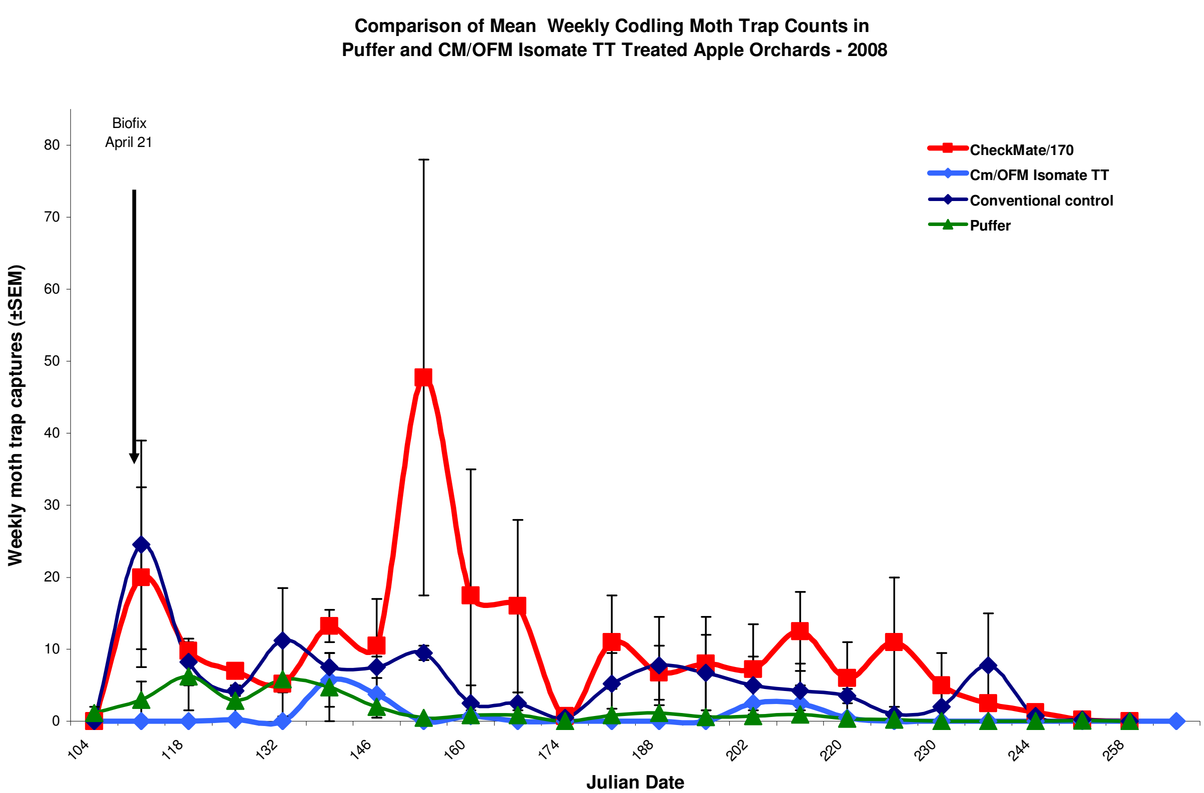


Table 1. Mean Codling moth fruit damage for Puffer, CheckMate and Isomate pheromone dispenser treated orchards – 2008

Treatment	Mean % damaged fruit ± SEM
CM/OFM Puffer 1/A	0.20 ± 0.20
CM/OFM CheckMate 170/A	0.13 ± 0.13
CM/OFM Isomate TT 200/A	0.33 ± 0.20
Control	1.03 ± 0.87

Fig. 5. Mean weekly trap captures of codling moths in CM/OFM Isomate TT treated orchards in 2008

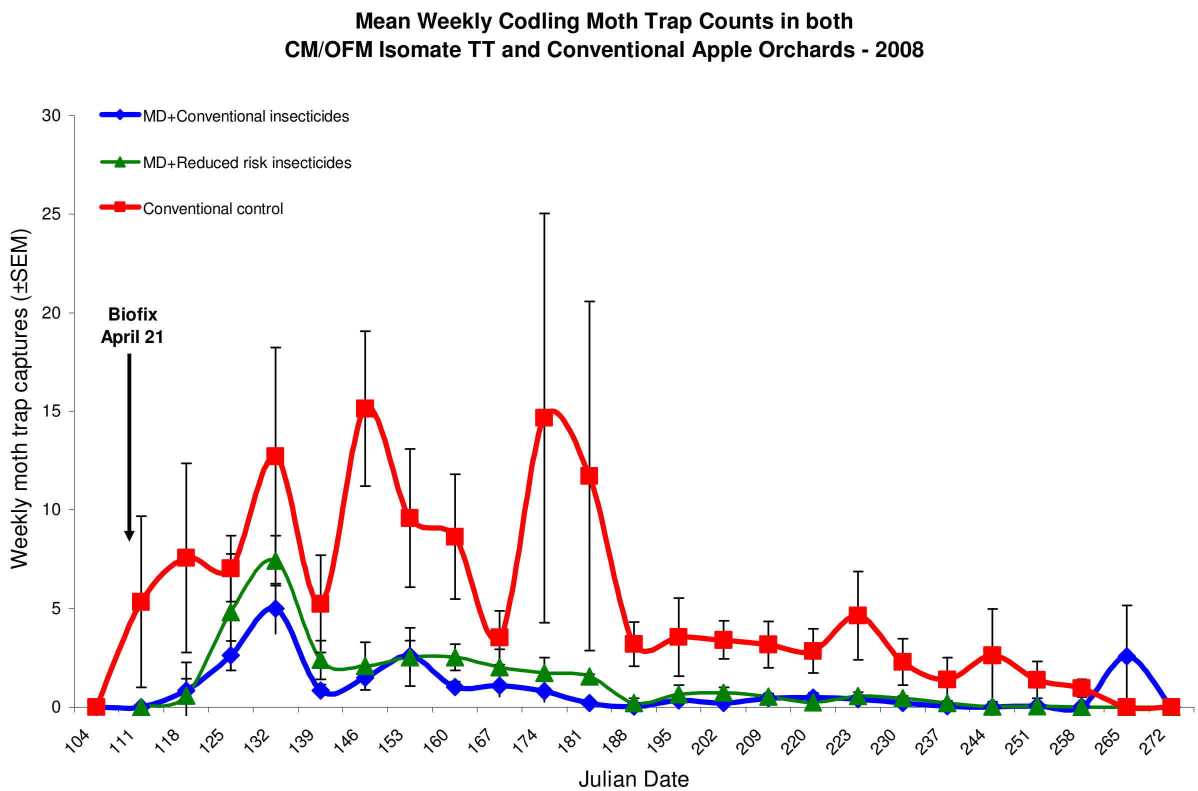


Fig. 6. Mean codling moth fruit damage in Isomate TT treated orchards compared to conventionally managed apple orchards – 2008

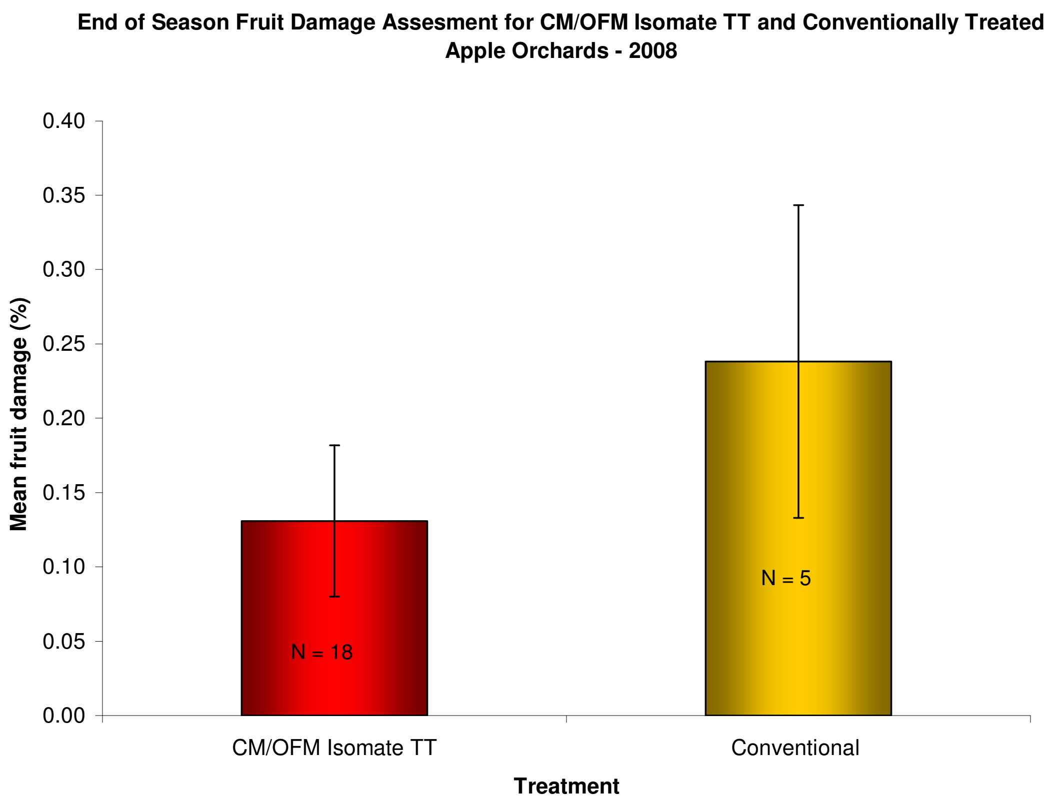


Fig. 7. Mean weekly trap captures of codling moth in orchards treated with 170/0.41ha CM/OFM CheckMate Duel compared to orchards treated with 200/0.41ha Isomate CM/OFM TT

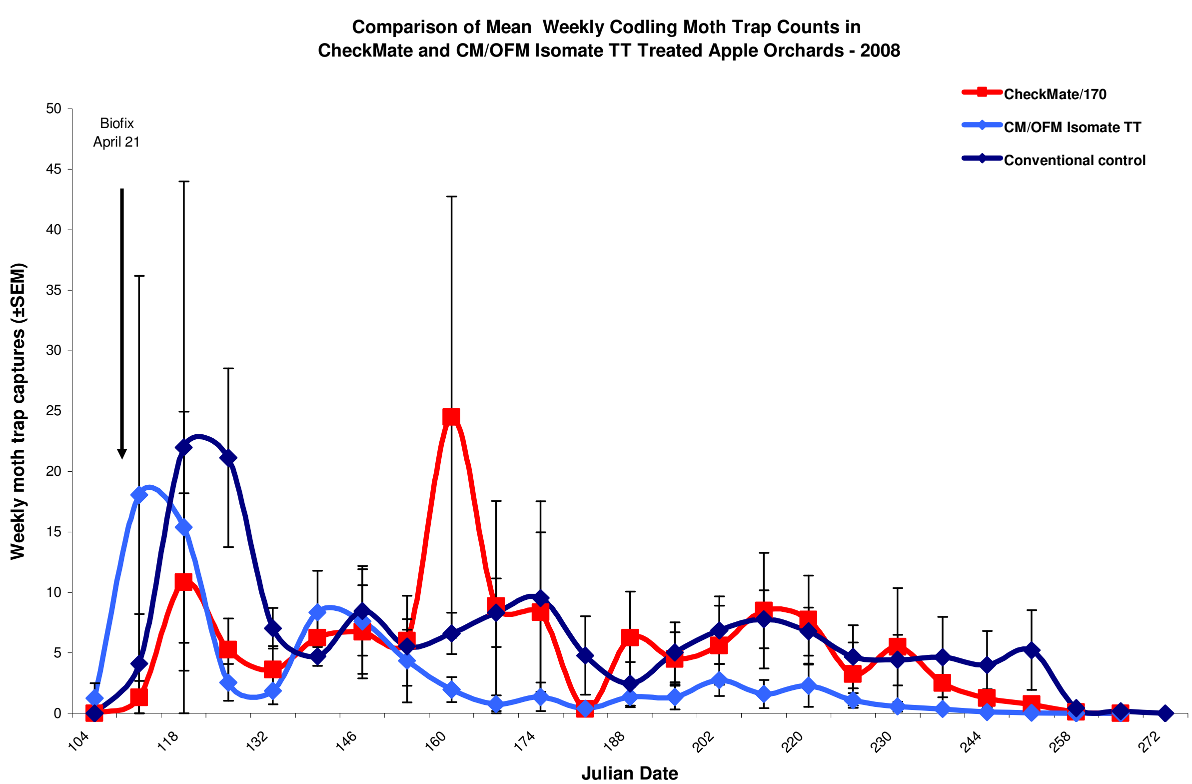


Fig. 8. Mean cumulative weekly trap captures of codling moths in orchards treated with 150 - 212/0.41ha CM/OFM CheckMate Duel compared to orchards treated with 200/0.41ha Isomate CM/OFM TT in 2008

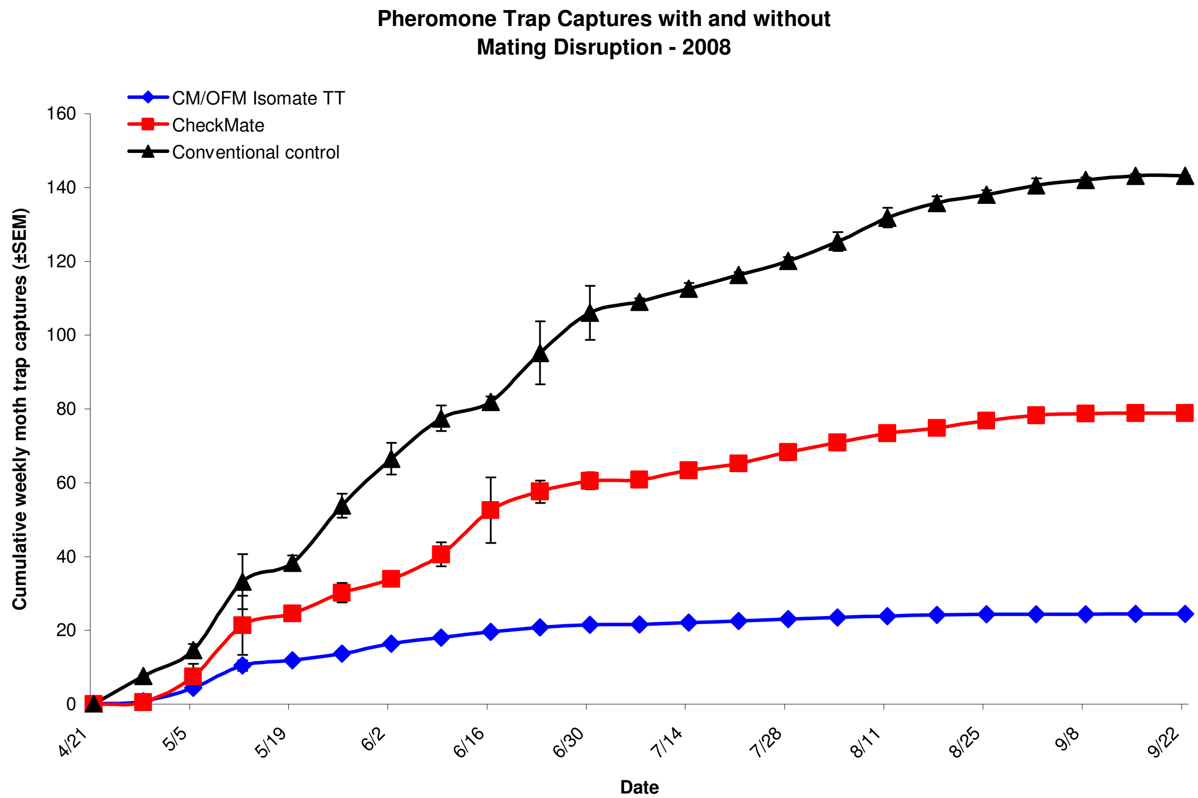
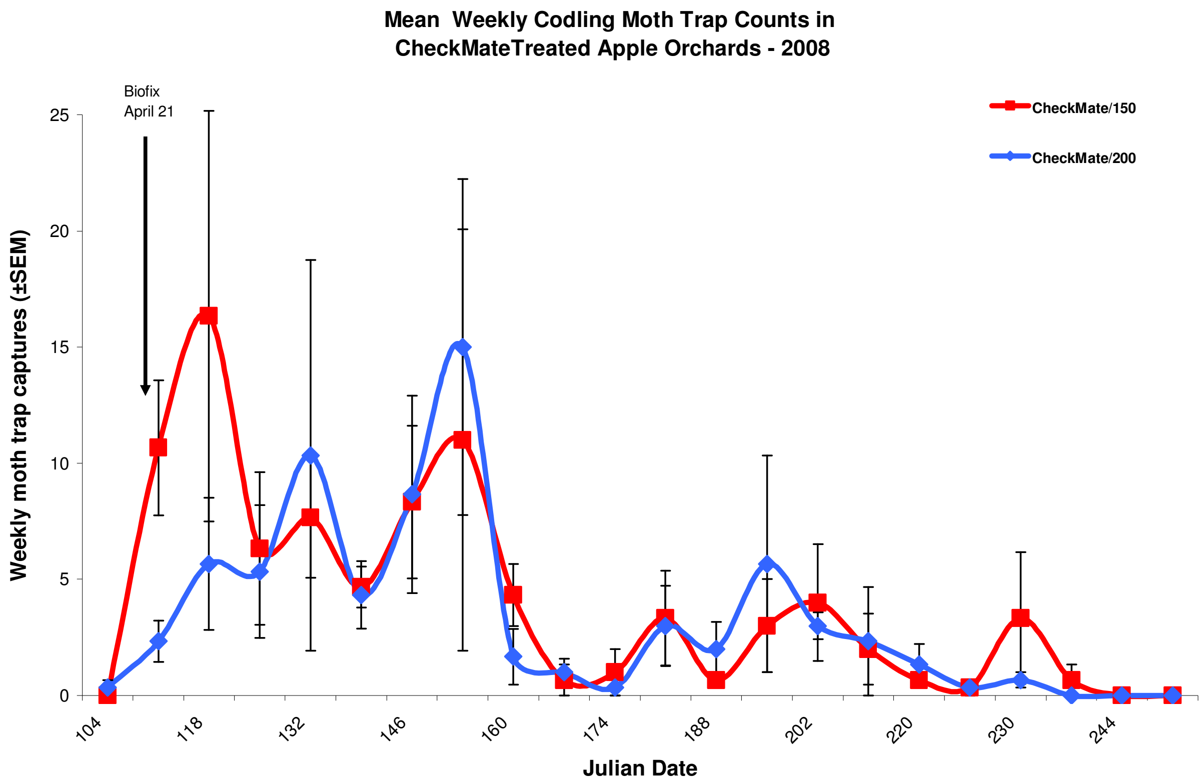
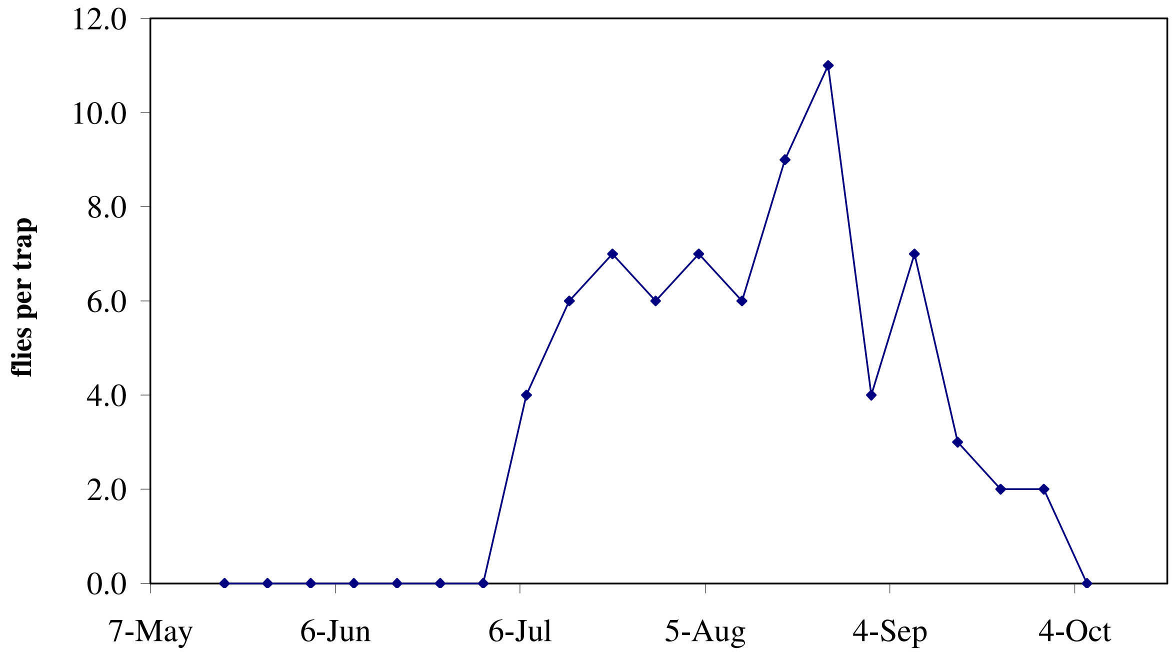


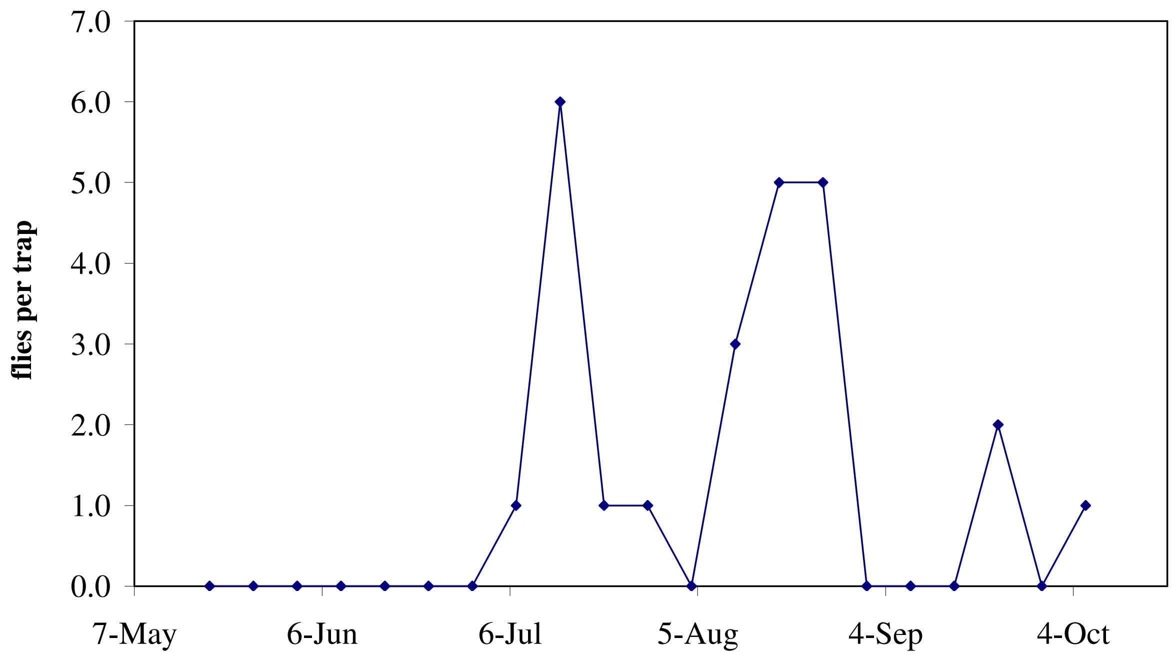
Fig. 9. Mean weekly trap captures of codling moths in orchards treated with 150/0.41ha CM/OFM CheckMate Duel compared to orchards treated with 200/0.41ha CM/OFM CheckMate Duel in 2008



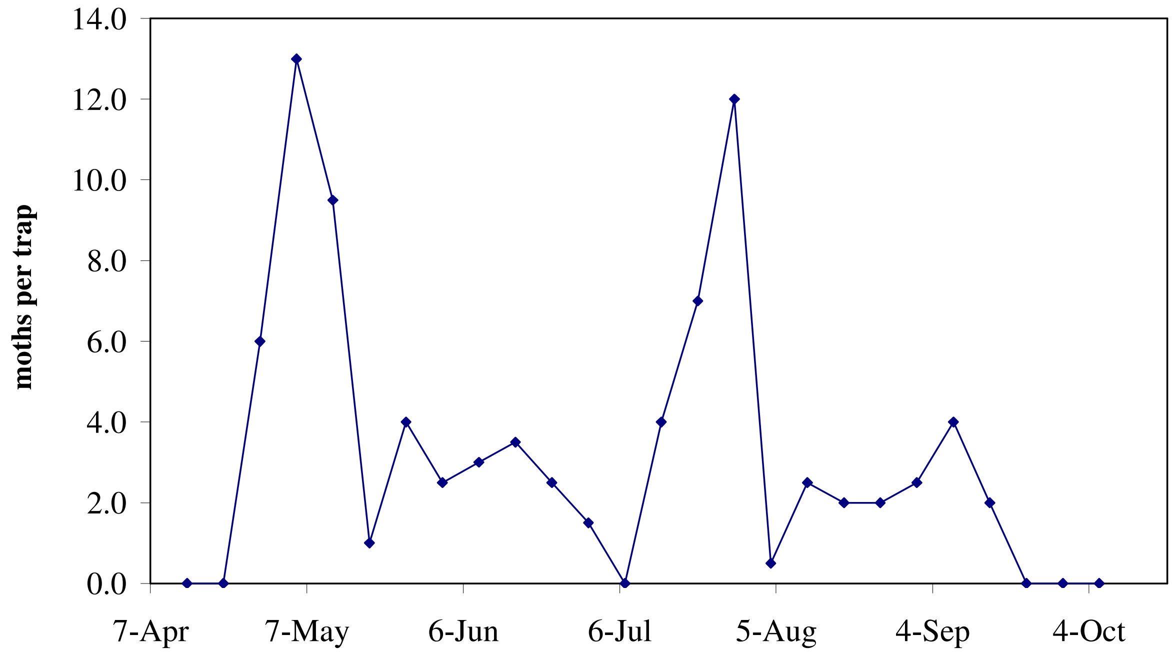
Apple Maggot Trap Captures, Clear Creek
Edneyville, Henderson County, NC, 2008



Apple Maggot Trap Captures
Sugarloaf Mountain, Henderson County, NC, 2008



Codling Moth Trap Captures, MHCRS
Mills River, Henderson County, NC, 2008



Codling Moth Trap Captures
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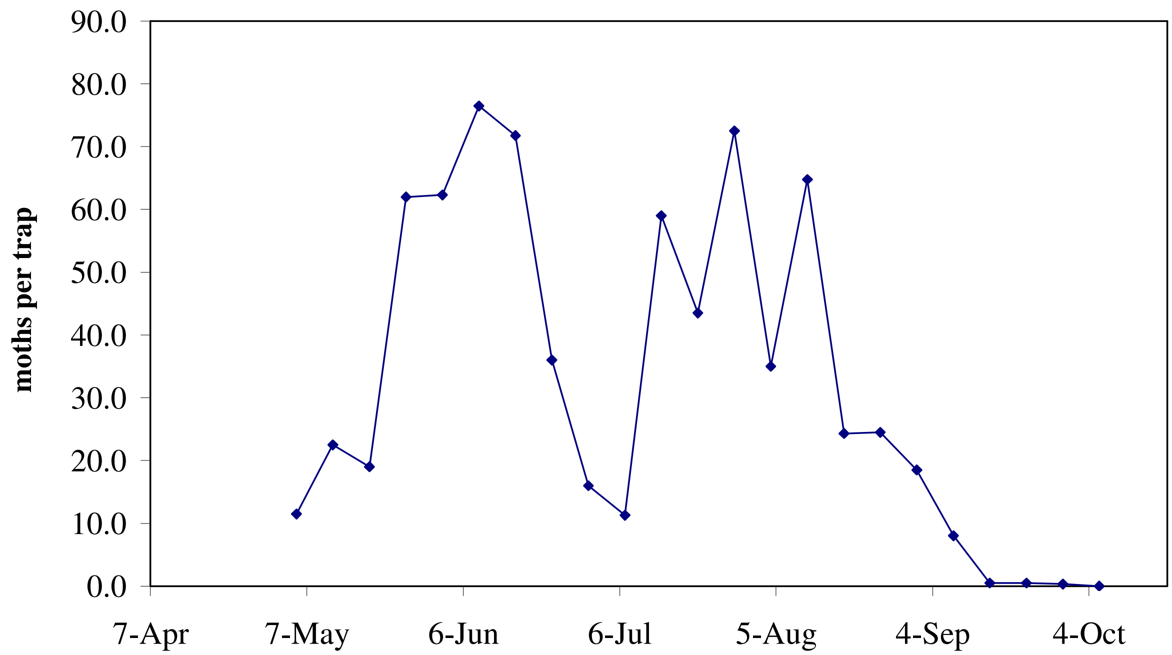

Lesser Apple Worm Trap Captures, MHCRS
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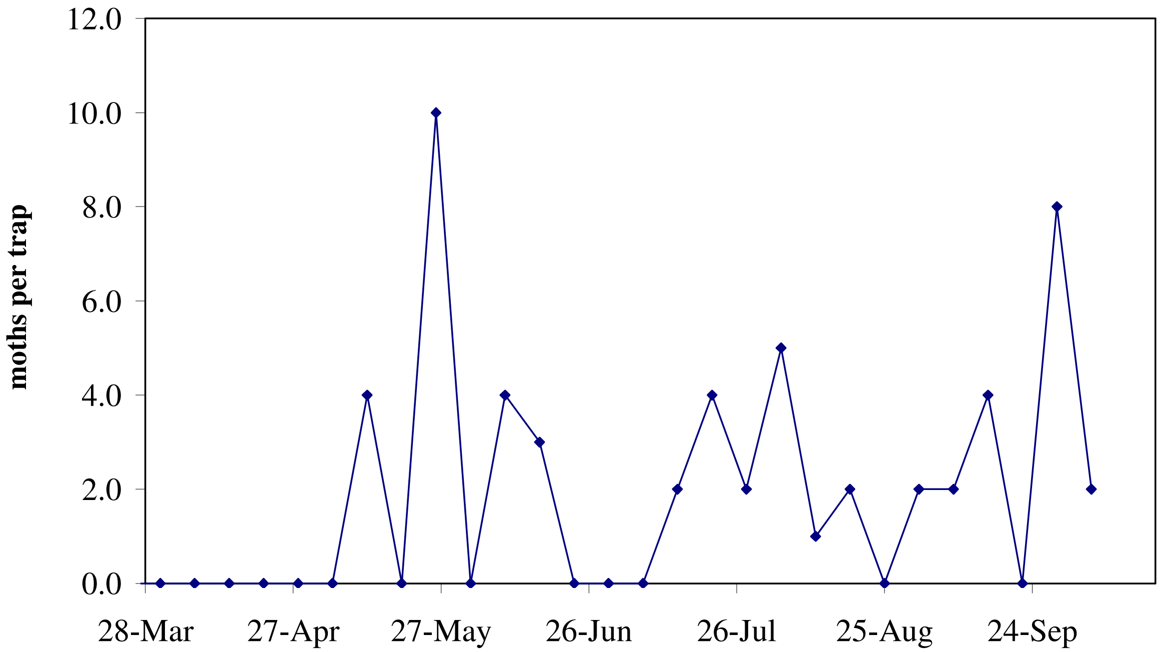
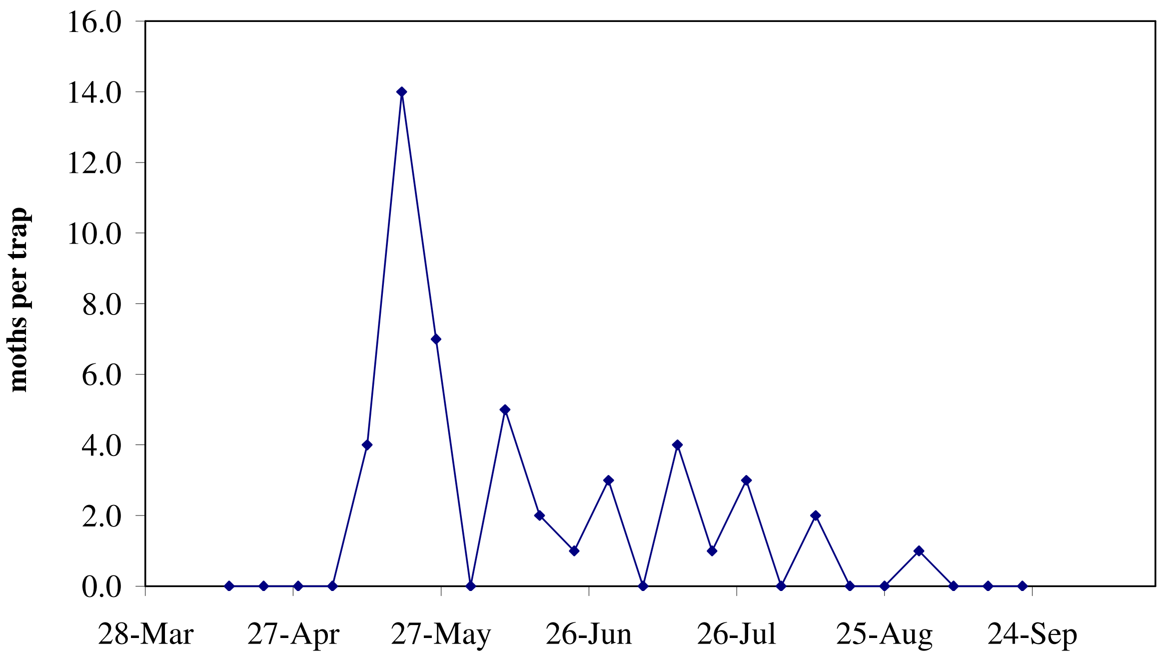
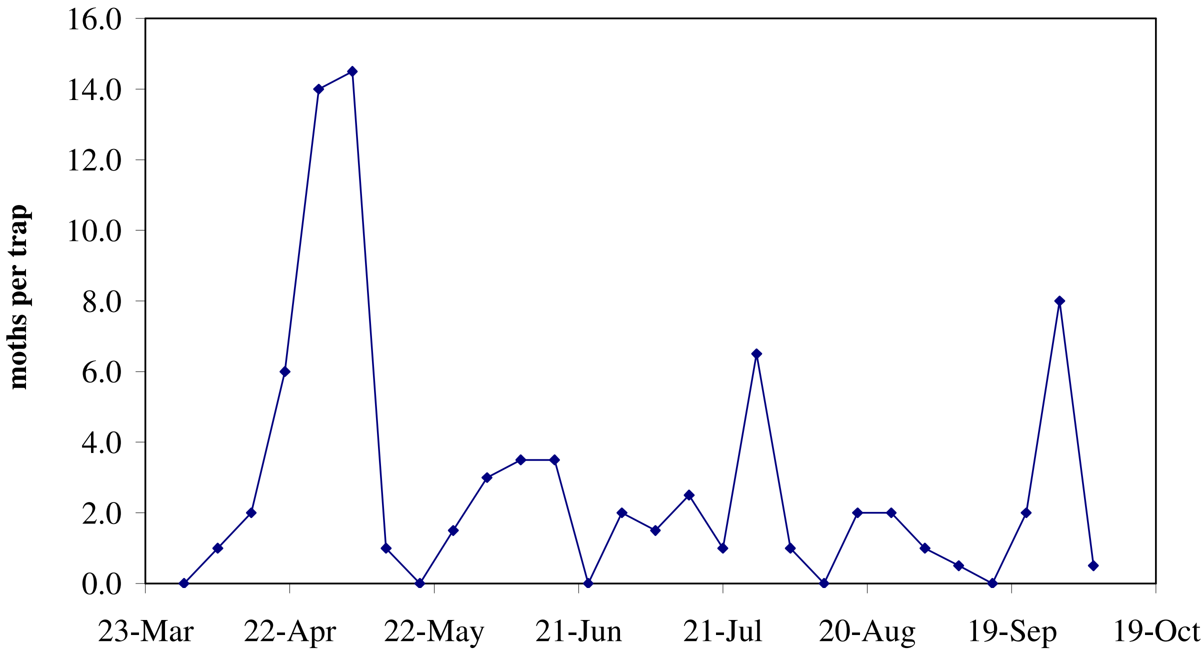


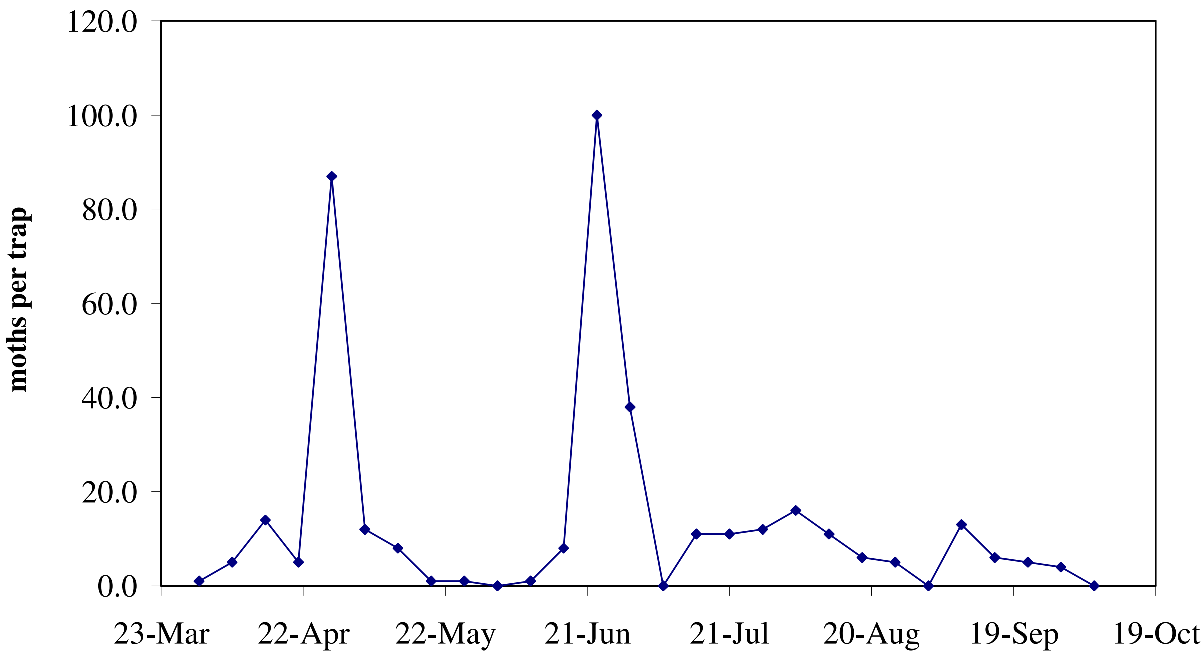
Obliquebanded Leafroller Trap Captures
Toluca, Lincoln County, NC, 2008



Oriental Fruit Moth Trap Captures, MHCRS
Mills River, Henderson County, NC, 2008



Oriental Fruit Moth Trap Captures
Edneyville, Henderson County, NC, 2008



Redbanded Leafroller Trap Captures, MHCRS
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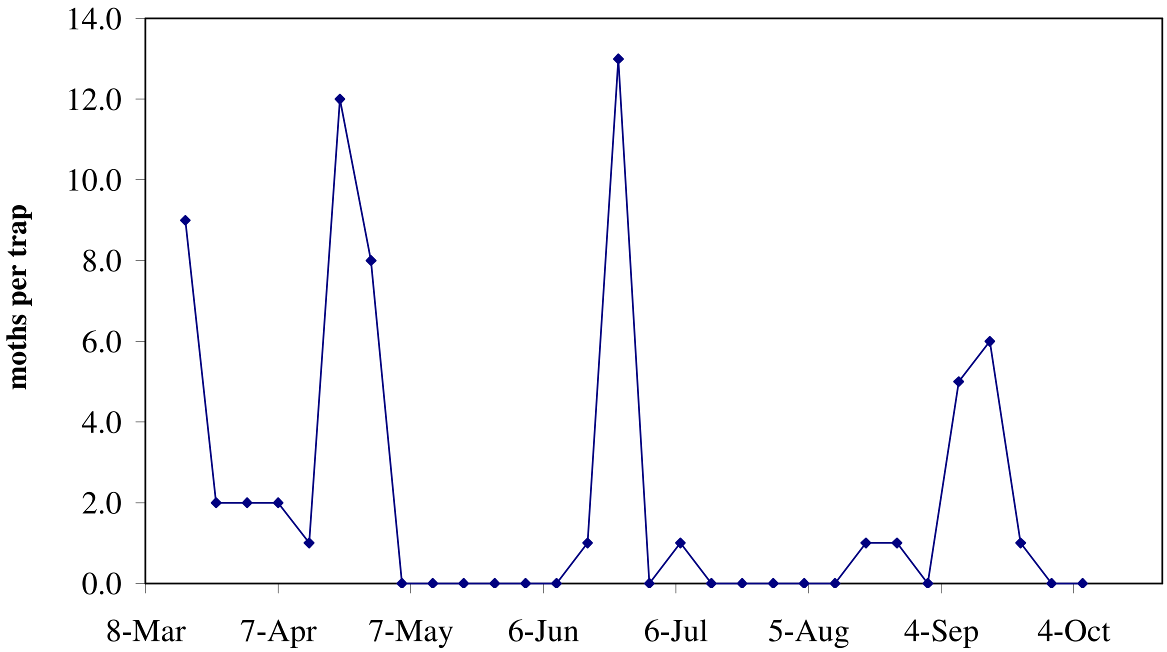
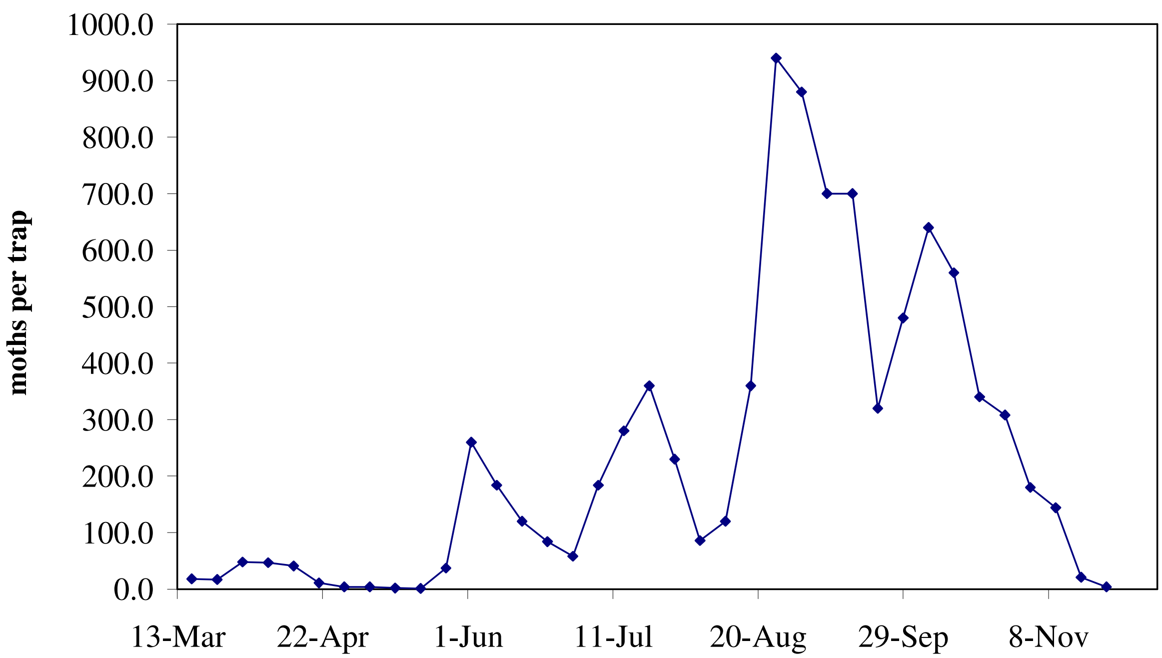
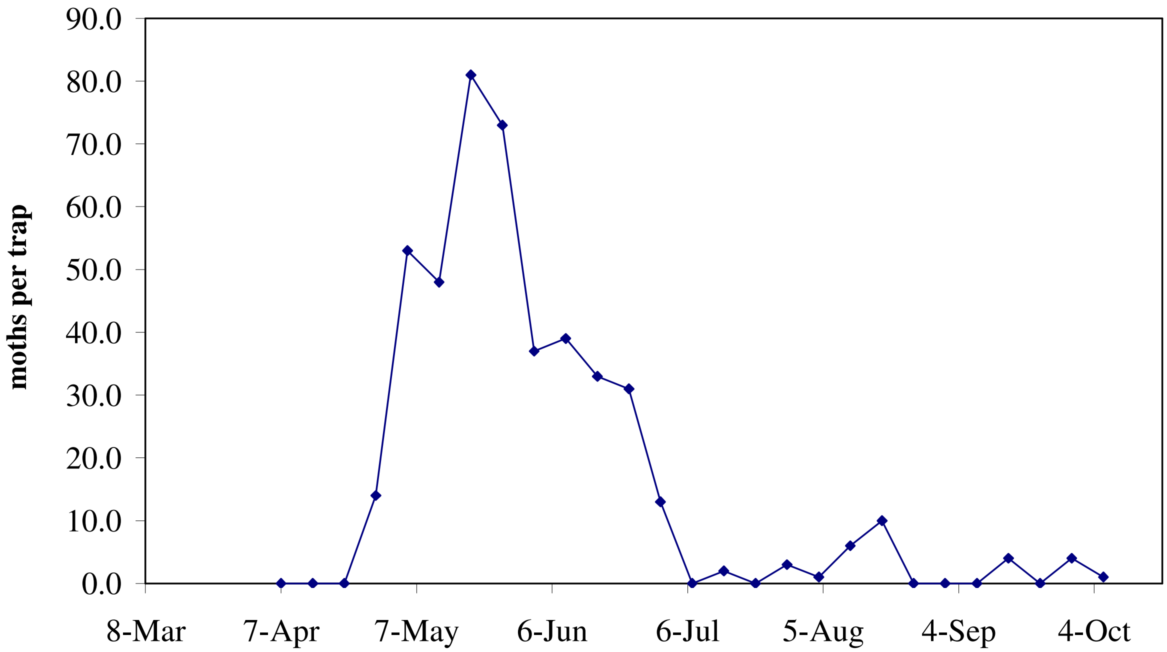


Spotted Tentiform Leafminer Trap Captures, MHCRS
Mills River, Henderson County, NC, 2008



Tufted Apple Bud Moth Trap Captures
Edneyville, Henderson County, NC, 2008



Tufted Apple Bud Moth Trap Captures
Edneyville, Henderson County, NC, 2008