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

2012

ANNUAL REPORT

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Acknowledgments

This report is a summary of pest management-related studies conducted on fruit and vegetable crops in 2012 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, the crop protection industry and consultants in western North Carolina is also presented.

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2012 Weather Data – Mountain Horticultural Crops Research Station, Mills River, NC

March

Day	Temp (°F) High	Temp (°F) Low	Rain (in.)
1	72.0	39.7	0.01
2	62.6	37.6	0.33
3	60.6	42.3	0.40
4	43.9	29.1	
5	44.8	27.9	
6	55.6	22.5	
7	59.5	31.5	
8	65.3	49.8	0.38
9	55.6	38.5	0.15
10	60.6	32.7	
11	62.6	27.0	
12	62.1	47.5	0.02
13	72.9	46.9	0.02
14	78.1	40.3	
15	76.5	40.6	0.04
16	76.8	49.1	0.48
17	72.7	49.1	
18	73.0	48.6	0.22
19	79.7	49.8	
20	79.7	48.9	0.49
21	74.3	50.4	
22	71.6	51.1	
23	69.3	54.5	0.53
24	70.7	50.2	0.05
25	58.6	48.2	0.01
26	70.0	52.5	
27	68.2	44.8	
28	78.6	41.9	
29	76.3	49.5	
30	76.6	46.4	0.14
31	72.9	49.8	0.10
			3.37

April

Day	Temp (°F) High	Temp (°F) Low	Rain (in.)
1	75.7	43.2	
2	79.2	46.9	
3	76.5	50.9	0.03
4	75.6	50.4	0.10
5	71.6	50.4	1.32
6	63.5	43.0	0.36
7	68.9	34.2	
8	72.1	37.0	
9	74.1	38.8	
10	68.9	45.7	
11	55.0	39.2	
12	64.4	35.4	
13	67.5	31.5	
14	71.6	37.2	
15	77.2	40.5	
16	79.9	55.9	
17	78.1	53.8	1.01
18	55.2	51.3	0.99
19	66.7	51.3	
20	70.9	53.2	
21	71.4	50.5	0.11
22	60.1	40.1	
23	52.5	38.5	
24	58.1	39.9	
25	72.0	44.2	0.15
26	69.6	52.2	0.56
27	74.3	53.1	
28	70.0	49.5	
29	81.9	49.1	
30	82.8	54.5	
			4.63

May

Day	Temp (°F) High	Temp (°F) Low	Rain (in.)
1	82.2	64.0	0.50
2	85.3	58.8	
3	84.0	53.6	
4	81.1	59.4	
5	77.5	55.8	
6	78.3	56.7	
7	75.6	61.7	
8	75.0	59.9	0.58
9	62.8	48.2	0.19
10	66.2	46.2	
11	71.8	40.5	
12	67.8	46.8	
13	61.5	53.2	0.38
14	74.8	57.4	0.74
15	73.0	55.9	0.11
16	75.9	54.7	
17	79.0	51.8	0.01
18	75.4	57.0	
19	77.0	52.7	0.74
20	79.9	52.7	0.01
21	79.7	49.6	0.01
22	75.6	54.3	
23	71.6	59.4	0.02
24	79.9	58.1	
25	85.5	57.2	
26	85.3	57.9	
27	81.9	60.4	
28	82.2	61.5	0.02
29	81.0	64.4	
30	82.0	55.9	
31	81.9	51.6	0.06
			3.37

June

Day	Temp (°F) High	Temp (°F) Low	Rain (in.)
1	73.2	55.0	0.01
2	66.9	47.7	
3	78.1	44.8	
4	78.1	53.4	
5	74.5	57.2	
6	68.5	58.1	0.05
7	76.6	58.3	
8	80.1	52.9	
9	79.7	55.6	
10	69.8	59.5	0.01
11	75.9	61.0	0.07
12	82.6	64.4	0.22
13	81.7	61.3	
14	79.5	59.5	
15	77.0	57.0	
16	77.7	52.2	
17	80.1	58.6	
18	81.5	60.6	
19	84.4	57.0	
20	87.3	57.7	
21	87.4	61.5	0.91
22	84.6	64.4	0.45
23	86.5	63.9	
24	87.8	62.6	
25	87.4	65.7	
26	81.3	54.9	
27	83.5	49.1	
28	94.8	51.4	
29	96.6	61.9	
30	98.8	63.1	
			1.72

2012 Weather Data – Mountain Horticultural Crops Research Station, Fletcher, NC

July				August				September				October			
	Temp (^{o}F)		Rain		Temp (^{o}F)		Rain		Temp (^{o}F)		Rain		Temp (^{o}F)		Rain
Day	High	Low	(in.)	Day	High	Low	(in.)	Day	High	Low	(in.)	Day	High	Low	(in.)
1	99.0	64.6	0.03	1	87.6	62.4	0.01	1	88.9	66.2		1	60.8	57.4	1.00
2	85.8	64.6	0.43	2	87.8	63.3	0.01	2	82.9	66.7		2	74.5	59.4	1.47
3	86.2	64.4		3	84.0	63.7	0.32	3	81.7	66.4	0.44	3	75.6	57.6	
4	88.2	65.1	0.34	4	82.2	66.6	0.19	4	77.7	68.0	0.14	4	74.5	51.8	
5	90.5	64.4		5	85.5	65.5		5	81.7	67.5	0.50	5	76.6	47.8	
6	90.5	63.3		6	84.4	66.6	0.14	6	83.1	65.3		6	72.0	50.2	
7	92.3	64.0		7	81.3	67.8		7	86.5	61.5		7	59.0	44.8	0.18
8	91.9	66.6		8	85.1	66.4		8	81.9	60.1	0.05	8	50.2	45.3	
9	84.0	66.4		9	82.6	65.1	0.30	9	73.2	51.1		9	60.1	46.0	
10	81.7	67.3	0.03	10	80.6	63.1	0.01	10	76.6	46.4		10	63.0	41.4	
11	74.7	66.2	0.65	11	77.4	61.5		11	76.1	53.6		11	68.0	39.4	
12	69.8	64.8	0.05	12	81.1	57.2		12	77.5	55.2		12	68.5	42.3	
13	79.7	66.6	1.21	13	81.5	54.5		13	73.9	52.9		13	64.0	45.1	
14	83.5	68.4	0.12	14	85.3	59.4		14	78.8	54.0		14	66.4	45.5	
15	85.5	66.6		15	81.3	59.2	0.06	15	82.8	51.6	0.07	15	70.9	48.2	0.61
16	87.4	63.7		16	84.9	55.2		16	73.2	61.5	0.08	16	66.4	42.1	0.06
17	86.9	66.2	0.04	17	75.6	59.7	0.02	17	71.2	61.5	1.21	17	69.3	37.2	
18	88.0	64.4		18	78.6	62.2	0.78	18	68.7	58.1	2.35	18	65.8	43.7	0.01
19	86.9	67.5	0.27	19	77.5	63.1	0.19	19	73.6	54.1		19	66.9	37.6	
20	83.1	67.6	0.09	20	78.1	58.5		20	73.6	55.4		20	62.2	38.5	
21	83.7	66.9	0.03	21	79.0	53.2	0.02	21	78.6	53.4		21	68.7	36.9	
22	88.7	64.4		22	80.6	57.0	0.01	22	82.2	54.0		22	76.1	37.8	
23	86.4	64.8	0.10	23	80.8	59.9		23	70.9	45.5		23	79.2	40.1	
24	87.4	66.0	0.01	24	79.3	60.6	0.34	24	70.2	41.4		24	79.5	40.1	
25	89.2	68.4	0.09	25	82.8	58.1	0.04	25	75.9	41.5		25	73.9	39.0	
26	93.4	69.8		26	84.4	60.4		26	81.9	50.4		26	76.3	50.0	
27	86.9	67.5	0.66	27	83.7	59.2		27	79.9	54.5		27	67.1	47.5	
28	87.8	66.2		28	83.5	59.5		28	81.7	52.9		28	53.6	40.5	0.09
29	85.1	62.4		29	83.3	66.0		29	70.9	56.5	0.66	29	45.7	37.9	
30	85.6	65.1		30	82.8	65.7		30	69.6	55.6	0.01	30	42.4	36.7	
31	74.7	64.2	0.75	31	87.4	66.2						31	54.5	34.5	
			4.90				2.44				5.51				3.42

At-Planting Drench Application of Cyazypyr

Tomato, *Lycopersicon esculentum* Mill. 'Florida 47'

Thrips (FT): *Frankliniella fusca* (Hinds), *F. tritici* (Fitch) and *F. occidentalis* (Pergande)
Flea beetle (FB): *Epitrix* spp.
Potato aphid (PA): *Macrosiphum euphorbiae* (Thomas)
Twospotted spider mite (TSSM): *Tetranychus urticae* (Koch)
Silverleaf whitefly (SWF): *Bemisia argentifolii* (Bellows and Perring)
Tomato fruitworm (TFW): *Helicoverpa zea* (Boddie)
Armyworms (AW): *Spodoptera* spp.
Stink bugs (SB): *Euschistus servus* (Say) and *Acrosternum hilare* (Say)

This study was conducted at the Mountain Horticultural Crops Research Station in Mills River, NC. Six-wk-old 'Florida 47' tomato transplants were set on 18 May on black plastic mulch with drip irrigation. Plots consisted of three 20-ft rows on 5-ft centers, with treatment rows separated by 10 ft of bare ground. Plants were spaced 1.5 ft within rows, and treatments were replicated four times and arranged in a RCB design. At-plant drench applications of cyazypyr 20SC (13.5 oz/acre) or Admire Pro 4.6F (10 oz/acre) were made by pouring 16 oz of insecticide-water solution at the base of each transplant immediately after planting. In addition, cyazypyr 20SC (10.3 oz/acre) was applied through the drip irrigation system (using a CO_2 powered injector) to one of the Admire Pro transplant treatments on 6 June. The pH of water for all cyazypyr solution treatments was adjusted to ~4.5 with sulfuric acid. A CO_2-powered backpack sprayer delivering 30 to 100 GPA (volume increased as plants grew) was used to make foliar applications of Radiant 1SC (6 oz/A) on 15 Jun and 20 Jul, Rimon (12 oz/A) on 22 Jun, Warrior 1EC (3 oz/A) on 29 Jun and 27 Jul, and Scorpion (5 oz/A) on 13 Aug. Tomatoes were staked and strung as needed and sprayed with a standard fungicide and herbicide program.

Thrips and flea beetles were monitored on plants for 5 wk after planting by counting the number observed in beat samples of 5 plants per plot. Once flowers appeared, thrips were counted by removing 10 flowers per plot, placing them in a vial of 50% ETOH, and counting dislodged insects under a stereomicroscope. Potato aphids were sampled by observing the terminal trifoliate leaflets of 10 recent, fully-expanded leaves per plot and recording the total number of apterous aphids. Twospotted spider mites were counted on 10 terminal leaflets per plot. Whiteflies were never observed in appreciable numbers and were therefore not counted. Season total insect-days were calculated by multiplying the average count between sample dates by the time interval between samples (days) and summing values from all sample dates. Mature fruit were harvested from the eight middle plants of each plot on 1, 15 and 28 Aug and 12 Sep and graded for size (Jumbo >3.5", XL 3-3.5", L 2.5-3", and M 2-2.5"), weight, and insect damage. All data were subjected to two-way ANOVA and means were separated by LSD (P = 0.05).

Indirect insect pest populations were extremely low in this trial and there were no significant differences were observed in field counts throughout the season. Peak densities of thrips populations reached less than 4 insects per beat sample and approximately 0.6 per flower (Tables

1 and 2), and although there were no significant differences among treatments, populations were higher in flowers from control plots than from treatment plots. Flea beetle populations never exceeded 1 per beat sample (Table 3), and potato aphid populations peaked at approximately 2 per trifoliate leaflet on 23-Aug (Table 4). Aphids were considerably higher in the control compared to the treatment plots, but differences were not statistically significant due to high variation among reps. Twospotted spider mites peaked at approximately 22 per leaflet on 23 Aug, with no significant differences observed (Table 5).

Total yields were moderately high in this trial, ranging from about 31 to 35 tons/acre (Table 6). There were no differences among treatments in total yield. All insecticide treatments had significantly higher marketable yield than the control, due largely to lower overall insect damage. Although not significant, it is noteworthy that all insecticide treatments had a numerically higher percentage of extra-large fruit compared with the control. All insecticide treatments had significantly lower percentage fruit damaged by lepidopterans, stink bugs and thrips, than the control. Lepidopteran damage, caused principally by tomato fruitworm, was highest on the last sample date (12 September), when the control had 18.4% damage (Table 7). This was approximately one month after the last foliar insecticide application, and it is interesting that neither of the cyazypyr treatments had any lepidopteran damage, while the non-cyazypyr treatment had 8.3% damage, which did not differ from the control.

Table 1. Total thrips on 'Florida 47' tomato plants treated with various insecticides. Mills River, NC. 2012.

			Thrips per 5 beat samples				
Treatment	Rate	App. method	24-May	31-May	7-Jun	13-Jun	20-Jun
Cyazypyr 20SC Foliar Program[1]	13.5 fl oz	Drench (5/18) Backpack sprayer	3.5a	2.0a	0.8a	1.3a	0.5a
Admire Pro 4.6 Cyazypyr 20SC Foliar Program[1]	10.5 fl oz 10.3 fl oz	Drench (5/18) Drip (6/6) Backpack sprayer	2.3a	1.3a	1.0a	0.5a	0.5a
Admire Pro 4.6 Foliar Program[1]	10.5 fl oz	Drench (5/18) Backpack sprayer	0.5a	0.5a	0.3a	1.5a	0.0a
Control	-	-	2.3a	1.5a	0.5a	0.8a	0.5a

Means in the same column followed by the same letter are not significantly different by LSD (p=0.05).
[1]Foliar program consisted of Radiant 1SC (6 oz/A) on 6/15 and 7/20, Rimon (12 oz/A) on 6/22, Warrior 1EC (3 oz/A) on 6/29 and 7/27, and Scorpion (5 oz/A) on 8/13.

Table 2. Thrips on 'Florida 47' tomato plants treated with various insecticides. Mills River, NC. 2012.

Treatment	Rate	App. method	13-Jun	20-Jun	27-Jun	4-Jul	11-Jul	18-Jul	25-Jul	2-Aug	8-Aug	15-Aug	CTD
			Adult thrips per 10 flowers										
Cyazypyr 20SC Foliar Program[1]	13.5 fl oz	Drench (5/18) Backpack sprayer	0.3a	0.5a	2.5a	1.5a	2.5a	3.3b	2.5a	1.8a	0.5a	0.8a	109.5a
Admire Pro 4.6 Cyazypyr 20SC Foliar Program[1]	10.5 fl oz 10.3 fl oz	Drench (5/18) Drip (6/6) Backpack sprayer	0.3a	0.8a	3.3a	1.5a	1.8a	0.0a	4.8a	0.8a	1.3ab	0.8a	103.3a
Admire Pro 4.6 Foliar Program[1]	10.5 fl oz	Drench (5/18) Backpack sprayer	0.0a	1.0a	4.3a	1.8a	2.0a	0.0a	2.8a	1.3a	0.3a	1.3a	98.4a
Control	-	-	0.8a	0.0a	1.8a	2.5a	4.0a	2.5ab	6.0a	2.8a	2.5b	1.8a	164.5a
			Immature thrips per 10 flowers										
Cyazypyr 20SC Foliar Program[1]	13.5 fl oz	Drench (5/18) Backpack sprayer	0.3a	0.0a	0.0a	0.0a	0.0a	0.3a	0.3a	0.8a	0.0a	0.0a	9.8a
Admire Pro 4.6 Cyazypyr 20SC Foliar Program[1]	10.5 fl oz 10.3 fl oz	Drench (5/18) Drip (6/6) Backpack sprayer	1.0a	0.0a	0.0a	0.5a	0.3a	0.0a	1.0a	0.5a	0.0a	0.0a	19.8a
Admire Pro 4.6 Foliar Program[1]	10.5 fl oz	Drench (5/18) Backpack sprayer	0.0a	0.0a	0.3a	0.0a	0.3a	0.0a	0.3a	0.3a	0.0a	0.0a	7.1a
Control	-	-	0.5a	0.0a	0.0a	0.3a	0.5a	1.8a	0.0a	0.8a	1.3a	0.0a	32.6a
			Total thrips per 10 flowers										
Cyazypyr 20SC Foliar Program[1]	13.5 fl oz	Drench (5/18) Backpack sprayer	0.5a	0.5a	2.5a	1.5a	2.5a	3.5b	2.8a	2.5a	0.5a	0.8a	119.3a
Admire Pro 4.6 Cyazypyr 20SC Foliar Program[1]	10.5 fl oz 10.3 fl oz	Drench (5/18) Drip (6/6) Backpack sprayer	1.3a	0.8a	3.3a	2.0a	2.0a	0.0a	5.8a	1.3a	1.3a	0.8a	123.0a
Admire Pro 4.6 Foliar Program[1]	10.5 fl oz	Drench (5/18) Backpack sprayer	0.0a	1.0a	4.5a	1.8a	2.3a	0.0a	3.0a	1.5a	0.3a	1.3a	105.5a
Control	-	-	1.3a	0.0a	1.8a	2.8a	4.5a	4.3b	6.0a	3.5a	3.8b	1.8a	197.1a

Means in the same column followed by the same letter are not significantly different by LSD (p=0.05).
[1]Foliar program consisted of Radiant 1SC (6 oz/A) on 6/15 and 7/20, Rimon (12 oz/A) on 6/22, Warrior 1EC (3 oz/A) on 6/29 and 7/27, and Scorpion (5 oz/A) on 8/13.

Table 3. Flea beetles on 'Florida 47' tomato plants treated with various insecticides. Mills River, NC. 2012.

Treatment	Rate	App. method	Flea beetles per 5 beat samples			
			13-Jun	20-Jun	4-Jul	Season Total
Cyazypyr 20SC Foliar Program[1]	13.5 fl oz	Drench (5/18) Backpack sprayer	0.5a	0.0a	0.0a	0.5a
Admire Pro 4.6 Cyazypyr 20SC Foliar Program[1]	10.5 fl oz 10.3 fl oz	Drench (5/18) Drip (6/6) Backpack sprayer	0.3a	0.3a	0.0a	0.5a
Admire Pro 4.6 Foliar Program[1]	10.5 fl oz	Drench (5/18) Backpack sprayer	0.5a	0.8a	0.0a	1.3a
Control	-	-	0.5a	0.5a	0.0a	1.0a

Means in the same column followed by the same letter are not significantly different by LSD (p=0.05).
[1]Foliar program consisted of Radiant 1SC (6 oz/A) on 6/15 and 7/20, Rimon (12 oz/A) on 6/22, Warrior 1EC (3 oz/A) on 6/29 and 7/27, and Scorpion (5 oz/A) on 8/13.

Table 4. Aphids on 'Florida 47' tomato plants treated with various insecticides. Mills River, NC. 2012.

			Aphids per 10 trifoliate leaflets											
Treatment	Rate	App. method	20-Jun	27-Jun	4-Jul	11-Jul	18-Jul	25-Jul	2-Aug	8-Aug	15-Aug	23-Aug	30-Aug	CTD
Cyazypyr 20SC Foliar Program[1]	13.5 fl oz	Drench (5/18) Backpack sprayer	0.0a	0.0a	0.0a	0.0a	0.0a	0.8a	0.0a	0.5a	0.0a	0.3a	1.0a	14.3a
Admire Pro 4.6 Cyazypyr 20SC Foliar Program[1]	10.5 fl oz 10.3 fl oz	Drench (5/18) Drip (6/6) Backpack sprayer	0.3a	3.0a	0.0a	0.0a	0.0a	0.3a	0.0a	0.3a	0.0a	0.0a	0.5a	27.1a
Admire Pro 4.6 Foliar Program[1]	10.5 fl oz	Drench (5/18) Backpack sprayer	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	1.0a	1.0a	3.3a	2.3a	46.3a
Control	-	-	0.0a	0.5a	0.0a	0.0a	0.3a	0.0a	1.0a	1.0a	14.8a	22.3a	9.3a	328.6a

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

[1]Foliar program consisted of Radiant 1SC (6 oz/A) on 6/15 and 7/20, Rimon (12 oz/A) on 6/22, Warrior 1EC (3 oz/A) on 6/29 and 7/27, and Scorpion (5 oz/A) on 8/13.

Table 5. Twospotted spider mites on 'Florida 47' tomato plants treated with various insecticides. Mills River, NC. 2012.

			Mites per 10 terminal leaves					
Treatment	Rate	App. method	2-Aug	8-Aug	15-Aug	23-Aug	30-Aug	Cumulative Mite Days
Cyazypyr 20SC Foliar Program[1]	13.5 fl oz	Drench (5/18) Backpack sprayer	13.3a	13.5a	43.3a	121.3a	140.0a	1851.3a
Admire Pro 4.6 Cyazypyr 20SC Foliar Program[1]	10.5 fl oz 10.3 fl oz	Drench (5/18) Drip (6/6) Backpack sprayer	0.0a	6.8a	28.0a	222.5a	171.5a	2522.9a
Admire Pro 4.6 Foliar Program[1]	10.5 fl oz	Drench (5/18) Backpack sprayer	0.8a	1.5a	26.0a	131.3a	124.0a	1625.4a
Control	-	-	15.5a	13.5a	49.5a	123.0a	88.8a	1738.6a

Means in the same column followed by the same letter are not significantly different by LSD (p=0.05).
[1]Foliar program consisted of Radiant 1SC (6 oz/A) on 6/15 and 7/20, Rimon (12 oz/A) on 6/22, Warrior 1EC (3 oz/A) on 6/29 and 7/27, and Scorpion (5 oz/A) on 8/13.

Table 6. Season total fruit (by weight) harvested from 'Florida 47' tomato plants treated with various insecticides. Mills River, NC. 2012.

Treatment	Rate	App. method	Total yield (tons)	Marketable					Non-Marketable				
				% Jumbo	% Extra Large	% Large	% Medium	% Total Marketable	% Lep	% Stink Bug	% Thrips	% Non-Insect	% Under-sized
Cyazypyr 20SC Foliar Program[1]	13.5 fl oz	Drench (5/18) Backpack sprayer	33.3a	24.0a	44.1a	12.7a	1.1a	81.8b	0.6a	5.9a	1.7a	10.1a	81.8b
Admire Pro 4.6 Cyazypyr 20SC Foliar Program[1]	10.5 fl oz 10.3 fl oz	Drench (5/18) Drip (6/6) Backpack sprayer	35.1a	31.4a	47.7a	4.8a	0.9a	84.8b	1.4a	1.8a	0.5a	11.6a	84.8b
Admire Pro 4.6 Foliar Program[1]	10.5 fl oz	Drench (5/18) Backpack sprayer	31.3a	21.5a	52.6a	5.0a	0.4a	79.5b	1.8a	4.4a	1.8a	12.6a	79.5b
Control	-	-	33.2a	24.6a	31.8a	3.8a	0.6a	60.7a	5.6b	21.9b	3.8b	7.9a	60.7a

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

[1]Foliar program consisted of Radiant 1SC (6 oz/A) on 6/15 and 7/20, Rimon (12 oz/A) on 6/22, Warrior 1EC (3 oz/A) on 6/29 and 7/27, and Scorpion (5 oz/A) on 8/13.

Table 7. Percent damage to fruit of 'Florida 47' tomato plants treated with various insecticides. Mills River, NC. 2012.

Treatment	Rate	App. method	% Lep				% Stink bug				% Thrips				% Non-insect			
			1-Aug	15-Aug	28-Aug	12-Sep	1-Aug	15-Aug	28-Aug	12-Sep	1-Aug	15-Aug	28-Aug	12-Sep	1-Aug	15-Aug	28-Aug	12-Sep
Cyazypyr 20SC Foliar Program[1]	13.5 fl oz	Drench (5/18) Back. sprayer	0.7a	0.9a	0.0a	0.0a	0.0a	6.5a	12.2a	2.5a	1.7a	2.7a	0.0a	0.0a	24.2ab	3.6a	0.0a	30.4a
Admire Pro 4.6 Cyazypyr 20SC Foliar Program[1]	10.5 fl oz 10.3 fl oz	Drench (5/18) Drip (6/6) Back. sprayer	1.5a	2.0a	0.0a	0.0a	0.0a	2.6a	2.3a	1.3a	0.5a	0.8a	0.0a	0.0a	36.5b	1.8a	0.5a	21.1a
Admire Pro 4.6 Foliar Program[1]	10.5 fl oz	Drench (5/18) Back. sprayer	1.5a	1.6a	1.7a	8.3ab	0.0a	7.0a	6.4a	3.4a	1.3a	2.1a	0.8a	0.0a	33.8b	2.0a	0.0a	32.3a
Control	-	-	6.3a	3.9a	9.6a	18.4b	9.2b	24.9b	35.1b	22.1b	5.2a	4.1a	1.0a	0.0a	17.9a	4.1a	0.6a	20.8a

Means in the same column followed by the same letter are not significantly different by LSD (p=0.05).
[1]Foliar program consisted of Radiant 1SC (6 oz/A) on 6/15 and 7/20, Rimon (12 oz/A) on 6/22, Warrior 1EC (3 oz/A) on 6/29 and 7/27, and Scorpion (5 oz/A) on 8/13.

Cyazypyr Foliar Insecticide Trial

Tomato, *Lycopersicon esculentum* Mill. 'Florida 47'

Thrips (FT): *Frankliniella fusca* (Hinds), *F. tritici* (Fitch) and *F. occidentalis* (Pergande)
Flea beetle (FB): *Epitrix* spp.
Potato aphid (PA): *Macrosiphum euphorbiae* (Thomas)
Twospotted spider mite (TSSM): *Tetranychus urticae* (Koch)
Silverleaf whitefly (SWF): *Bemisia argentifolii* (Bellows and Perring)
Tomato fruitworm (TFW): *Helicoverpa zea* (Boddie)
Armyworms (AW): *Spodoptera* spp.
Stink bugs (SB): *Euschistus servus* (Say) and *Acrosternum hilare* (Say)

This study was conducted at the Mountain Horticultural Crops Research Station in Mills River, NC. Six-wk-old 'Florida 47' tomato transplants were set on 29 May on black plastic mulch with drip irrigation. Plots consisted of two 20-ft rows on 5-ft centers with treatment rows separated by 10 ft of bare ground. Plants were spaced 1.5 ft within rows, and treatments were replicated four times and arranged in a RCB design. All plants except those in the untreated control received 16 oz of a standard Admire Pro 10.5 oz/A transplant drench solution. Treatments consisted of three different rates of cyazypyr 10SE (13.5, 16.9 and 20.6 oz/A) at 14 (22 June) and 21 days after planting (29 June), a standard sprayed with Radiant 1SC (6 oz/A) and Rimon 0.83EC (10 oz/A) at 14 and 21 DAT after planting, respectively, and a non-treated control. All treatments were subsequently sprayed with the same standard insecticide program the remainder of the season, and consisted of Coragen 1.67SC (4 oz/A) on 6 and 20 Jul, Danitol 2.4EC (10 2/3 oz/A) on 16 Jul, Radiant 1SC (6 oz/A) on 27 Jul, and Scorpion 35SL (4 oz/A) on 13 Aug. A CO_2-powered backpack sprayer delivering 30 to 100 GPA (volume increased as plants grew) was used to make all insecticide applications. Tomatoes were staked and strung as needed and sprayed with a standard fungicide and herbicide program.

Thrips were monitored on plants for 2 wk after planting by counting the number of thrips observed in beat samples on 5 plants. Once flowers appeared, thrips were counted weekly by removing 10 flowers per plot, placing them in a vial of 50% ETOH, and counting dislodged insects under a stereomicroscope. Flea beetles were monitored by counting the number of beetles observed in beat samples of 5 plants. Potato aphids were sampled by observing the terminal trifoliate leaflets of 10 recent, fully-expanded leaves per plot, and recording the total number of aphids. Twospotted spider mites were counted on 10 terminal leaflets per plot. Whiteflies were never observed in appreciable numbers and therefore were not counted. Season total insect-days were calculated by multiplying the average count between sample dates by the time between samples (days) and summing values from all sample dates. Mature fruit were harvested from the eight middle plants of each plot on 1, 15, and 28 Aug and 12 Sep and graded for size (Jumbo >3.5", XL 3-3.5", L 2.5-3", and M 2-2.5"), weight, and insect damage. All data were subjected to two-way ANOVA and means were separated by LSD (P = 0.05).

Overall insect populations were very low in this trial. Peak densities of thrips reached only 1.5 per 5 beat samples and less than 1 per flower (Tables 1 and 2). There were no significant differences in beat samples; in flower samples, the control had significantly higher cumulative immature and total thrips days any of the treatments, but there were no differences among insecticide treatments. Flea beetle populations were also very low, with a season total average of less than 1.5 insects per 5 beats across treatments (Table 3). Potato aphids began appearing in significant numbers in late July, but numbers in the control peaked at only 1.9 aphids per leaf on 20 Sep (Table 4). Despite the low numbers, insecticide treatments significantly reduced populations below the control in August and September, except for 23 Aug, when the Rimon/Radiant treatment did not differ from the control. Twospotted spider mites peaked at only about 9 per trifoliate leaflet in the control late September. None of the treatments affected mite populations in either a positive or negative manner in relation to the control (Table 5).

Season total yields averaged about 33 tons per acre across all treatments, and there were no significant differences among treatments (Table 6). All insecticide treatments had significantly higher marketable fruit than the control. Percentage marketable fruit averaged almost 90% across the four insecticide treatments, all of which were significantly higher than the control. Season total lepidopteran damage was low with only 3.3% of control fruit damaged, while stink bug damage was 10.6% in the control. All insecticide treatments significantly reduced lepidopteran and stink bug damage below the control. Insect damage by date is shown in Table 7.

Table 1. Total thrips on 'Florida 47' tomato plants treated with various insecticides. Mills River, NC. 2012.

			Thrips per 5 beat samples	
Treatment	Rate	App. timing	13-Jun	20-Jun
HGW86 10SE + Standard[1]	13.5 fl oz	14 + 21 DAP (see below)[1]	0.8a	0.5a
HGW86 10SE + Standard[1]	16.9 fl oz	14 + 21 DAP (see below)[1]	1.3a	0.0a
HGW86 10SE + Standard[1]	20.6 fl oz	14 + 21 DAP (see below)[1]	0.8a	0.8a
Thrips foliar[2] + Standard[1]		(see below)[2] (see below)[1]	0.5a	1.5a
Control	-	-	0.3a	0.0a

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

[1]Standard treatment consisted of Coragen (4 oz/A) on 7/6 and 7/20, Danitol (10⅔ oz/A) on 7/16, Radiant (6 oz/A) on 7/27, and Scorpion (4 oz/A) on 8/13.

[2]Thrips foliar treatment consisted of Radiant (6 oz/A) on 6/22 and Rimon (10 oz/A) on 6/29. These treatments were discontinued after 6/29 due to low thrips populations.

Table 2. Total thrips on 'Florida 47' tomato plants treated with various insecticides. Mills River, NC. 2012.

Treatment	Rate	App. timing	20-Jun	27-Jun	4-Jul	11-Jul	18-Jul	25-Jul	2-Aug	8-Aug	15-Aug	CTD
			Adult thrips per 10 flowers									
HGW86 10SE + Standard[1]	13.5 fl oz	14 + 21 DAP (see below)[1]	0.0a	1.5a	1.0a	0.8a	0.3a	2.0a	0.3a	0.8a	2.3a	54.0a
HGW86 10SE + Standard[1]	16.9 fl oz	14 + 21 DAP (see below)[1]	0.0a	0.5a	1.3a	2.5a	0.5a	2.5a	0.5a	2.0a	1.3a	72.9a
HGW86 10SE + Standard[1]	20.6 fl oz	14 + 21 DAP (see below)[1]	0.0a	0.5a	1.0a	1.8a	0.5a	4.0a	0.5a	0.8a	2.5a	73.4a
Thrips foliar[2] + Standard[1]		(see below)[2] (see below)[1]	0.0a	0.3a	1.5a	1.8a	0.0a	4.0a	2.8a	0.8a	1.5a	83.9a
Control	-	-	0.0a	1.0a	1.5a	2.3a	0.8a	7.5a	4.0a	1.3a	1.3a	135.3a
			Immature thrips per 10 flowers									
HGW86 10SE + Standard[1]	13.5 fl oz	14 + 21 DAP (see below)[1]	0.0a	0.0a	0.0a	0.0a	0.0a	0.3a	0.0a	0.0a	0.0a	1.9a
HGW86 10SE + Standard[1]	16.9 fl oz	14 + 21 DAP (see below)[1]	0.0a	0.0a	0.0a	0.5a	0.0a	0.3a	0.0a	0.3a	0.0a	7.0ab
HGW86 10SE + Standard[1]	20.6 fl oz	14 + 21 DAP (see below)[1]	0.0a	0.0a	0.0a	0.3a	0.5a	0.3a	0.0a	0.8a	0.0a	12.0b
Thrips foliar[2] + Standard[1]		(see below)[2] (see below)[1]	0.3a	0.0a	0.0a	0.0a	0.3a	0.5a	0.0a	0.3a	0.0a	8.0ab
Control	-	-	0.0a	0.0a	0.5a	0.8a	0.0a	1.0a	0.0a	1.3a	0.0a	24.4c
			Total thrips per 10 flowers									
HGW86 10SE + Standard[1]	13.5 fl oz	14 + 21 DAP (see below)[1]	0.0a	1.5a	1.0a	0.8a	0.3a	2.3a	0.3a	0.8a	2.3a	55.9a
HGW86 10SE + Standard[1]	16.9 fl oz	14 + 21 DAP (see below)[1]	0.0a	0.5a	1.3a	3.0a	0.5a	2.8a	0.5a	2.3a	1.3a	79.9a
HGW86 10SE + Standard[1]	20.6 fl oz	14 + 21 DAP (see below)[1]	0.0a	0.5a	1.0a	2.0a	1.0a	4.3a	0.5a	1.5a	2.5a	85.4a
Thrips foliar[2] + Standard[1]		(see below)[2] (see below)[1]	0.3a	0.3a	1.5a	1.8a	0.3a	4.5a	2.8a	1.0a	1.5a	91.9a
Control	-	-	0.0a	1.0a	2.0a	3.0a	0.8a	8.5a	4.0a	2.5a	1.3a	159.6b

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

[1]Standard treatment consisted of Coragen (4 oz/A) on 7/6 and 7/20, Danitol (10⅔ oz/A) on 7/16, Radiant (6 oz/A) on 7/27, and Scorpion (4 oz/A) on 8/13.

[2]Thrips foliar treatment consisted of Radiant (6 oz/A) on 6/22 and Rimon (10 oz/A) on 6/29. These treatments were discontinued after 6/29 due to low thrips populations.

Table 3. Flea beetles on 'Florida 47' tomato plants treated with various insecticides. Mills River, NC. 2012.

			Flea beetles per 10 plants (beat)				
Treatment	Rate	App. timing	20-Jun	27-Jun	4-Jul	11-Jul	Season Total
HGW86 10SE + Standard[1]	13.5 fl oz	14 + 21 DAP (see below)[1]	0.0a	1.5a	0.0a	1.5a	1.5a
HGW86 10SE + Standard[1]	16.9 fl oz	14 + 21 DAP (see below)[1]	0.0a	2.3a	0.0a	2.3a	2.3a
HGW86 10SE + Standard[1]	20.6 fl oz	14 + 21 DAP (see below)[1]	0.0a	0.5a	0.0a	0.5a	0.5a
Thrips foliar[2] + Standard[1]		(see below)[2] (see below)[1]	0.3a	0.5a	0.0a	0.8a	0.8a
Control	-	-	0.5a	1.8a	0.0a	2.3a	2.3a

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

[1]Standard treatment consisted of Coragen (4 oz/A) on 7/6 and 7/20, Danitol (10⅔ oz/A) on 7/16, Radiant (6 oz/A) on 7/27, and Scorpion (4 oz/A) on 8/13.

[2]Thrips foliar treatment consisted of Radiant (6 oz/A) on 6/22 and Rimon (10 oz/A) on 6/29. These treatments were discontinued after 6/29 due to low thrips populations.

Table 4. Potato aphids on 'Florida 47' tomato plants treated with various insecticides. Mills River, NC. 2012.

Treatment	Rate	App. timing	Aphids per 10 trifoliate leaves													
			20-Jun	27-Jun	4-Jul	11-Jul	18-Jul	25-Jul	2-Aug	8-Aug	15-Aug	23-Aug	30-Aug	6-Sep	20-Sep	CAD
HGW86 10SE + Standard[1]	13.5 fl oz	14 + 21 DAP (see below)[1]	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.3a	0.0a	0.5a	1.5a	17.6a
HGW86 10SE + Standard[1]	16.9 fl oz	14 + 21 DAP (see below)[1]	0.0a	0.5a	0.0a	0.0a	0.0a	0.0a	0.0a	0.3a	0.3a	0.0a	1.8a	0.0a	4.8a	52.5a
HGW86 10SE + Standard[1]	20.6 fl oz	14 + 21 DAP (see below)[1]	0.0a	0.0a	0.0a	0.0a	0.0a	0.5a	0.0a	0.0a	1.0a	0.0a	1.0a	0.8a	0.3a	27.9a
Thrips foliar[2] + Standard[1]		(see below)[2] (see below)[1]	1.5a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.5a	0.0a	4.0ab	0.0a	0.0a	5.0a	73.5a
Control	-	-	1.5a	0.0a	0.0a	0.0a	0.0a	6.3a	1.3a	12.5a	5.8b	8.5b	12.0b	8.5a	18.8b	553.5b

Means in the same column followed by the same letter are not significantly different by LSD (p=0.05).
[1]Standard treatment consisted of Coragen (4 oz/A) on 7/6 and 7/20, Danitol (10⅔ oz/A) on 7/16, Radiant (6 oz/A) on 7/27, and Scorpion (4 oz/A) on 8/13.
[2]Thrips foliar treatment consisted of Radiant (6 oz/A) on 6/22 and Rimon (10 oz/A) on 6/29. These treatments were discontinued after 6/29 due to low thrips populations.

Table 5. Twospotted spider mites on 'Florida 47' tomato plants treated with various insecticides. Mills River, NC. 2012.

			Mites per 10 leaflets							
Treatment	Rate	App. timing	8-Aug	15-Aug	23-Aug	30-Aug	6-Sep	13-Sep	20-Sep	CMD
HGW86 10SE + Standard[1]	13.5 fl oz	14 + 21 DAP (see below)[1]	3.5a	6.0a	17.5a	6.0a	28.8a	52.3a	82.5a	1086.3a
HGW86 10SE + Standard[1]	16.9 fl oz	14 + 21 DAP (see below)[1]	0.0a	0.5a	1.0a	0.0a	18.8a	53.3a	76.5a	783.0a
HGW86 10SE + Standard[1]	20.6 fl oz	14 + 21 DAP (see below)[1]	2.0a	7.3a	35.5a	14.0a	40.0a	117.0a	106.3a	1896.5a
Thrips foliar[2] + Standard[1]		(see below)[2] (see below)[1]	0.0a	0.0a	4.8a	2.5a	42.5a	63.0a	78.8a	1067.3a
Control	-	-	1.3a	5.0a	48.5a	36.3a	33.3a	81.0a	87.0a	1763.6a

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

[1]Standard treatment consisted of Coragen (4 oz/A) on 6 and 20 Jul, Danitol (10⅔ oz/A) on 16 Jul, Radiant (6 oz/A) on 27 Jul, and Scorpion (4 oz/A) on 13 Aug.

[2]Thrips foliar treatment consisted of Radiant (6 oz/A) on 22 Jun and Rimon (10 oz/A) on 29 Jun. These treatments were discontinued after 29 Jun due to low thrips populations.

Table 6. Season total fruit (by weight) harvested from 'Florida 47' tomato plants treated with various insecticides. Mills River, NC. 2012.

Treatment	Rate	App. timing	Total yield (lbs)	Marketable % Jumbo	Marketable % Extra Large	Marketable % Large	Marketable % Medium	Marketable % Total Marketable	Non-Marketable % Lep	Non-Marketable % Stink Bug	Non-Marketable % Thrips	Non-Marketable % Non-Insect	Non-Marketable % Under-sized
HGW86 10SE + Standard[1]	13.5 fl oz	14 + 21 DAP (see below)[1]	32.4a	23.9a	61.1b	7.3a	0.6a	92.9c	0.2a	0.4a	1.0a	5.5a	0.0a
HGW86 10SE + Standard[1]	16.9 fl oz	14 + 21 DAP (see below)[1]	33.0a	26.7a	54.2ab	6.0a	0.3a	87.2b	0.0a	1.9a	0.5a	10.4a	0.0a
HGW86 10SE + Standard[1]	20.6 fl oz	14 + 21 DAP (see below)[1]	33.9a	28.9a	54.5ab	5.9a	1.4a	90.6c	0.1a	0.5a	0.4a	8.4a	0.1a
Thrips foliar[2] + Standard[1]		(see below)[2] (see below)[1]	35.6a	24.8a	53.9ab	8.7a	0.6a	88.0c	0.0a	1.7a	0.6a	9.8a	0.0a
Control	-	-	29.4a	19.4a	45.3a	6.0a	0.6a	71.2a	3.3b	10.6b	1.0a	13.9a	0.0a

Means in the same column followed by the same letter are not significantly different by LSD (p=0.05).
[1]Standard treatment consisted of Coragen (4 oz/A) on 7/6 and 7/20, Danitol (10⅔ oz/A) on 7/16, Radiant (6 oz/A) on 7/27, and Scorpion (4 oz/A) on 8/13.
[2]Thrips foliar treatment consisted of Radiant (6 oz/A) on 6/22 and Rimon (10 oz/A) on 6/29. These treatments were discontinued after 6/29 due to low thrips populations.

Table 7. Percent damage to fruit of 'Florida 47' tomato plants treated with various insecticides. Mills River, NC. 2012.

			% Lep				% Stink bug				% Thrips				% Non-insect			
Treatment	Rate	App. timing	1-Aug	15-Aug	28-Aug	12-Sep	1-Aug	15-Aug	28-Aug	12-Sep	1-Aug	15-Aug	28-Aug	12-Sep	1-Aug	15-Aug	28-Aug	12-Sep
HGW86 10SE + Standard[1]	13.5 fl oz	14 + 21 DAP (see below)[1]	1.4a	0.0a	0.0a	0.0a	0.0a	0.4a	0.7a	0.0a	4.4a	1.3a	0.0a	0.0a	11.3a	5.3a	2.2a	11.4a
HGW86 10SE + Standard[1]	16.9 fl oz	14 + 21 DAP (see below)[1]	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	3.8a	3.3a	3.8a	0.0a	1.9a	0.0a	12.3a	11.7a	0.4a	15.8a
HGW86 10SE + Standard[1]	20.6 fl oz	14 + 21 DAP (see below)[1]	0.0a	0.5a	0.0a	0.0a	0.0a	0.0a	0.0a	2.0a	3.9a	0.0a	0.0a	0.0a	8.4a	12.2a	1.7a	8.4a
Thrips foliar[2] + Standard[1]		(see below)[2] (see below)[1]	0.0a	0.0a	0.0a	0.0a	0.0a	0.6a	3.4a	1.6a	6.7a	0.0a	0.0a	0.0a	12.3a	6.3a	2.0a	18.0a
Control	-	-	0.0a	2.6b	6.4b	2.9a	0.0a	2.9b	20.8b	17.5b	5.3a	0.4a	0.6a	0.0a	13.0a	16.8a	4.5a	19.0a

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

[1]Standard treatment consisted of Coragen (4 oz/A) on 7/6 and 7/20, Danitol (10⅔ oz/A) on 7/16, Radiant (6 oz/A) on 7/27, and Scorpion (4 oz/A) on 8/13.

[2]Thrips foliar treatment consisted of Radiant (6 oz/A) on 6/22 and Rimon (10 oz/A) on 6/29. These treatments were discontinued after 6/29 due to low thrips populations.

Cyazypyr Foliar Pepper Insecticide Trial

Pepper, *Capsicum annuum*, 'Paladin'

Thrips (FT): *Frankliniella tritici* (Fitch) and *Frankliniella occidentalis* (Pergande)
Insidious flower bug (IFB): *Orius insidiosus* (Say)
Green peach aphid (GPA): *Myzus persicae* (Sulzer)
Tomato fruitworm (TFW): *Helicoverpa zea* (Boddie)
European corn borer (ECB): *Ostrinia numilalis* (Hübner)
Stink bugs (SB): *Euschistus servus* (Say) and *Acrosternum hilare* (Say)

This study was conducted at the Mountain Horticultural Crops Research Station in Mills River, NC. Six-wk-old 'Paladin' pepper transplants were set on 1 June on black plastic mulch with drip irrigation. Plots consisted of single 20-ft long beds planted with double rows of peppers spaced 15" apart within rows, and each treatment was separated by a non-treated border row. Treatments were replicated four times and arranged in a RCB design. All plants except those in control plots received 8 oz of an Admire Pro 4SC (10.5 oz/A) at transplanting. Treatments consisted of three rates of cyazypyr 10SE (13.5, 16.9 and 20.6 oz/A) applied at 21, 35 and 45 days after planting, all of which were following by a season foliar insecticide program (see footnote 1 in Tables); a standard treatment consisting of Radiant 1SC (6 oz/A) at 21 and 35 days after planting and Coragen 1.67SC (3 oz/A) at 35 DAP, and subsequently sprayed as were the cyazypyr treatments; a treatment sprayed season long with Asana XL (5.8 oz/A) beginning on 20 July; and a non-treated control. A CO_2-powered backpack sprayer delivering 50 GPA was used to make foliar applications. Peppers were staked and strung as needed and sprayed with a standard fungicide program.

Flower 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. Green peach aphids were sampled by observing 10 mid- to lower-plant leaves per plot, and recording the total number of aphids. Cumulative insect days were calculated by multiplying the average count between sample dates by the time between samples (days) and summing values from all sample dates. Mature fruit were harvested from whole plots on 24 Jul, 8 and 22 Aug, and 5 and 17 Sep. Fruit were graded for size (US Fancy >3.5", US No. 1 2.5-3.5", US No. 2 <2.5"), weight, and damage by stink bugs and lepidopteran pests (lepidopteran damage was further categorized as 'stem damage,' 'European corn borer,' and 'other'). All data were subjected to two-way ANOVA and means were separated by LSD (P = 0.05).

Thrips populations peaked at >11 thrips (adults + immatures) per flower in the control on 15 Aug (Table 1). *Frankliniella tritici* was the most abundant thrips species, and the Asana treatment was the one to significantly reduce cumulative thrips-days below the control. Insidious flower bug populations were fairly low, with fewer than 0.3 per flower observed in any treatment on any sample date, and there were no differences among treatments (Table 2). Green peach aphid populations were also extremely low and not of sufficient density to assess product efficacy, although cumulative aphid days were significantly higher in the control plots (Table 3).

Season total yield averaged 24.5 tons/acre across all treatments, and there were no significant differences among treatments in season-total yield, fruit size, percent marketability, or insect damage (Tables 4 and 5). This was due largely to the very low and highly variable levels of damage in plots (stink bug damage was almost nonexistent). Season-total damage attributed to causes not related to insects averaged approximately 5%, but did not vary significantly among treatments.

Table 1. Thrips on flowers of 'Paladin' pepper plants treated with various insecticides. Mills River, NC. 2012.

Treatment	Rate	Application dates	27-Jun	4-Jul	11-Jul	18-Jul	25-Jul	2-Aug	8-Aug	15-Aug	23-Aug	30-Aug	CTD
			Adult thrips per 10 flowers										
Cyazypyr 10SE + Foliar standard[1]	13.5 fl oz	6/22, 7/6, 7/16 (see below)[1]	9.5a	3.3a	4.5a	1.5a	0.8a	9.0a	6.0a	89.5b	5.8a	0.5a	921.8b
Cyazypyr 10SE + Foliar standard[1]	16.9 fl oz	6/22, 7/6, 7/16 (see below)[1]	9.8a	3.3a	3.3a	1.3a	1.3a	7.3a	8.3a	93.0b	6.5a	1.0a	951.9b
Cyazypyr 10SE + Foliar standard[1]	20.6 fl oz	6/22, 7/6, 7/16 (see below)[1]	7.0a	1.5a	1.8a	0.8a	1.5a	6.0a	9.8a	92.0b	8.0a	0.3a	920.0b
Foliar standard[2]		(see below)[2]	6.5a	3.5a	0.8a	2.3a	0.3a	7.0a	13.5a	80.8b	8.8a	0.5a	879.9b
Asana	5.8 fl oz	7/20, 7/27, 8/10, 8/21, 8/28, 9/4	7.8a	2.5a	2.5a	1.8a	3.3a	4.0a	9.5a	33.0a	6.3a	0.3a	483.8a
Control	—	—	13.8a	3.5a	3.0a	1.0a	1.8a	6.0a	8.3a	103.3b	10.5a	4.3b	1077.4b
			Immature thrips per 10 flowers										
Cyazypyr 10SE + Foliar standard[1]	13.5 fl oz	6/22, 7/6, 7/16 (see below)[1]	0.0a	0.3a	0.5a	0.8a	0.0a	1.5a	0.5a	4.0a	0.5a	0.5a	59.8a
Cyazypyr 10SE + Foliar standard[1]	16.9 fl oz	6/22, 7/6, 7/16 (see below)[1]	0.0a	0.8a	0.0a	0.5a	0.0a	0.0a	0.5a	7.0a	0.3a	0.5a	68.1a
Cyazypyr 10SE + Foliar standard[1]	20.6 fl oz	6/22, 7/6, 7/16 (see below)[1]	0.0a	0.3a	0.5a	0.0a	0.0a	0.0a	3.5b	7.0a	0.5a	0.5a	86.0a
Foliar standard[2]		(see below)[2]	0.0a	0.0a	0.3a	0.5a	0.5a	0.5a	0.8a	5.5a	0.0a	1.0a	62.1a
Asana	5.8 fl oz	7/20, 7/27, 8/10, 8/21, 8/28, 9/4	0.0a	1.3a	0.0a	1.3a	1.0a	0.5a	0.8a	3.0a	0.8a	0.5a	63.3a
Control	—	—	0.0a	3.5b	0.5a	0.5a	0.0a	0.5a	1.3a	8.3a	4.0a	3.3b	146.4b
			Total thrips per 10 flowers										
Cyazypyr 10SE + Foliar standard[1]	13.5 fl oz	6/22, 7/6, 7/16 (see below)[1]	9.5a	3.5a	5.0a	2.3a	0.8a	10.5a	6.5a	93.5b	6.3a	1.0a	981.5b
Cyazypyr 10SE + Foliar standard[1]	16.9 fl oz	6/22, 7/6, 7/16 (see below)[1]	9.8a	4.0a	3.3a	1.8a	1.3a	7.3a	8.8a	100.0b	6.8a	1.5a	1020.0b
Cyazypyr 10SE + Foliar standard[1]	20.6 fl oz	6/22, 7/6, 7/16 (see below)[1]	7.0a	1.8a	2.3a	0.8a	1.5a	6.0a	13.3a	99.0b	8.5a	0.8a	1006.0b
Foliar standard[2]		(see below)[2]	6.5a	3.5a	1.0a	2.8a	0.8a	7.5a	14.3a	86.3b	8.8a	1.5a	942.0b
Asana	5.8 fl oz	7/20, 7/27, 8/10, 8/21, 8/28, 9/4	7.8a	3.8a	2.5a	3.0a	4.3a	4.5a	10.3a	36.0a	7.0a	0.8a	547.0a
Control	—	—	13.8a	7.0a	3.5a	1.5a	1.8a	6.5a	9.5a	111.5b	14.5a	7.5b	1223.8b

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

[1]Foliar standard treatment following HGW86 consisted of Asana (5.8 oz/A) on 7/20, Radiant (6 oz/A) on 7/27, 8/21, and 8/28, Coragen (3.5 oz/A) on 8/10, and Warrior (3.5 oz/A) on 9/4.

[2]Season-long foliar standard treatment consisted of Radiant (6 oz/A) on 6/22, 7/6, 7/27, 8/21, and 8/28, Coragen (3.5 oz/A) on 7/16 and 8/10, Asana (5.8 oz/A) on 7/20, and Warrior (3.5 oz/A) on 9/4.

Table 2. Insidious flower bugs on flowers of 'Paladin' pepper plants treated with various insecticides. Mills River, NC. 2012.

			Insidious flower bugs per 10 flowers										
Treatment	Rate	Application dates	27-Jun	4-Jul	11-Jul	18-Jul	25-Jul	2-Aug	8-Aug	15-Aug	23-Aug	30-Aug	CFBD
Cyazypyr 10SE + Foliar standard[1]	13.5 fl oz	6/22, 7/6, 7/16 (see below)[1]	0.5a	0.5a	0.3a	1.0a	1.0a	1.0a	0.5a	1.0a	0.0a	0.0a	39.3a
Cyazypyr 10SE + Foliar standard[1]	16.9 fl oz	6/22, 7/6, 7/16 (see below)[1]	0.5a	0.3a	0.8a	2.8a	0.8a	0.8a	0.5a	0.8a	0.5a	0.0a	51.5a
Cyazypyr 10SE + Foliar standard[1]	20.6 fl oz	6/22, 7/6, 7/16 (see below)[1]	0.5a	0.5a	0.3a	1.3a	0.8a	0.8a	0.8a	1.8a	0.0a	0.0a	44.6a
Foliar standard[2]		(see below)[2]	0.0a	0.5a	0.3a	1.0a	0.3a	1.5a	0.5a	0.3a	1.0a	0.0a	37.3a
Asana	5.8 fl oz	7/20, 7/27, 8/10, 8/21, 8/28, 9/4	0.3a	0.5a	0.5a	1.5a	0.8a	0.5a	0.3a	1.0a	0.5a	1.8a	46.5a
Control	–	–	0.8a	2.0a	0.5a	2.3a	1.0a	0.8a	0.8a	0.5a	1.3a	1.0a	70.1a

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

[1]Foliar standard treatment following HGW86 consisted of Asana (5.8 oz/A) on 7/20, Radiant (6 oz/A) on 7/27, 8/21, and 8/28, Coragen (3.5 oz/A) on 8/10, and Warrior (3.5 oz/A) on 9/4.

[2]Season-long foliar standard treatment consisted of Radiant (6 oz/A) on 6/22, 7/6, 7/27, 8/21, and 8/28, Coragen (3.5 oz/A) on 7/16 and 8/10, Asana (5.8 oz/A) on 7/20, and Warrior (3.5 oz/A) on 9/4.

Table 3. Green peach aphids on leaves of 'Paladin' pepper plants treated with various insecticides. Mills River, NC. 2012.

			Aphids per 10 leaves											
Treatment	Rate	Application dates	20-Jun	27-Jun	4-Jul	11-Jul	18-Jul	25-Jul	2-Aug	8-Aug	15-Aug	23-Aug	30-Aug	Cumulative aphid days
Cyazypyr 10SE + Foliar standard[1]	13.5 fl oz	6/22, 7/6, 7/16 (see below)[1]	0.0a	0.5a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	3.8a
Cyazypyr 10SE + Foliar standard[1]	16.9 fl oz	6/22, 7/6, 7/16 (see below)[1]	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a
Cyazypyr 10SE + Foliar standard[1]	20.6 fl oz	6/22, 7/6, 7/16 (see below)[1]	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a
Foliar standard[2]		(see below)[2]	0.0a	0.0a	0.3a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	1.9a
Asana	5.8 fl oz	7/20, 7/27, 8/10, 8/21, 8/28, 9/4	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a
Control	–	–	0.0a	1.5a	0.0a	0.0a	0.0a	0.3a	0.0a	0.5b	0.0a	0.3a	1.3a	22.6b

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

[1]Foliar standard treatment following HGW86 consisted of Asana (5.8 oz/A) on 7/20, Radiant (6 oz/A) on 7/27, 8/21, and 8/28, Coragen (3.5 oz/A) on 8/10, and Warrior (3.5 oz/A) on 9/4.

[2]Season-long foliar standard treatment consisted of Radiant (6 oz/A) on 6/22, 7/6, 7/27, 8/21, and 8/28, Coragen (3.5 oz/A) on 7/16 and 8/10, Asana (5.8 oz/A) on 7/20, and Warrior (3.5 oz/A) on 9/4.

Table 4. Season total fruit (by weight) harvested from 'Paladin' pepper plants treated with various insecticides. Mills River, NC. 2012.

			Total	Marketable				Non-Marketable				
Treatment	Rate	Application dates	yield (tons)	% US Fancy	% US No. 1	% US No. 2	% Total Marketable	% Stem damage	% European corn borer	% Other Lep	% Stink bug	% Non-insect
Cyazypyr 10SE + Foliar standard[1]	13.5 fl oz	6/22, 7/6, 7/16 (see below)[1]	24.9a	76.7a	14.0a	5.6a	96.2a	0.4a	0.0a	0.0a	0.0a	3.4a
Cyazypyr 10SE + Foliar standard[1]	16.9 fl oz	6/22, 7/6, 7/16 (see below)[1]	23.8a	76.6a	12.2a	6.1a	94.9a	0.2a	0.0a	0.2a	0.2a	4.6a
Cyazypyr 10SE + Foliar standard[1]	20.6 fl oz	6/22, 7/6, 7/16 (see below)[1]	25.9a	76.0a	15.0a	4.9a	95.8a	0.2a	0.0a	0.2a	0.0a	3.7a
Foliar standard[2]		(see below)[2]	26.6a	77.3a	13.1a	3.8a	94.1a	0.0a	0.0a	0.7a	0.0a	5.2a
Asana	5.8 fl oz	7/20, 7/27, 8/10, 8/21, 8/28, 9/4	24.3a	74.3a	13.3a	5.1a	92.7a	0.4a	0.0a	1.5a	0.0a	5.4a
Control	–	–	21.2a	75.0a	15.2a	4.2a	94.3a	0.5a	0.1a	0.9a	0.1a	4.1a

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

[1]Foliar standard treatment following HGW86 consisted of Asana (5.8 oz/A) on 7/20, Radiant (6 oz/A) on 7/27, 8/21, and 8/28, Coragen (3.5 oz/A) on 8/10, and Warrior (3.5 oz/A) on 9/4.

[2]Season-long foliar standard treatment consisted of Radiant (6 oz/A) on 6/22, 7/6, 7/27, 8/21, and 8/28, Coragen (3.5 oz/A) on 7/16 and 8/10, Asana (5.8 oz/A) on 7/20, and Warrior (3.5 oz/A) on 9/4.

Table 5. Percent damage to fruit of ‘Paladin’ pepper plants treated with various insecticides. Mills River, NC. 2012.

			% Stem damage					% European corn borer					% Other lep					% Stink bug				
Treatment	Rate	Application dates	24-Jul	8-Aug	22-Aug	5-Sep	17-Sep	24-Jul	8-Aug	22-Aug	5-Sep	17-Sep	24-Jul	8-Aug	22-Aug	5-Sep	17-Sep	24-Jul	8-Aug	22-Aug	5-Sep	17-Sep
Cyazypyr 10SE + Foliar standard[1]	13.5 fl oz	6/22, 7/6, 7/16 (see below)[1]	0.9a	0.9a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a
Cyazypyr 10SE + Foliar standard[1]	16.9 fl oz	6/22, 7/6, 7/16 (see below)[1]	0.3a	0.4a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.8a	0.0a	0.5a	0.0a	0.0a	0.0a	0.0a	0.0a	0.6a
Cyazypyr 10SE + Foliar standard[1]	20.6 fl oz	6/22, 7/6, 7/16 (see below)[1]	0.6a	0.6a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	1.1a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a
Foliar standard[2]		(see below)[2]	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	1.4a	0.4a	0.0a	0.2a	0.0a	0.0a	0.0a	0.0a	0.0a
Asana	5.8 fl oz	7/20, 7/27, 8/10, 8/21, 8/28, 9/4	0.5a	0.0a	0.4a	2.1a	0.5a	0.0a	0.0a	0.0a	0.0a	0.0a	0.6a	2.0a	2.2a	0.0a	2.2a	0.0a	0.0a	0.0a	0.0a	0.0a
Control	–	–	0.4a	0.3a	0.0a	0.0a	1.6a	0.0a	0.0a	0.0a	0.0a	0.5a	0.0a	1.2a	1.3a	1.0a	1.6a	0.0a	0.0a	0.0a	0.0a	0.7a

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

[1]Foliar standard treatment following HGW86 consisted of Asana (5.8 oz/A) on 7/20, Radiant (6 oz/A) on 7/27, 8/21, and 8/28, Coragen (3.5 oz/A) on 8/10, and Warrior (3.5 oz/A) on 9/4.

[2]Season-long foliar standard treatment consisted of Radiant (6 oz/A) on 6/22, 7/6, 7/27, 8/21, and 8/28, Coragen (3.5 oz/A) on 7/16 and 8/10, Asana (5.8 oz/A) on 7/20, and Warrior (3.5 oz/A) on 9/4.

Cucumber Chemigation Trial

Cucumber, *Cucumis sativus* 'Dasher II'

Cucumber beetle (CB): *Diabrotica undecimpunctata howardi* (Barber) and *Acalymma vittatum* (Fabricius)
Potato aphid (PA): *Macrosiphum euphorbiae* (Thomas)
Thrips (FT): *Frankliniella fusca* (Hinds), *F. tritici* (Fitch) and *F. occidentalis* (Pergande)
Insidious flower bug (IFB): *Orius insidiosus* (Say)
Miscellaneous lepidopterans (LEP)

This study was conducted at the Mountain Horticultural Crops Research Station in Mills River, NC. 'Dasher II' cucumber seeds were direct seeded on 6 Jun into black plastic mulch with drip irrigation. Plots consisted of single 25-ft long beds planted with a single row of cucumbers spaced 12" apart within rows. Rows were separated by 10 ft of bare ground. Treatments were replicated four times and arranged in a RCB design. Insecticide chemigation treatments were applied via a CO_2 injector into a 1" poly tube that delivered materials to treatment drip lines. Water used to mix HGW86 applications was acidified to pH 4-5 with sulfuric acid, and water for the Admire Pro application was pH 7. All treatments except the control were sprayed with a standard program of Asana XL (5.8 oz/A) at 17, 24, and 31 days after the second chemigation applications. Materials, rates, and application dates are listed in the tables. Cucumbers were staked and strung as needed and sprayed with a standard fungicide program.

Cucumber beetles were monitored by shaking 5 plants and recording the number of adult beetles dislodged from plants. Aphids were monitored by recording the number of apterous aphids on 10 leaves per plot. Flower thrips and insidious flower bugs were monitored by removing 5 flowers per plot, placing them in a vial of 50% ETOH, and counting dislodged insects under a stereomicroscope. Mature fruit were harvested from the center 15 ft of row of each plot on 17, 19, 23, 26, and 30 Jul and 2, 6, 10, 13, 16, and 20 Aug. For the purposes of analysis, harvests were combined into Week 1 (17, 19 Jul), Week 2 (23, 26 Jul), Week 3 (30 Jul and 2 Aug), Week 4 (6, 10 Aug), and Week 5 (13, 16, and 20 Aug). Fruit were graded for marketability, weight, and insect damage, which included categories for clean fruit, slight surface scarring (≤10%), heavy surface scarring (>10%), and fruit with lepidopteran entries. All surface scarring damage was assumed to be the result of adult cucumber beetle feeding. All data were subjected to two-way ANOVA and means were separated by LSD ($P = 0.05$).

There were very few cucumber beetles observed during beat samples, and populations never exceeded 1 per plant (Table 1). Aphid populations were also very low until 28 Aug, when numbers increased to >12 aphids per leaf in the Admire Pro treatment (Table 2). This was much higher than any other treatment, but differences were not statistically significant because aphids were concentrated in only two of the four replications across all treatments. Thrips populations were also relatively low, with a peak of fewer than 0.3 total (adults + immatures) thrips per flower in the Admire Pro treatment on 25 Jul (Table 3). There were no significant differences observed at any time during the trial. There were also no significant differences among treatments in season total fruit yield, with the overall average yield across all treatments being 200.2 lbs per 15 ft-row. Season total marketable fruit ranged from 72.9% in the control treatment to 79.9% in the Admire Pro treatment; there were no significant differences. In fact, the only significant difference observed in harvested fruit was in percentage of season total lep damage, which was 1.2% in the control and approximately zero in all treatment plots (Tables 4 and 5).

Table 1. Cucumber beetles on 'Dasher II' cucumber plants treated with insecticides through drip irrigation. Mills River, NC. 2012.

Treatment	Rate	Application dates	Cucumber beetles per 5 plants 27-Jun	4-Jul	11-Jul	18-Jul	25-Jul	2-Aug	8-Aug	28 Aug	Season Total
Cyazypyr 20SC – drip + Asana XL	5.1 fl oz 5.8 oz/A	6/20, 7/3 7/20, 7/27, 8/3	0.3a	0.8a	0.5a	3.5a	0.8a	2.3a	0.3a	2.3a	10.5a
Cyazypyr 20SC – drip + Asana XL	6.75 fl oz 5.8 oz/A	6/20, 7/3 7/20, 7/27, 8/3	0.3a	0.5a	0.8a	1.5a	4.0b	3.3a	0.3a	3.0a	13.3a
Cyazypyr 20SC – drip + Asana XL	10.3 fl oz 5.8 oz/A	6/20, 7/3 7/20, 7/27, 8/3	0.0a	2.0a	1.3a	1.8a	1.3a	1.3a	0.0a	4.0a	11.8a
Admire Pro 4.6SC – drip + Asana XL	10.0 fl oz 5.8 oz/A	7/3 7/20, 7/27, 8/3	0.0a	1.3a	0.5a	2.5a	1.8a	2.5a	0.0a	3.0a	12.0a
Untreated Control	-		0.5a	0.3a	0.0a	2.0a	0.8a	2.0a	0.5a	2.3a	8.3a

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

Table 2. Aphids on 'Dasher II' cucumber plants treated with insecticides through drip irrigation. Mills River, NC. 2012.

			Aphids per 10 leaves							
Treatment	Rate	Application dates	4-Jul	11-Jul	18-Jul	25-Jul	2-Aug	8-Aug	28-Aug	Cumulative aphid days
Cyazypyr 20SC – drip + Asana XL	5.1 fl oz 5.8 oz/A	6/20, 7/3 7/20, 7/27, 8/3	0.8a	0.0a	0.0a	0.0a	0.0a	0.0a	73.0a	732.6a
Cyazypyr 20SC – drip + Asana XL	6.75 fl oz 5.8 oz/A	6/20, 7/3 7/20, 7/27, 8/3	0.5a	0.0a	0.0a	0.0a	0.0a	0.0a	15.5a	156.8a
Cyazypyr 20SC – drip + Asana XL	10.3 fl oz 5.8 oz/A	6/20, 7/3 7/20, 7/27, 8/3	2.0a	0.0a	1.3a	0.0a	0.0a	0.0a	16.0a	175.8a
Admire Pro 4.6SC – drip + Asana XL	10.0 fl oz 5.8 oz/A	7/3 7/20, 7/27, 8/3	1.3a	0.0a	0.0a	0.0a	0.0a	1.3a	126.8a	1288.1a
Untreated Control	-		0.3a	0.3a	0.3a	0.0a	0.0a	2.8a	22.0a	260.1a

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

Table 3. Thrips and insidious flower bugs in 'Dasher II' cucumber flowers treated with insecticides through drip irrigation. Mills River, NC. 2012.

Treatment	Rate	Application dates	4-Jul	11-Jul	18-Jul	25-Jul	Cumulative insect days
			Adult thrips per 10 flowers				
Cyazypyr 20SC – drip + Asana XL	5.1 fl oz 5.8 oz/A	6/20, 7/3 7/20, 7/27, 8/3	1.0a	0.5a	0.0a	1.5a	12.3a
Cyazypyr 20SC – drip + Asana XL	6.75 fl oz 5.8 oz/A	6/20, 7/3 7/20, 7/27, 8/3	1.0a	1.0a	0.0a	0.8a	13.1a
Cyazypyr 20SC – drip + Asana XL	10.3 fl oz 5.8 oz/A	6/20, 7/3 7/20, 7/27, 8/3	0.5a	0.5a	0.3a	0.3a	7.9a
Admire Pro 4.6SC – drip + Asana XL	10.0 fl oz 5.8 oz/A	7/3 7/20, 7/27, 8/3	0.0a	1.8a	0.5a	2.0a	22.8a
Untreated Control	-		1.3a	0.3a	0.8a	0.5a	13.1a
			Immature thrips per 10 flowers				
Cyazypyr 20SC – drip + Asana XL	5.1 fl oz 5.8 oz/A	6/20, 7/3 7/20, 7/27, 8/3	0.0a	0.0a	0.0a	0.0a	0.0a
Cyazypyr 20SC – drip + Asana XL	6.75 fl oz 5.8 oz/A	6/20, 7/3 7/20, 7/27, 8/3	0.0a	0.0a	0.0a	0.3a	0.9a
Cyazypyr 20SC – drip + Asana XL	10.3 fl oz 5.8 oz/A	6/20, 7/3 7/20, 7/27, 8/3	0.0a	0.0a	0.0a	0.5a	1.8a
Admire Pro 4.6SC – drip + Asana XL	10.0 fl oz 5.8 oz/A	7/3 7/20, 7/27, 8/3	0.0a	0.3a	0.0a	0.5a	3.5a
Untreated Control	-		0.0a	0.0a	0.0a	1.0a	3.5a
			Total thrips per 10 flowers				
Cyazypyr 20SC – drip + Asana XL	5.1 fl oz 5.8 oz/A	6/20, 7/3 7/20, 7/27, 8/3	1.0a	0.5a	0.0a	1.5a	12.3a
Cyazypyr 20SC – drip + Asana XL	6.75 fl oz 5.8 oz/A	6/20, 7/3 7/20, 7/27, 8/3	1.0a	1.0a	0.0a	1.0a	14.0a
Cyazypyr 20SC – drip + Asana XL	10.3 fl oz 5.8 oz/A	6/20, 7/3 7/20, 7/27, 8/3	0.5a	0.5a	0.3a	0.8a	9.6a
Admire Pro 4.6SC – drip + Asana XL	10.0 fl oz 5.8 oz/A	7/3 7/20, 7/27, 8/3	0.0a	2.0a	0.5a	2.5a	26.3a
Untreated Control	-		1.3a	0.3a	0.8a	1.5a	16.6a
			Insidious flower bugs per 10 flowers				
Cyazypyr 20SC – drip + Asana XL	5.1 fl oz 5.8 oz/A	6/20, 7/3 7/20, 7/27, 8/3	0.3a	1.0a	0.0a	0.5a	9.6a
Cyazypyr 20SC – drip + Asana XL	6.75 fl oz 5.8 oz/A	6/20, 7/3 7/20, 7/27, 8/3	1.3a	0.0a	0.0a	0.8a	7.0a
Cyazypyr 20SC – drip + Asana XL	10.3 fl oz 5.8 oz/A	6/20, 7/3 7/20, 7/27, 8/3	0.8a	0.5a	0.0a	0.5a	7.9a
Admire Pro 4.6SC – drip + Asana XL	10.0 fl oz 5.8 oz/A	7/3 7/20, 7/27, 8/3	0.0a	0.0a	0.0a	0.5a	1.8a
Untreated Control	-		1.0a	0.0a	0.0a	0.8a	6.1a

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

Table 4. Season total fruit (by weight) harvested from 'Dasher II' cucumber plants treated with insecticides through drip irrigation. Mills River, NC. 2012.

				Marketable			Non-Marketable		
Treatment	Rate	Application dates	Total yield (lbs)	% clean fruit	% w/ slight scarring	% total marketable	% w/ heavy scarring	% w/ lep entries	% other damage
Cyazypyr 20SC – drip + Asana XL	5.1 fl oz 5.8 oz/A	6/20, 7/3 7/20, 7/27, 8/3	213.1a	35.9a	39.2a	75.1a	24.9a	0.0a	0.0a
Cyazypyr 20SC – drip + Asana XL	6.75 fl oz 5.8 oz/A	6/20, 7/3 7/20, 7/27, 8/3	190.5a	40.6a	35.0a	75.6a	24.4a	0.0a	0.0a
Cyazypyr 20SC – drip + Asana XL	10.3 fl oz 5.8 oz/A	6/20, 7/3 7/20, 7/27, 8/3	210.2a	39.9a	38.1a	78.0a	21.9a	0.1a	0.0a
Admire Pro 4.6SC – drip + Asana XL	10.0 fl oz 5.8 oz/A	7/3 7/20, 7/27, 8/3	206.1a	40.8a	39.1a	79.9a	20.0a	0.0a	0.5a
Untreated Control	-		181.1a	34.2a	38.6a	72.9a	25.9a	1.2b	0.0a

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

Table 5. Percent damage to fruit of 'Dasher II' cucumber plants treated with insecticides through drip irrigation. Mills River, NC. 2012.

		% clean fruit[2]					% w/ slight scarring					% w/ heavy scarring					% w/ lep entries				
Treatment[1]	Rate	Wk 1	Wk 2	Wk 3	Wk 4	Wk 5	Wk 1	Wk 2	Wk 3	Wk 4	Wk 5	Wk 1	Wk 2	Wk 3	Wk 4	Wk 5	Wk 1	Wk 2	Wk 3	Wk 4	Wk 5
Cyazypyr 20SC – drip + Asana XL	5.1 fl oz 5.8 oz/A	39.1a	39.8a	33.3a	43.9a	19.1a	34.9a	42.6a	50.6a	13.0a	42.9a	26.0a	17.6a	16.1a	43.1a	38.0a	0.0a	0.0a	0.0a	0.0a	0.0a
Cyazypyr 20SC – drip + Asana XL	6.75 fl oz 5.8 oz/A	46.8a	49.5a	35.3a	43.5a	16.8a	43.8a	38.0a	47.0a	9.6a	33.1a	9.5a	12.5a	17.7a	46.9a	50.0a	0.0a	0.0a	0.0a	0.0a	0.0a
Cyazypyr 20SC – drip + Asana XL	10.3 fl oz 5.8 oz/A	40.7a	44.3a	38.5a	46.6a	14.9a	52.3a	42.6a	44.7a	8.7a	50.2a	6.0a	13.0a	16.8a	44.7a	34.9a	1.0a	0.0a	0.0a	0.0a	0.0a
Admire Pro 4.6SC – drip + Asana XL	10.0 fl oz 5.8 oz/A	42.6a	48.0a	39.7a	40.3a	25.3a	40.7a	39.1a	53.2a	14.1a	41.1a	16.2a	12.9a	7.2a	45.6a	33.6a	0.0a	0.0a	0.0a	0.0a	0.0a
Untreated Control	-	33.3a	42.1a	28.8a	30.1a	14.4a	45.8a	38.7a	51.1a	14.5a	51.3a	20.2a	18.6a	19.5a	52.7a	34.3a	0.7a	0.5a	0.6a	2.8a	0.0a

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

[1]Application dates were 6/20 and 7/3 for Cyazypyr, 7/3 for Admire Pro, and 7/20, 7/27, and 8/3 for Asana XL.

[2]Harvest dates for Wk 1 were 7/17 and 7/19, Wk 2 were 7/23 and 7/26, Wk 3 were 7/30 and 8/2, Wk 4 were 8/6 and 8/10, and Wk 5 were8/13, 8/16, and 8/20.

Tomato Foliar Insecticide Trial II - 2012

Tomato, *Lycopersicon esculentum* Mill. 'FL-47'

Thrips (FT): *Frankliniella tritici* (Fitch) and *Frankliniella occidentalis* (Pergande)
Potato aphid (PA): *Macrosiphum euphorbiae* (Thomas)
Twospotted spider mite (TSSM): *Tetranychus urticae* (Koch)
Tomato fruitworm (TFW): *Helicoverpa zea* (Boddie)
Armyworms (AW): *Spodoptera* spp.
Stink bugs (SB): *Euschistus servus* (Say) and *Acrosternum hilare* (Say)

This study was conducted at the Mountain Horticultural Crops Research Station in Mills River, NC. Six-wk-old 'Florida 47' tomato transplants were set on 5 June on black plastic mulch with drip irrigation. Plots consisted of single 25-ft long rows on 5-ft centers with treatment rows separated by single non-treated rows. Plants were spaced 1.5 ft within rows, and treatments were replicated four times and arranged in a RCBD. Tomatoes were staked and strung as needed and sprayed with a standard fungicide program. Insecticide treatments were applied on 22 and 29 June, 6, 13 20 and 27 July, 3, 13, 21 and 28 August, and 10 and 25 Sept, with a CO_2-powered backpack sprayer delivering 40 (2 nozzles/row) to 90 GPA (6 nozzles/row); gallonage increased as plants grew. LI-700 was used as an adjuvant for all treatment applications at 0.25%. Materials and rates are listed in the tables. Flower thrips were monitored by removing 10 flowers per plot, placing them in a vial of 50% ETOH, and counting dislodged adults and immatures under a stereomicroscope. Potato aphids were sampled by observing 10 recent, fully-expanded leaves per plot, and recording the total number of alate aphids. TSSM were counted on 10 terminal leaflets per plot. Mature fruit were harvested from the middle eight plants of each plot on 8 and 22 Aug, 5 and 17 Sept, and 3 Oct, and weighed, graded for size and quality, and assessed for insect damage. All data were subjected to two-way ANOVA and means were separated by LSD ($P = 0.05$).

Insect populations were low in this trial, especially thrips, aphids and twospotted spider mite. Thrips populations were of low to moderate density. Counts on 18 July and season cumulative thrips days were the only instances where significant differences were observed, and populations were lowest in those treatments that in included Radiant or Entrust (Table 1). There were no differences among treatments in aphid densities (Table 2), and twospotted spider mite differed only on the last sample date 27 September (Table 3). Total tomato yield averaged 37.8 tons/acre across all treatments, and although there were no differences among treatments in total yield (Table 4), the MBI-203 plus Radiant treatment did have significantly higher marketable yield than the control. Total damage due to lepidopteran pests, primarily tomato fruitworm and stink bugs was highly variable. MBI-203 and MBI-206 applied alone were the only treatments that did not significantly reduce total lepidopteran damage below the control, and Dipel and Entrust were most effective at minimizing lepidopteran damage. There were no significant differences among treatments in stink bug damage. Lepidopteran damage was most intense on the last harvest date with 37.9% damaged fruit in the control; the high rate of MBI-206 appeared to be slightly more effective than MBI-203, and Dipel had the lowest level of damage (Table 5). Stink bug damage was highly variable with no trends observed.

Table 1. Mean thrips populations in tomato (cv. FL-47) flowers treated with various insecticides at approximately weekly intervals from 22 June to 25 September. Mills River, NC. 2012.

		Thrips per 10 flowers										
Treatment	Rate/A	6/20	6/27	7/4	7/11	7/18	7/25	8/2	8/8	8/15	9/6	CTD
MBI-203 DF2	1 lb	0.8	2.3	1.0	2.3	3.0ab	6.0	2.3	1.0	2.0	0.0a	160.0abcde
MBI-203 DF2	2 lb	0.0	1.3	0.3	1.3	2.3abc	9.0	4.0	2.3	3.0	0.0a	189.4bcde
MBI-203 DF2 + Radiant	1 lb 6 oz	0.0	0.8	0.3	1.0	1.0a	4.0	4.0	0.3	3.0	0.0a	124.6abc
MBI-206	1 gal	0.0	1.0	0.8	5.8	5.8bc	3.0	6.3	1.8	5.0	0.0a	243.8e
MBI-206	2 gal	0.0	0.5	0.5	3.3	6.5c	3.0	5.3	1.0	3.3	0.0a	188.6abcde
MBI-203 DF2, rotate with Radiant	1 lb 6 oz	0.3	0.3	0.5	1.8	1.3a	4.8	2.5	0.8	1.0	0.8b	108.3ab
MBI-206, rotate with Radiant	1 gal 6 oz	0.0	0.5	1.0	1.5	1.0a	6.0	3.0	2.0	2.3	0.3ab	143.1abcd
Dipel DF	1 lb	0.0	0.3	1.3	3.3	4.3bc	7.3	3.3	0.8	4.5	0.5ab	216.5de
Entrust SC	6 oz	0.3	0.5	1.3	1.3	1.5ab	2.5	3.5	1.0	1.0	0.0a	97.5a
Control	—	0.0	1.5	0.5	5.0	4.0abc	6.8	4.5	2.3	2.3	0.0a	207.4cde

Means within the same column followed by the same letter are not significantly different by LSD (P = 0.05). ANOVA’s were not significant on those dates with no letters.

Table 2. Mean potato aphids on tomato (cv. FL-47) leaves treated with various insecticides at approximately weekly intervals from 22 June to 25 September. Mills River, NC. 2012.

		Mean aphids per leaf											
Treatment	Rate/A	7/11	7/18	7/25	8/2	8/8	8/15	8/23	8/30	9/6	9/13	9/20	CAD
MBI-203 DF2	1 lb	0.0	0.2	0.1	0.2	0.4	0.1	0.7	0.6	0.3	0.4	0.2	21.9
MBI-203 DF2	2 lb	0.0	0.1	0.1	0.3	0.5	0.2	0.4	0.5	0.9	0.4	0.8	24.9
MBI-203 DF2 + Radiant	1 lb 6 oz	0.4	0.9	2.7	2.2	4.8	4.1	2.6	0.6	0.0	0.3	0.3	137.6
MBI-206	1 gal	0.9	0.0	0.1	0.5	0.2	0.4	0.2	0.2	0.1	0.4	0.3	22.3
MBI-206	2 gal	0.0	0.1	0.6	0.2	0.6	0.3	0.4	0.4	0.1	0.2	1.2	25.2
MBI-203 DF2, rotate with Radiant	1 lb 6 oz	1.7	0.1	0.9	0.4	0.8	0.1	0.2	0.0	0.6	0.6	0.3	41.2
MBI-206, rotate with Radiant	1 gal 6 oz	0.0	0.0	0.3	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.3	10.1
Dipel DF	1 lb	0.0	1.8	2.2	0.4	0.6	0.4	0.4	1.4	0.7	0.0	0.9	61.7
Entrust SC	6 oz	0.4	0.4	0.0	0.1	0.6	0.8	0.1	0.5	0.2	0.0	0.4	21.9
Control	—	0.3	0.0	0.3	0.5	1.3	1.0	1.6	2.2	0.3	0.2	0.9	58.9

Table 3. Mean twospotted spider mites on tomato (cv. FL-47) leaves treated with various insecticides at approximately weekly intervals from 22 June to 25 September. Mills River, NC. 2012.

		Mites per trifoliate leaflet									
Treatment	Rate/A	7/18	8/8	8/15	8/23	8/30	9/6	9/13	9/20	9/27	CMD
MBI-203 DF2	1 lb	0.0	0.1	0.3	4.9	1.4	2.7	6.2	12.2	13.1abc	153.9a
MBI-203 DF2	2 lb	0.1	0.1	0.7	0.6	0.5	2.6	6.5	11.3	14.1abc	117.1a
MBI-203 DF2 + Radiant	1 lb 6 oz	0.0	0.1	0.1	0.6	0.7	1.2	4.0	10.9	13.2abc	84.8a
MBI-206	1 gal	0.0	0.2	0.5	1.4	0.4	2.4	5.3	9.0	19.3cd	103.5a
MBI-206	2 gal	0.0	0.5	0.4	0.9	1.4	2.1	8.8	9.3	13.4abc	134.7a
MBI-203 DF2, rotate with Radiant	1 lb 6 oz	0.0	0.0	0.4	1.4	1.2	2.9	6.1	11.3	22.8d	124.1a
MBI-206, rotate with Radiant	1 gal 6 oz	0.0	0.2	0.1	0.7	1.1	3.7	4.7	10.5	18.6bcd	110.8a
Dipel DF	1 lb	0.0	0.0	0.1	0.5	0.4	3.1	4.2	9.7	14.2abc	92.4a
Entrust SC	6 oz	0.0	1.8	0.4	1.6	0.2	2.5	3.6	6.8	10.9a	107.6a
Control	—	0.0	0.0	0.6	2.8	2.2	2.7	5.8	8.2	12.6ab	127.6a

Means within the same column followed by the same letter are not significantly different by LSD (P = 0.05). ANOVA's were not significant on those dates with no letters.

Table 4. Yield and insect damage of tomatoes (cv. FL-47) treated with various insecticides at approximately weekly intervals. Mills River, NC. 2012.

Treatment	Rate/A	Total Yield (tons/A)	% Marketable fruit					% insect damaged		
			Total	Jumbo	XL	L	M	Lep	Stink bug	Thrips
MBI-203 DF2	1 lb	36.3a	65.1ab	14.8a	33.6a	13.8a	2.9a	6.5cd	16.5a	0.8a
MBI-203 DF2	2 lb	35.1a	69.5ab	19.6a	33.1a	14.4a	2.3a	8.8cd	12.5a	0.8a
MBI-203 DF2 + Radiant	1 lb 6 oz	37.8a	81.3c	21.1a	39.0a	17.1a	4.0a	5.7bc	5.0a	0.1a
MBI-206	1 gal	39.0a	70.5abc	14.1a	41.5a	12.2a	2.8a	5.6bc	15.2a	0.5a
MBI-206	2 gal	38.7a	61.8a	18.7a	32.4a	9.3a	1.4a	7.1cd	19.0a	0.3a
MBI-203 DF2, rotate with Radiant	1 lb 6 oz	39.2a	72.5abc	16.4a	33.4a	20.4a	2.3a	3.2ab	15.2a	0.3a
MBI-206, rotate with Radiant	1 gal 6 oz	37.6a	75.4bc	16.1a	39.8a	17.0a	2.5a	5.5bc	10.9a	0.4a
Dipel DF	1 lb	39.0a	65.8ab	18.3a	32.6a	11.8a	3.0a	2.7ab	22.1a	1.6a
Entrust SC	6 oz	37.6a	74.8bc	16.3a	40.0a	15.9a	2.6a	2.2a	12.2a	0.1a
Control	—	37.9a	67.0ab	18.3a	34.4a	11.2a	3.0a	9.9d	14.6a	0.4a

Means within the same column followed by the same letter are not significantly different by LSD (P = 0.05). ANOVA's were not significant on those dates with no letters.

Table 5. Insect damaged tomato (cv. FL-47) fruit by date on tomatoes treated with various insecticides at approximately weekly intervals. Mills River, NC. 2012.

		% Lepidopteran					% Stink bug				
Treatment	Rate/A	8/8	8/22	9/5	9/17	10/3	8/8	8/22	9/5	9/17	10/3
MBI-203 DF2	1 lb	0.0a	6.1a	3.8a	3.9abc	16.8abc	2.4a	23.5a	22.7a	14.4a	19.4ab
MBI-203 DF2	2 lb	3.6a	0.7a	6.4a	9.1c	28.7cd	1.2a	13.0a	19.0a	10.4a	23.7ab
MBI-203 DF2 + Radiant	1 lb 6 oz	0.0a	5.3a	4.2a	2.5bc	20.5bcd	1.1a	11.0a	6.8a	3.0a	4.6a
MBI-206	1 gal	0.0a	6.6a	2.8a	16.1bc	17.9abc	2.2a	21.7a	17.0a	22.9a	20.2ab
MBI-206	2 gal	0.0a	6.6a	12.4b	6.0ab	13.9ab	3.7a	14.4a	34.6a	17.2a	22.0ab
MBI-203 DF2, rotate with Radiant	1 lb 6 oz	2.0a	1.8a	2.2a	4.8a	8.2a	4.8a	17.0a	20.4a	7.3a	29.5bc
MBI-206, rotate with Radiant	1 gal 6 oz	0.0a	2.8a	6.7ab	7.0ab	10.8ab	2.0a	6.6a	15.5a	9.9a	19.8ab
Dipel DF	1 lb	0.9a	2.6a	1.4a	1.1ab	7.0a	1.8a	12.1a	27.0a	15.1a	48.8c
Entrust SC	6 oz	0.0a	0.0a	3.4a	0.0a	11.1ab	1.6a	11.5a	19.7a	11.3a	20.4ab
Control	—	0.6a	3.5a	3.6a	5.3c	37.9d	2.4a	12.9a	33.4a	20.0a	8.6ab

Means within the same column followed by the same letter are not significantly different by LSD (P = 0.05). ANOVA's were not significant on those dates with no letters.

Evaluation of Drip Application of Neonicotinoid Insecticides and Coragen on Tomato

Tomato, *Lycopersicon esculentum* Mill. 'Biltmore'

Brown stink bug (BSB): *Euschistus servus* (Say)
Brown marmorated stink bug (BMSB): *Halyomorpha halys*
Potato aphid (PA): *Macrosiphum euphorbiae* (Thomas)
Lepidopteran (Leps):
Tomato fruitworm: *Helicoverpa zea* (Boddie)
Armyworms: *Spodoptera* spp.

This study was conducted at the Mountain Horticultural Crops Research Station in Mills River, NC. Six-wk-old 'Biltmore' tomato transplants were set on 31 May on black plastic mulch with drip irrigation. Plots consisted of single 25-ft rows on 5-ft centers, with treatment rows separated by non-treated rows. Plants were spaced 1.5 ft within rows, and treatments were replicated four times and arranged in a RCB design. Tomatoes were staked and strung as needed and sprayed with a standard fungicide program. Neonicotinoid insecticide treatments were applied on 2 Jul (first fruit set), with a CO_2 injector into drip lines. Coragen 1.67SC (4 fl oz/acre) was applied to all treatments except the control on 20 June Materials and rates are listed in the tables. All treatments (except control) were also treated with Coragen (4 fl oz/A) via drip irrigation on 20 June, and a second application was applied on 25 July only to the Admire Pro and Scorpion neonicotinoid treatments.

On 11 Jul (8-d after neonic treatments) and 17 Aug (46-d after neonic treatments), 3rd to 4th instar BMSB were caged onto plants using paint strainer bags. One cage was placed on one leaf in each plot, and 10 BMSB nymphs were placed into each cage. (Due to limited numbers of available BMSB nymphs, only three of the four replications received cages.) After 24 hours the cages were removed and number of live, moribund, dead, and missing nymphs was recorded. All data were subjected to two-way ANOVA and means were separated by LSD ($P = 0.05$). Potato aphids were also monitored at weekly intervals by counting the number of alate aphids on 10 leaves per plot. Vine rip fruit were harvested at 8 to 14-d intervals between 8 August and 28 September. Fruit were weighed and graded for size and quality (including insect damage), and data were subjected to two-way ANOVA by date and for all harvests combined.

Survivability of BMSB nymphs on tomato foliage was poor, with only about 50% of nymphs caged on plants surviving after 24 hr. There were no differences in survivorship among treatments on either sample date (Table 1). Potato aphids were low in this trial with aphids first appearing in the control in late July and peaking at only about 5 aphids per leaf on the last sample date on 20 September (Table 2). All treatments significantly reduced aphid densities below those of the control. Total yields were high in all treatments, averaging almost 50 tons/acre across all treatments (Table 3). All insecticide treatments had significantly higher marketable yields than the control, with the treatments receiving two applications of Coragen having the highest. These differences were due to higher numbers of Jumbo size fruit (>3.5 inches) and lower insect damage in these treatments. Lepidopteran and stink bug damage was of relatively low intensity, but all treatments significantly reduced lepidopteran damage below the control, with the treatments receiving two applications having the lowest level of damage. The lowest level of stink bug damage was observed in the Scorpion treatment, with only Belay failing to significantly reduce damage below the control. Although thrips damaged fruit was low, it was interesting that damage was significantly higher in the Platinum and Belay treatments than the control. Lepidopteran and stink bug damage by date is shown in table 4. The second application of Coragen on 25 July was most important in reducing lepidopteran damage in late September. Stink bug damage was highly variable on individual dates, with significant differences only observed on the first harvest date, when damage was significantly lower in all treatments compared with the control, and lowest in the Platinum and Scorpion treatments.

Table 1. Survival of brown marmorated stink bugs after being caged on tomato plants (cv. Biltmore) treated with various insecticides via drip irrigation on 2 July. Mills River, NC. 2012.

		% Dead		% Moribund		% Alive		% Missing	
Treatment	Rate	11-Jul	17-Aug	11-Jul	17-Aug	11-Jul	17-Aug	11-Jul	17-Aug
Admire Pro 4.6SC	10.5 fl oz	50.0 a	53.3 a	20.0 a	16.7 a	30.0 a	30.0 a	0.0 a	0.0 a
Platinum 75SG	3.67 oz	43.3 a	63.3 a	3.3 a	0.0 a	53.3 a	36.7 a	0.0 a	0.0 a
Scorpion 35SL	10.5 fl oz	36.7 a	56.7 a	10.0 a	3.3 a	50.0 a	40.0 a	3.3 a	0.0 a
Belay 2.13SC	12 fl oz	30.0 a	60.0 a	6.7 a	6.7 a	60.0 a	33.3 a	3.3 a	0.0 a
Control	-	33.3 a	33.3 a	6.7 a	13.3 a	53.3 a	53.3 a	6.7 a	0.0 a

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

Table 2. Mean potato aphid populations on tomatoes (cv. Biltmore) treated with various neonicotinoid insecticides through drip irrigation on 2 July. Mills River, NC. 2012

		Aphids/10 leaves											Cumulative aphid-days
Treatment	Rate	4-Jul	11-Jul	25-Jul	2-Aug	8-Aug	15-Aug	23-Aug	30-Aug	6-Sep	13-Sep	20-Sep	
Admire Pro 4.6SC	10.5 fl oz	0a	0a	0a	0a	0a	0a	0a	3.3a	1.0a	0.3a	2.5a	40.3a
Platinum 75SG	3.67 oz	4.3a	0.3a	0a	0a	0a	0a	3.5a	0a	0a	0a	2.0a	50.8a
Scorpion 35SL	10.5 fl oz	0a	0a	0.3a	0a	3.3a	5.8b	8.5a	6.0a	0a	13.8b	5.0a	286.5a
Belay 2.13SC	12 fl oz	0a	0a	0a	0a	0a	0a	1.0a	0a	1.5a	0a	3.0a	28.5a
Control	-	0a	0a	3.0a	6.8b	7.8a	17.0b	13.0a	64.5a	33.3b	35.0b	54.0b	1,473.9b

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

Table 3. Season total yield and insect damage to tomatoes (cv Biltmore) treated with various insecticides via drip irrigation. Mills River, NC. 2012.

			Total Yield	%Marketable					% Culls		
Treatment	Rate	Date	(tons/A)	Market.	Jumbo	X-L	L	M	Lep	Stink bug	Thrips
Admire Pro 4.6SC Coragen 1.67SC	10.5 fl oz 4.0 fl oz	7/2 6/20, 7/25	48.4a	85.5d	42.9b	31.2a	9.7a	1.7a	1.8ab	5.1ab	0.9ab
Platinum 75SG Coragen 1.67SC	3.67 oz 4.0 fl oz	7/2 6/20	49.6a	80.8c	34.0a	33.0a	12.2a	1.6a	2.4bc	7.0b	1.0bc
Scorpion 35SL Coragen 1.67SC	10.5 fl oz 4.0 fl oz	7/2 6/20, 7/25	51.0a	87.3e	47.9c	31.1a	7.7a	0.5a	1.1a	4.0a	0.5a
Belay 2.13SC Coragen 1.67SC	12 fl oz 4.0 fl oz	7/2 6/20	54.5a	76.4b	40.2b	27.0a	8.2a	1.0a	2.9c	9.9c	2.1c
Control	—	—	45.0a	72.9a	32.3a	28.4a	10.9a	1.3a	7.2d	11.6c	0.5a

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

Table 4. Percentage fruit damage to tomatoes (cv. Biltmore) treated with various insecticides via drip irrigation. Mills River, NC. 2012.

			% Lepidopteran damage					% Stink bug damage				
Treatment	Rate	Date	8/8	8/22	9/6	9/20	9/28	8/8	8/22	9/6	9/20	9/28
Admire Pro 4.6SC Coragen 1.67SC	10.5 oz 4.0 oz	7/2 6/20, 7/25	0a	2.3a	2.7b	4.2ab	2.4a	1.4ab	4.3a	4.6a	13.0a	13.1a
Platinum 75SG Coragen 1.67SC	3.67 oz 4.0 oz	7/2 6/20	0a	0.5a	1.4ab	5.4ab	10.8b	0a	9.4a	7.3a	12.9a	17.1a
Scorpion 35SL Coragen 1.67SC	10.5 oz 4.0 oz	7/2 6/20, 7/25	0a	1.4a	0.7a	1.7a	3.2a	0a	2.1a	9.1a	4.2a	12.6a
Belay 2.13SC Coragen 1.67SC	12.0 oz 4.0 oz	7/2 6/20	0.8a	0.5a	1.1ab	6.1b	22.8c	1.6b	7.3a	11.2a	21.2a	13.9a
Control	—	—	0a	6.7a	8.8c	16.0c	23.3c	3.7c	15.4a	13.8a	19.7a	5.6a

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

Tomato Acaricide Trials

Tomato, *Lycopersicon esculentum* Mill. 'Picus'

Twospotted spider mite (TSSM): *Tetranychus urticae* (Koch)

The twospotted spider (TSSM) mite is a serious pest tomato and cucurbit crops in North Carolina. Populations can be difficult to control due to warm summer temperatures that result in very short generation times, and due to the occurrence of acaricide resistance development. Naturally occurring biological control agents do not provided the necessary level of control in field-grown vegetable crops, and reliance on acaricides will be necessary for the foreseeable future. One component of a resistance management program is to minimize exposure of mite populations to any individual acaricide by rotation or the use of alternative tactics to suppress mite populations and therefore reduce the need for acaricide applications. Hence, studies were conducted in 2012 to evaluate several non-traditional compounds that may could be used to aid in suppressing TSSM populations, and therefore reduce the frequency of acaricide applications. Radiant (a.i., spinetoram) is a common insecticide used for lepidopteran and thrips control in vegetables, and previous studies have demonstrated this product has some acaricidal activity. Hence, materials were also evaluated in combination with Radiant to detect potential synergistic effects.

Laboratory Studies.

Laboratory bioassays were conducted to assess the activity of three compounds (Kanolite, EcoTech, Saf-T-Sid, and Biomite) used alone and in combination with Radiant. For each treatment, 10 mites were placed on a 1.8 cm diameter bean leaf disk and exposed to two rates of each, a single rate of Radiant, and a mixture of Radiant with test materials. Controls were sprayed with water only. Materials were applied with an artist airbrush calibrated to deliver approximately 20 ul of solution per disk. Leaf disks placed on moist cotton and incubated at 25°C (16:8 L:D). At 3 and 24 hr post treatment, each disk was observed to record the number of live and dead mites, number that escaped from the leaf disk arena, and the number of eggs oviposited. Each treatment was replicated 5 times. Data were subjected to a two-way ANOVA and means were separated by LSD ($P = 0.05$). A second experiment following the same protocol as described above was conducted three different materials; Biomite, MBI-203DF, MBI-206 and a control.

Saf-T-Side was the only material that resulted in significant mortality after 3-hr exposure, with mortality ranging from 16 to 26% (Table 1). The combination of Saf-T-Sid + a reduced rate of Radiant (3 oz/A) enhanced this activity. While all matreials reduced ovpoisition at 3 hr, Saf-T-Sid and Radiant were most effective. Based on the number of mites that escaped from the arena, Saf-T-Side appeared to have some repellency to mites. At 24 hr after exposure, Saf-T-Side and Radiant (alone and in combination with all products, exhibited the highest mortality levels and the greatest impact on oviposition. Kanolite and EcoTech applied alone had minimal mortality or oviposition effects. Biomite, which was evaluated alone, also exhibited significant activity at 3 and 24 hr (Table 2) compared to the control. In particular it appeared to have significant repellency activity and, along with MBI-203 DF, reduced oviposition to levels similar to that of Saf-T-Sid.

Table 1. TSSM mortality, repellency ((% escaped) and fecundity at 3 and 24 hr after exposure to various treatments.

Treatment (Amt/100 gal)	3-hr			24 hr		
	% Mort.	% Escaped	Eggs/♀	% Mort.	% Escaped	Eggs/♀
Kanolite (1 pt)	0.0a	2.0a	0.25abc	2.0a	4.0a	17.0e
Kanolite (2 pt)	8.0ab	0.0a	0.61d	16.0bc	6.0a	18.8e
Kan (1 pt) + Rad (3 oz)	6.0ab	2.0a	0.22abc	56.0d	8.0ab	0.7a
Saf-T-Sid (0.5%)	26.0c	28.0b	0.00a	42.0d	32.0c	2.6ab
Saf-T-Sid (1.0%)	16.0bc	36.0b	0.22abc	26.0c	48.0d	4.6b
Saf (0.5 pt) + Rad (3 oz)	42.0d	58.0c	0.00a	44.0d	56.0d	0.0a
Ecotech (1 pt)	0.0a	30.0b	0.35bcd	2.0a	18.0abc	10.3c
Ecotech (2 pt)	6.0ab	6.0a	0.50cd	4.0ab	6.0a	10.4c
Eco(1 pt) + Rad (3 oz)	10.0ab	26.0b	0.00a	76.0e	22.0bc	0.0a
Radiant (6 oz)	0.0a	10.0a	0.10ab	54.0d	16.0ab	0.7a
Control	0.0a	6.8a	1.00e	2.0a	8.0ab	13.7d

Means within the same column followed by the same letter are not significantly different by t-test ($P<0.05$).

Table 2. TSSM mortality, repellency ((% escaped) and fecundity at 3 and 24 hr after exposure to various treatments.

Treatment (Amt/100 gal)	3-hr			24 hr		
	% Mort.	% Escaped	Eggs/♀	% Mort.	% Escaped	Eggs/♀
Biomite (2 pt)	8.0a	34.0b	0.08a	28.0b	54.0b	2.83a
MBI-203DF (2 lb)	0a	0a	0.30b	12.0ab	0a	2.23a
MBI-206 (2 gal)	0a	0a	0.88c	0a	0a	6.72b
Control	1.0a	3.3a	1.0c	2.4a	12.4a	11.5c

Means within the same column followed by the same letter are not significantly different by t-test ($P<0.05$).

Field Studies.

This study was conducted at the Mountain Horticultural Crops Research Station in Mills River, NC. Six-wk-old 'Florida 47' tomato transplants were set on 5 June on black plastic mulch with drip irrigation. Plots consisted of single 25-ft long rows on 10 foot centers. Plants were spaced 1.5 ft within rows, and treatments were replicated four times and arranged in a RCB design. One week before planting, transplants were infested with TSSM from a laboratory colony (susceptible to miticides). In addition, all plots were sprayed with Sevin XLR (1 qt/A) on 8, 15, 22 and 29 June to help build TSSM populations. An initial application of treatments was applied on 20 July when mites averaged 3.5 mites/leaf across all treatments. Treatments 1-4 consisted of a single application of acaricides, while treatments 5-8 consisted of weekly applications of Radiant with and without either Saf-T-Sid, Biomite, or Eco-Tech. On 17 August, a second application of the same acaricides was made to treatments 1-4, while treatments 5-8 received a different combination of products compared with the first application. Mite populations were monitored in all treatments at approximately 3- to 4-day intervals by recording the number of mites observed with a 10X visor lens on 10 leaflets per plot. All data were subjected to a two-way ANOVA, and means were separated by LSD ($P = 0.05$). Data are presented as mean number of mites per leaflet. In addition, cumulative mite days were calculated by multiplying the mean mite density on successive sample dates by the sample interval (days), and summing mite days across all sample dates. Cumulative mite days were calculated separately for the first and second application.

Following the first application of treatments on 20 July, Portal and Acramite provided the greatest initial knockdown of mites and the longest residual activity, with mite densities slightly lower in Acramite versus Portal, although these differences were not significant (Table 3). Among the remaining treatments, not all significantly reduced populations below the control on every sample date, but all did significantly reduce CMD compared with the control. Interestingly, none of those materials that exhibited mite activity in laboratory bioassays (Saf-T-Sid, Biomite or EcoTech) significantly improved the performance of Radiant.

Following the second application of materials on 7 August (Table 4), Portal and Acramite again provided the most effective knockdown activity and residual activity. There was very little difference among the remaining treatments, all of which had lower mite counts and cumulative mite days compared with the control.

Summary:

Saf-T-Sid, EcoTech (particularly when used in combination with Radiant) and Biomite all exhibited promising results in laboratory bioassays as potential tools to suppress TSSM populations. In field studies, all of these materials applied with Radiant significantly reduced mite densities below the control, but mite densities did not differ significantly from Radiant applied alone. As expected, Portal and Acramite provided the most effective control under field conditions. It should be noted that results in these small plot studies can differ from treatment of whole fields, because small plot experiments allow for interplot movement of mites, which likely accelerates the buildup of mites following applications compared to whole field applications.

Table 3. Mite densities (mites/leaflet) on tomatoes treated with various acaricidal programs on 20 July. CMD are the cumulative mite days accumulated from 18 July to 6 August. Mills River, NC. 2012.

TRT	Product	Rate/A	Application date	18 Jul Pre-spray	23 Jul 3 DAT	26 Jul 6 DAT	30 Jul 10 DAT	2 Aug 13 DAT	6 Aug 17 DAT	CMD
1	Portal 5EC	32 fl oz	7/20	3.1a	3.3a	4.4a	5.7ab	9.5ab	12.9ab	99.2a
2	Akari 5SC	32 fl oz	7/20	5.1a	6.0ab	7.6ab	10.7b	15.4bc	22.6bcd	172.0b
3	NAI-2399-2	32 fl oz	7/20	4.3a	6.6ab	12.2ab	11.7bc	22.6c	28.1d	228.6bcd
4	Acramite 50WP	1 lb	7/20	2.9a	3.8a	3.9a	3.5a	5.5a	8.6a	67.9a
5	Radiant 1SC	6 oz	7/20, 7/27, 8/3	1.9a	14.2cd	12.4bc	15.3bcd	22.4c	19.5bcd	235.5bcd
6	Radiant 1SC+ Saf-T-Side	6 oz 1%	7/20, 7/27, 8/3	3.0a	7.2abc	17.5ab	12.2ab	22.6c	13.9ab	221.4bc
7	Radiant 1SC+ Biomite	6 oz 2 pt	7/20, 7/27, 8/3	2.3a	8.3abc	16.5abc	18.1bcd	37.9d	25.1cd	316.3d
8	Radiant 1SC+ EcoTech	6 oz 2 pt	7/20, 7/27, 8/3	3.7a	7.3abc	17.9abc	19.9cd	32.0cd	15.0abc	284.9cd
9	Control	—	7/20, 7/27, 8/3	5.1a	15.0c	26.8c	29.7e	46.9d	58.9e	501.9e

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

Table 4. Mite densities (mites/leaflet) on tomatoes treated with various acaricidal programs on 7 August. CMD are mite days accumulated from 6 August to 23 August. Mills River, NC. 2012.

				6 Aug	10 Aug	14 Aug	17 Aug	20 Aug	23 Aug	
TRT	Product	Rate/A	Application date	Pre-spray	3 DAT	7 DAT	10 DAT	13 DAT	16 DAT	CMD
1	Portal 5EC	32 fl oz	8/7	12.9ab	4.6ab	10.6a	20.1a	14.9a	39.2a	245.1a
2	Akari 5SC	32 fl oz	8/7	22.6bcd	20.1de	32.4bc	44.4b	39.7b	95.6b	634.6b
3	NAI-2399-2	32 fl oz	8/7	28.1d	12.6cd	34.2bc	44.5b	44.7b	55.3ab	576.5b
4	Acramite 50WP	1 lb	8/7	8.6a	1.7a	6.2a	20.3a	11.0a	35.0a	192.1a
5	Portal 5EC BioMite	32 fl oz 2 pt	8/7 8/21	19.5bcd	19.8de	31.5bc	59.0bc	70.5bc	65.9ab	715.4b
6	Acramite 50WP Biomite	1 lb 2 pt	8/7 8/21	13.9ab	8.7bc	29.9b	61.2bc	51.0b	62.0ab	596.6b
7	Oberon 2SC Saf-T-Sid	8.5 fl oz 1%	8/7 8/21	25.1cd	29.4e	72.8d	59.9bc	43.6b	67.9ab	834.6b
8	Saf-T-Sid	1%	8/7, 8/21	15.0abc	22.0de	53.8cd	73.7c	81.7c	57.3ab	858.0b
9	Control	—	—	58.9e	88.3f	139.3e	205.4d	165.3d	167.2c	2321.4c

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

Peach Insecticide Trial

PEACH, *Prunus persica* (L.) ‘Contender’ and ‘Winblo’

Oriental fruit moth (OFM): *Grapholita molesta* (Busck)
Catfacing insects (CF):
Plum Curculio: *Conotrachelus nenuphar* (Herbst)
Stink bugs: *Euschistus servus* (Say) and *Acrosternum hilare* (Say)
Tarnished plant bugs: *Lygus lineolaris* (Palisot de Beauvois)

The trial was conducted in a four-year-old mixed variety block of ‘Contender’ and’Winblo’ peaches at the Mountain Horticultural Crops Research Station, Mills River, NC. Trees were spaced 15 ft within rows, and rows were on 20-ft centers. Plots consisted of single trees, and treatment trees were separated by at least one non-sprayed tree. To minimize spray drift effects, every other row in the block was used for treatment trees. Each treatment was replicated four times in a RCBD. Treatments consisted of evaluation of different rates of cyazypyr for control of non-lepidopteran pests, and evaluation of the experimental material DPX-KN128 for control of OFM. DPX-KN128 treatments (1-5) were in ‘Winblo’ trees and Cyazypyr treatments (7-10) were in ‘Contender’ trees, while the standard (trt 6) and control (trt 11) were in both ‘Contender’ and ‘Winblo’ trees. Both cyazypyr and DPX-KN128 treatments were limited to three applications per season and the dates of applications and other insecticides applied are reported in the tables. OFM shoot damage was recorded on each treatment tree on 7 and 21 May and 22 June, and fruit damage was recorded on 2 May, 22 June, and 16 and 22 June, by harvesting 50 fruit per plot and recording number with catfacing and lepidopteran damage.

First generation OFM populations were of relatively low intensity, with a mean of only 2 and 6 flagged shoots in the control on 7 and 21 May, respectively (Table 1). The number of flagged shoots Populations remained relatively low through the second generation, with only 5.3 shoots flagged in the control. Interestingly, the high rate of 5.9 oz rates of KN128 and Avaunt were the only treatments that did not significantly reduced flagged shoots below the control. On both 2 May and 22 June, all insecticide treatments significantly OFM damaged fruit below the control (Table 2), although the KN128 and Avaunt treatments were slightly higher than all other insecticide treatments. At harvest in mid-July, all treatments had significantly lower levels of OFM damaged fruit than the control, but the 4.8 rates of KN128 and Avaunt had significantly higher OFM damaged fruit than the standard treatment or those with cyazypyr. Catfacing damage was highly variable and did not significantly differ among treatments on any sample date.

Table 1. Mean OFM shoot damage to peaches sprayed with different insecticide programs. Mills River, NC. 2012.

				Flagged shoots/tree		
TRT	Insecticide	Rate/A	Application date	5/7	5/21	6/22
1	Imidan 70WP	3.0 lb	4/3	0.3a	0.3a	0.8ab
	Asana XL	8.0 oz	4/18, 6/25			
	KN128 30WDG	4.8 oz	5/17, 6/8, 7/10			
2	Imidan 70WP	3.0 lb	4/3	0a	0.3a	2.0bc
	Asana XL	8.0 oz	4/18, 6/25			
	KN128 30WDG	5.9 oz	5/17, 6/8, 7/10			
3	Imidan 70WP	3.0 lb	4/3	0.3a	0a	1.3ab
	Asana XL	8.0 oz	4/18, 6/25			
	Avaunt 30WDG	4.8 oz	5/17, 6/8, 7/10			
4	Imidan 70WP	3.0 lb	4/3	0a	0.3a	2.0bc
	Asana XL	8.0 oz	4/18, 6/25			
	Avaunt 30WDG	5.9 oz	5/17, 6/8, 7/10			
5	Imidan 70WP	3.0 lb	4/3	0.3a	0.5a	0a
	Asana XL	8.0 oz	4/18, 6/25			
	Altacor 35WDG	3.0 oz	5/17, 6/8, 7/10			
6	Imidan 70WP	3.0 lb	4/3	0a	0.8a	0.8ab
	Asana XL	8.0 oz	4/18, 6/25, 5/17, 6/8, 7/10			
7	Imidan 70WP	3.0 lb	4/3	0a	1.3a	1.0ab
	*Cyazypyr 10SE	10.1 oz	4/18, 6/25, 7/10			
	Asana XL	8.0 oz	5/17, 6/8			
8	Imidan 70WP	3.0 lb	4/3	0a	0a	1.0ab
	*Cyazypyr 10SE	13.5 oz	4/18, 6/25, 7/10			
	Asana XL	8.0 oz	5/17, 6/8			
9	Imidan 70WP	3.0 lb	4/3	0a	0.3a	1.3ab
	*Cyazypyr 10SE	20.5 oz	4/18, 6/25, 7/10			
	Asana XL	8.0 oz	5/17, 6/8			
10	Imidan 70WP	3.0 lb	4/3	0a	0.8a	1.5ab
	Cyazypyr 10SE	13.5 oz	4/18, 6/25, 7/10			
	Asana XL	8.0 oz	5/17, 6/8			
11	Control			2.0b	6.3a	5.3c

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

*Indicates that Induce (0.25%) was included as an adjuvant to cyazypyr applications.

Table 2. Mean fruit damage caused by catfacing insects (CF) and OFM. Mills River, NC. 2012.

				5/2		6/22		7/16-7/22		
TRT	Insecticide	Rate/A	Application date	CF	OFM	CF	OFM	CF	OFM	
1	Imidan 70WP Asana XL KN128 30WDG	3.0 lb 8.0 oz 4.8 oz	4/3 4/18, 6/25 5/17, 6/8, 7/10	5.0a	0.5a	4.0a	3.5a	6.1a	4.6bc	89.2c
2	Imidan 70WP Asana XL KN128 30WDG	3.0 lb 8.0 oz 5.9 oz	4/3 4/18, 6/25 5/17, 6/8, 7/10	9.0a	0.5a	3.0a	2.0a	3.6a	2.1abc	94.3abc
3	Imidan 70WP Asana XL Avaunt 30WDG	3.0 lb 8.0 oz 4.8 oz	4/3 4/18, 6/25 5/17, 6/8, 7/10	5.0a	1.5a	4.5a	3.5a	5.0a	5.5c	89.5c
4	Imidan 70WP Asana XL Avaunt 30WDG	3.0 lb 8.0 oz 5.9 oz	4/3 4/18, 6/25 5/17, 6/8, 7/10	4.0a	0a	3.0a	2.0a	3.0a	0.5ab	96.5a
5	Imidan 70WP Asana XL Altacor 35WDG	3.0 lb 8.0 oz 3.0 oz	4/3 4/18, 6/25 5/17, 6/8, 7/10	6.5a	0.5a	1.5a	1.0a	2.5a	1.5abc	96.0a
6	Imidan 70WP Asana XL	3.0 lb 8.0 oz	4/3 4/18, 6/25, 5/17, 6/8, 7/10	4.5a	0.5a	2.5a	3.0a	3.0a	0a	97.0a
7	Imidan 70WP *Cyazypyr 10SE Asana XL	3.0 lb 10.1 oz 8.0 oz	4/3 4/18, 6/25, 7/10 5/17, 6/8	6.5a	1.5a	1.0a	0.5a	10.5a	0a	89.5bc
8	Imidan 70WP *Cyazypyr 10SE Asana XL	3.0 lb 13.5 oz 8.0 oz	4/3 4/18, 6/25, 7/10 5/17, 6/8	17.0a	1.5a	3.0a	2.0a	5.5a	1.0ab	93.5abc
9	Imidan 70WP *Cyazypyr 10SE Asana XL	3.0 lb 20.5 oz 8.0 oz	4/3 4/18, 6/25, 7/10 5/17, 6/8	13.5a	1.5a	1.0a	2.5a	1.0a	0a	99.0a
10	Imidan 70WP Cyazypyr 10SE Asana XL	3.0 lb 13.5 oz 8.0 oz	4/3 4/18, 6/25, 7/10 5/17, 6/8	2.5a	1.0a	1.0a	1.0a	5.5a	0a	94.5abc
11	Control			8.0a	5.0b	5.0a	7.5b	5.4a	11.7d	82.9d

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

*Indicates that Induce (0.25%) was included as an adjuvant to cyazypyr applications.

Evaluation of Agri-Flex and Endigo on Peaches

PEACH, *Prunus persica* (L.) 'Contender'

Twospotted spider mite: *Tetranychus urticae* Koch
Oriental fruit moth: *Grapholita molesta* (Busck)
Plum Curculio: *Conotrachelus nenuphar* (Herbst)
Stink bugs: *Euschistus servus* (Say) and *Acrosternum hilare* (Say)

The trial was conducted in a four year old block of 'Contender' peaches at the Mountain Horticultural Crops Research Station, Mills River, NC. Trees were planted 15 ft apart in rows on 20 ft centers. Plots consisted of single trees with a non-sprayed tree separating treatment trees within rows, and a non-sprayed row separating treatment rows. All insecticide applications were made with a tractor-mounted air blast sprayer delivering 90 GPA. Treatments were arranged in a randomized complete block design with four replications. Six treatments were designed to compare the effect of two applications each of Agri-Flex 1.55SC, Agri-Mek 0.70SC, Endigo 2.06ZC, and Endigo 2.71ZC to an industry standard and a non-treated control. The two treatment dates were 18 April (first cover spray) and 25 June, and were timed to coincide with early season catfacing damage caused by plum curculio and stink bugs, and late season stink bugs. Additional insecticides applied to plots on "non-treatment" dates are shown in Table 1 and 2. Twospotted spider mites were monitored at approximately weekly intervals by observing 10 leaves per plot with a 10X visor lens and recording the number of motile mites. Fruit were assessed for insect damage at harvest on 24 July by harvesting 50 peaches per treatment and recording damage by various insect pests. All data were subjected to a two-way ANOVA and means were separated by LSD (P=0.05).

Overall pest pressure was very low in this trial. Twospotted spider mite populations were particularly low, despite the extensive use of Asana for general insecticide sprays. Only a few mites were detected on two of the nine sample dates (Table 1). Direct insect pests were also low, with insects accounting for a total of only about 11% damaged fruit at harvest (Table 2). Although season-ending catfacing and OFM damaged fruit were higher in the control than all other treatments, no significant differences were detected among treatments due to the relatively low and variable pest pressure.

Table 1. Mean twospotted spider mite populations on peaches treated with different insecticides on 18 April and 25 June. Mills River, NC. 2012.

			Mean mites/10 leaves								
Treatment	Rate/A	Applic. date	2 May	7 May	16 May	23 May	5 Jun	13 Jun	29 Jun	13 Jul	18 Jul
Actara 25WDG	4.5 oz	4/3	0	0	0	0	0	0	0	0	0
Agri-Flex 1.55SC	8.5 oz	4/18, 6/25									
+ Hort Oil	0.25%	4/18, 6/25									
Asana XL	8.0 oz	5/17, 6/8, 7/10									
Actara 25WDG	4.5 oz	4/3	0	0.3	0	0	0	0	0	0	0
Agri-Mek 0.7SC	3.0 oz	4/18, 6/25									
+ Hort Oil	0.25%	4/18, 6/25									
Asana XL	8.0 oz	5/17, 6/8, 7/10									
Actara 25WDG	4.5 oz	4/3	0	0	0	0	0	0.3	0	0	0
Endigo 2.06ZC	6.0 oz	4/18, 6/25									
Asana XL	8.0 oz	5/17, 6/8, 7/10									
Actara 25WDG	4.5 oz	4/3	0	0	0	0	0	0.3	0	0	0
Endigo 2.71ZC	6.0 oz	4/18, 6/25									
Asana XL	8.0 oz	5/17, 6/8, 7/10									
Imidan 70WP	3.0 lb	4/3	0	0.3	0	0	0	0	0	0	0
Asana XL	8.0 oz	4/18, 5/17 – 7/10									
Control	—		0	0	0	0	0	0	0	0	0

Table 2. Mean OFM shoot damage and damage to fruit by catfacing insects and OFM. Mills River, NC. 2012.

			OFM-infested shoot tips/tree				% Fruit Damage		
							Catfacing		OFM
Treatment	Rate/A	Applic. date	5/7	5/21	6/22	Tot	5/2*	7/24	7/24
Actara 25WDG	4.5 oz	4/3	0.8a	1.5a	0.3a	2.5a	7.0a	0.5a	0.5a
Agri-Flex 1.55SC	8.5 oz	4/18, 6/25							
+ Hort Oil	0.25%	4/18, 6/25							
Asana XL	8.0 oz	5/17, 6/8, 7/10							
Actara 25WDG	4.5 oz	4/3	0.5a	1.0a	0.5a	2.0a	11.5a	1.0a	1.5a
Agri-Mek 0.7SC	3.0 oz	4/18, 6/25							
+ Hort Oil	0.25%	4/18, 6/25							
Asana XL	8.0 oz	5/17, 6/8, 7/10							
Actara 25WDG	4.5 oz	4/3	0.3a	0.0a	0.5a	0.8a	8.5a	1.5a	1.5a
Endigo 2.06ZC	6.0 oz	4/18, 6/25							
Asana XL	8.0 oz	5/17, 6/8, 7/10							
Actara 25WDG	4.5 oz	4/3	1.5a	0.5a	0.8a	2.8a	11.0a	3.0a	3.0a
Endigo 2.71ZC	6.0 oz	4/18, 6/25							
Asana XL	8.0 oz	5/17, 6/8, 7/10							
Imidan 70WP	3.0 lb	4/3	0.0a	0.8a	0.8a	1.5a	4.5a	2.5a	3.5a
Asana XL	8.0 oz	4/18, 5/17 – 7/10							
Control	—	—	2.0a	6.0a	4.8a	12.8b	8.0a	5.0a	6.5a

*catfacing damage recorded on 2 May occurred before fruit thinning, which accounts for the decline in damage at harvest.

Efficacy of Early Season Cyazpyr Applications for Plum Curculio Control

APPLE: Malus domestica Borkhauser 'Delicious' and 'Golden Delicious'

Green fruit worm (GFW): *Lithophane antennata* (Walker) and *Amphipyra pyramidoides* (Guenée)
Plum curculio (PC): *Conotrachelus nenuphar* (Herbst)
Rosy apple aphid (RAA): *Dysaphis plantaginea* (Passerini)

The trial was conducted in a mature block of 'Golden Delicious' apples at the Mountain Horticultural Crops Research Station, Mills River, NC. Trees were spaced 10 ft apart within rows and rows were on 25 ft centers. Plots consisted of two trees and each treatment was replicated four times in a RCBD. Treatments consisted of various insecticide programs applied from the pink stage on 27 March through the third cover spray on 18 May. The primary focus of the study was on plum curculio, which was affected principally by insecticides applied at petal fall (10 April) and first cover (20 April). Applications were made with a tractor-mounted air-blast sprayer delivering 100 GPA, and Induce (0.25%) was added as an adjuvant to all insecticide mixtures. Rosy apple aphids were monitored by conducting a 2 minute search per plot and recording the number of live colonies on 16 May. Damage assessments for fruit damage caused by plum curculio were conducted on 2 and 9 May and 8 June, by observing 50 fruit per plot and recording the number with PC feeding or oviposition scars. Early season damage by internal-feeding lepidopterans was conducted on 22 June, which coincided with the end of first generation codling moth flight.

A mild winter and very early spring was followed by a mid-April frost that resulted in a light crop 2012. Insect populations were several weeks earlier than normal, but populations were very low throughout the season. Rosy apple aphids were extremely low and none were detected in plots. Early season plum curculio damage was of relatively high intensity, increasing from 9.5% to 33.0% damaged fruit between 2 May and 8 June (Table 1). All treatments reduced damage below the control, although differences were significant only the 9 and 21 May sample dates. Among those fruit that were damaged, there was no difference in the number of PC injuries per fruit, which averaged 1.0 and 1.2 injuries per fruit on 21 May and 6 June, respectively. First generation codling moth damage, as measured on 22 June was low with only 4% of control fruit damaged, and all treatments significantly reduced damage below the control.

Table 1. Mean early and mid-season plum curculio (PC) and internal lepidopteran damage to 'Golden Delicious' apples treated with different insecticide programs. Mills River, NC. 2012.

TRT	Insecticide	Rate/A	Application Date	% PC fruit damage 5/2	5/9	5/21	6/8	Injuries/fruit 5/21	6/8	% Internal Lep Damage (6/22)
1	Closer 2SC Imidan 70WP Delegate 25WDG	3 fl oz 3 lbs 5.2 oz	3/27 (Pink) 4/10 (PF) 4/20, 5/4, 5/18	5.0a	4.0a	8.5a	17.5a	1.1a	1.2a	0.8a
2	Actara 25WDG Cyazypyr 10SE Altacor 30WDG	4.5 oz 13.5 fl oz 4 oz	3/27 (Pink) 4/10 (PF), 4/20 5/4, 5/18	3.0a	6.5a	3.0a	15.0a	0.5a	1.2a	1.5a
3	Actara 25WDG Cyazypyr 10SE Altacor 30WDG	4.5 oz 16.9 fl oz 4 oz	3/27 (Pink) 4/10 (PF), 4/20 5/4, 5/18	5.5a	2.0a	9.5a	20.0a	1.1a	1.2a	0.5a
4	Actara 25WDG Avaunt 30WDG Cyazypyr 10SE Altacor 30WDG	4.5 oz 5 oz 16.9 fl oz 4 oz	3/27 (Pink) 4/10 (PF) 4/20 5/4, 5/18	4.0a	3.5a	7.5a	26.0a	1.0a	1.3a	1.0a
5	Actara 25WDG Altacor 30WDG	4.5 oz 3 oz	3/27 (Pink), 4/10 (PF) 4/20, 5/4, 5/18	3.5a	2.0a	5.5a	21.0a	0.8a	1.1a	1.5a
6	Control	—	—	9.5a	13.5	17.5b	33.0a	1.0a	1.3a	4.0b

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

Apple Maggot Insecticide Trial

APPLE, *Malus domestica* Borkhauser 'Rome Beauty'

Apple Maggot: Rhagoletis pomenella (Walsh)

The trial was conducted in a mature block of 'Golden Delicious' apples at the Mountain Horticultural Crops Research Station, Mills River, NC. Treatments consisted of two trees with a non-treated tree separating treatment trees, and each treatment replicated four times in a randomized complete block design. Treatments consisted of three different application intervals (7, 10 and 14 days) cyazypyr 10SE (16.9 fl oz/acre), a standard treatment consisting of Imidan 70WP (3 lb/A) at 14-day intervals, and a non-treated control. Applications were initiated on 27 July and continued to 27 August, for a total of 5, 4 and 3 applications in the 7-, 10-, and 14-day interval treatments, respectively. All applications were made with an airblast sprayer delivering 100 GPA. Fruit were harvested for damage assessment on 5 September by harvesting 50 fruit per plot, placed in cold storage for approximately 3 weeks, and the evaluated for damage by cutting each apple and observing the interior of fruit for maggot tunneling. Data were subjected to a two-way ANOVA and means were separated by LSD (P = 0.05).

Apple maggot populations were of low intensity in this trail, with 8% of non-treated fruit infested with maggots (Table 1). Three was very little difference in infestation rates between dropped fruit and those on the tree; averaged across all treatments, 4.7 and 5.3% of dropped fruit and tree fruit were infested, respectively. Although there were no significant differences among treatments, numerically all insecticide treatments had lower infestation rates than the control, and the shorter interval application intervals of cyazypyr.

Table 1. Apple maggot damage to apples harvested from the tree and drops. .

			% damage		
Treatment	Rate/Acre	Application dates	Tree	Drops	Total
Cyazypyr 10SE	16.9 fl oz	7/27, 8/3, 8/10, 8/17, 8/25	2.5a	1.0a	1.8a
Cyazypyr 10SE	16.9 fl oz	7/27, 8/6, 8/17, 8/27	5.5a	5.5a	5.5a
Cyazypyr 10SE	16.9 fl oz	7/27, 8/10, 8/25	8.5a	4.5a	6.5a
Imidan 70WP	3.0 lb	7/27, 8/10, 8/25	4.0a	3.5a	3.8a
Control	—	—	8.0a	8.0a	8.0a

Means within the same column followed by the same letter are not significantly different.

Full Season Insecticide Program on Apple

APPLE, *Malus domestica* Borkhauser 'Golden Delicious'

Rosy Apple Aphid (RAA): *Dysaphis plantaginea* (Passerini)
European Red Mite (ERM): *Panonychus ulmi* (Koch)
Green apple aphids (GAA): *Aphis pomi* De Geer and *A. spiraecola* Patch
Potato Leafhopper: *Empoasca fabae* (Harris)
Internal-feeding Lepidopterans:
Oriental fruit moth, *Grapholita molesta* (Busck)
Codling Moth: *Cydia pomonella* (L.)
Plum Curculio: *Conotrachelus nenuphar* (Herbst)
Plant Bugs: *Lygus lineolaris* (Palisot de Beauvois)
Apple Maggot, *Rhagoletis pomonella* (Walsh)

This trial was conducted in a mature block of 'Golden Delicious' apples with trees spaced 10-ft apart within rows on 25-ft centers. Estimate tree-row-volume was approximately 300 GPA. Plots consisted of 2 adjacent trees within a row, and at least one non-treated tree separating treatment plots. Each treatment was replicated 4 times and arranged in a RCBD. The objective of the trial was to compare different insecticide programs for control of the arthropod complex attacking apple in NC. Insecticides and application dates for all treatments are shown in Table 1. Applications were made with a tractor-mounted air-blast sprayer delivering 100 GPA, and Induce (0.25%) was added as an adjuvant to all insecticide mixtures. Rosy apple aphids were monitored by conducting a 2 minute search per plot and recording the number of live colonies on 16 May. Counts of European red mite (ERM) and predatory mites, green apple aphids, and potato leafhopper 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. PLH were counted on 10 terminal shoots per plot, and GAA were assessed by counting the number of aphids on the most infested leaf on 10 shoots per plot. Early season damage assessments for fruit damage caused by plum curculio were conducted on 2 and 9 May and 8 June, by observing 50 fruit per plot and recording the number with PC feeding or oviposition scars. Early season damage by internal-feeding lepidopterans was conducted on 22 June, which coincided with the end of first generation codling moth flight. At harvest on 30 August, 100 fruit per plot were harvested and evaluated for insect damage. All data were subjected to a two-way ANOVA, and means from significant ANOVAs ($p \leq 0.05$) were separated by LSD ($P = 0.05$).

A mild winter and very early spring were followed by a mid-April frost that resulted in a light crop 2012. Insect populations were several weeks earlier than normal, but populations were very low throughout the season. Rosy apple aphid and green aphids were extremely low and were not detected in sufficient numbers to detect treatment differences (Table 1). Potato leafhoppers were at their peak densities in mid-June, and densities corresponded with insecticides applied on 4 June, demonstrating the effectiveness of Assail and lack of efficacy of Intrepid (treatment 1). European red mite populations were also very low, with a total of only 11.1 season total cumulative mite days (Table 2). Early season plum curculio damage was of moderate to high intensity, increasing from 9.5% to 33.0% damaged fruit between 2 May and 8 June (Table 3). All treatments reduced damage below the control, although differences were significant only the 9 and 21 May sample dates. First generation codling moth damage, as measured on 22 June was low with only 4% of control fruit damaged, and all treatments significantly reduced damage below the control. Overall insect damage was very low at harvest (Table 4), with plum curculio and plant bug damage accounting for the majority of damage; PC and PB damage in the control was 9.3% and 8.0%, respectively.

Table 1. Mean rosy apple aphid (RAA), green apple aphid (GAA), and potato leafhopper (PLH) on 'Golden Delicious' apples treated with different insecticide programs. Mills River, NC. 2012.

				RAA/3 min	GAA (most infested leaf per shoot)			PLH/ 10 shoots		
TRT	Insecticide	Rate/A	Application Date	5/16	5/23	6/8	6/13	5/23	6/8	6/13
1	Closer 2SC	3 fl oz	3/27 (Pink)	0	0.5	0.0	0.8	0.3	4.8ab	11.5b
	Imidan 70WP	3 lbs	4/10 (PF)							
	Delegate 25WDG	5.2 oz	4/20, 5/4, 5/18							
	Intrepid 2F	12 fl oz	6/4,							
	Altacor 30WDG	3 oz	7/5, 7/20, 8/3							
2	Actara 25WDG	4.5 oz	3/27 (Pink)	0	0.5	0.0	0.8	0.3	0.8a	0.5a
	Cyazypyr 10SE	13.5 fl oz	4/10 (PF), 4/20, 7/5, 7/20, 8/3							
	Altacor 30WDG	4 oz	5/4, 5/18							
	Assail 30WD	5.0 oz	6/4							
3	Actara 25WDG	4.5 oz	3/27 (Pink)	0	0.3	0.0	0.0	0.3	0.3a	2.0a
	Cyazypyr 10SE	16.9 fl oz	4/10 (PF), 4/20, 7/5, 7/20, 8/3							
	Altacor 30WDG	4 oz	5/4, 5/18							
	Assail 30WD	5.0 oz	6/4							
	Cyazypyr 10SE	13.5 oz								
4	Actara 25WDG	4.5 oz	3/27 (Pink)	0	0.5	0.0	2.5	0.0	0.0a	1.8a
	Avaunt 30WDG	5 oz	4/10 (PF)							
	Cyazypyr 10SE	16.9 fl oz	4/20, 7/5, 7/20, 8/3							
	Altacor 30WDG	4 oz	5/4, 5/18							
	Assail 30WD	5.0 oz	6/4							
	Cyazypyr 10SE	16.9 fl oz								
5	Actara 25WDG	4.5 oz	3/27 (Pink), 4/10 (PF)	0	0.0	0.0	3.8	0.0	0.0a	0.0a
	Altacor 30WDG	3 oz	4/20							
	Calypso 4SC	6 fl oz	5/4, 5/18							
	Delegate 25WDG	5.2 oz	7/5, 7/20, 8/3							
6	Control	—	—	0	0.3	0.0	1.5	0.3	8.8b	2.3a

Table 2. Mena European red mites on 'Golden Delicious' apples treated with different insecticide programs. Mills River, NC. 2012.

				Mites per 10 leaves						
TRT	Insecticide	Rate/A	Application Date	6-8	6-13	6-22	6-27	7-13	7-18	CMD
1	Closer 2SC	3 fl oz	3/27 (Pink)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Imidan 70WP	3 lbs	4/10 (PF)							
	Delegate 25WDG	5.2 oz	4/20, 5/4, 5/18							
	Intrepid 2F	12 fl oz	6/4,							
	Altacor 30WDG	3 oz	7/5, 7/20, 8/3							
2	Actara 25WDG	4.5 oz	3/27 (Pink)	0.0	0.0	4.8	0.3	0.0	0.8	37.8
	Cyazypyr 10SE	13.5 fl oz	4/10 (PF), 4/20, 7/5, 7/20, 8/3							
	Altacor 30WDG	4 oz	5/4, 5/18							
	Assail 30WD	5.0 oz	6/4							
3	Actara 25WDG	4.5 oz	3/27 (Pink)	0.0	0.0	0.3	0.0	0.0	0.0	1.8
	Cyazypyr 10SE	16.9 fl oz	4/10 (PF), 4/20, 7/5, 7/20, 8/3							
	Altacor 30WDG	4 oz	5/4, 5/18							
	Assail 30WD	5.0 oz	6/4							
	Cyazypyr 10SE	13.5 oz								
4	Actara 25WDG	4.5 oz	3/27 (Pink)	0.0	0.0	2.5	0.0	0.0	0.3	18.1
	Avaunt 30WDG	5 oz	4/10 (PF)							
	Cyazypyr 10SE	16.9 fl oz	4/20, 7/5, 7/20, 8/3							
	Altacor 30WDG	4 oz	5/4, 5/18							
	Assail 30WD	5.0 oz	6/4							
	Cyazypyr 10SE	16.9 fl oz								
5	Actara 25WDG	4.5 oz	3/27 (Pink), 4/10 (PF)	0.8	0.0	0.3	0.0	0.3	0.0	6.3
	Altacor 30WDG	3 oz	4/20							
	Calypso 4SC	6 fl oz	5/4, 5/18							
	Delegate 25WDG	5.2 oz	7/5, 7/20, 8/3							
6	Control	—	—	0.0	0.0	0.8	0.0	0.5	0.3	11.1

Table 3. Mean early and mid-season plum curculio (PC) and internal lepidopteran damage to 'Golden Delicious' apples treated with different insecticide programs. Mills River, NC. 2012.

TRT	Insecticide	Rate/A	Application Date	% PC damage 5/2	5/9	5/21	6/8	% Internal Lep Damage (6/22)
1	Closer 2SC Imidan 70WP Delegate 25WDG Intrepid 2F Altacor 30WDG	3 fl oz 3 lbs 5.2 oz 12 fl oz 3 oz	3/27 (Pink) 4/10 (PF) 4/20, 5/4, 5/18 6/4, 7/5, 7/20, 8/3	5.0a	4.0a	8.5a	17.5a	0.8a
2	Actara 25WDG Cyazypyr 10SE Altacor 30WDG Assail 30WD	4.5 oz 13.5 fl oz 4 oz 5.0 oz	3/27 (Pink) 4/10 (PF), 4/20, 7/5, 7/20, 8/3 5/4, 5/18 6/4	3.0a	6.5a	3.0a	15.0a	1.5a
3	Actara 25WDG Cyazypyr 10SE Altacor 30WDG Assail 30WD Cyazypyr 10SE	4.5 oz 16.9 fl oz 4 oz 5.0 oz 13.5 oz	3/27 (Pink) 4/10 (PF), 4/20, 7/5, 7/20, 8/3 5/4, 5/18 6/4	5.5a	2.0a	9.5a	20.0a	0.5a
4	Actara 25WDG Avaunt 30WDG Cyazypyr 10SE Altacor 30WDG Assail 30WD Cyazypyr 10SE	4.5 oz 5 oz 16.9 fl oz 4 oz 5.0 oz 16.9 fl oz	3/27 (Pink) 4/10 (PF) 4/20, 7/5, 7/20, 8/3 5/4, 5/18 6/4	4.0a	3.5a	7.5a	26.0a	1.0a
5	Actara 25WDG Altacor 30WDG Calypso 4SC Delegate 25WDG	4.5 oz 3 oz 6 fl oz 5.2 oz	3/27 (Pink), 4/10 (PF) 4/20 5/4, 5/18 7/5, 7/20, 8/3	3.5a	2.0a	5.5a	21.0a	1.5a
6	Control	—	—	9.5a	13.5b	17.5b	33.0a	4.0b

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

Table 4. Mean percent insect damage to 'Golden Delicious' apples treated with different insecticide programs. Mills River, NC. 2012.

TRT	Insecticide	Rate/A	Application Date	Lep	LR	PC	PB	AM	SJS
1	Closer 2SC	3 fl oz	3/27 (Pink)	0.5	0.0	1.8a	4.8abc	0.5	0.5
	Imidan 70WP	3 lbs	4/10 (PF)						
	Delegate 25WDG	5.2 oz	4/20, 5/4, 5/18						
	Intrepid 2F	12 fl oz	6/4,						
	Altacor 30WDG	3 oz	7/5, 7/20, 8/3						
2	Actara 25WDG	4.5 oz	3/27 (Pink)	0.0	0.0	1.0a	1.5a	0.0	4.8
	Cyazypyr 10SE	13.5 fl oz	4/10 (PF), 4/20, 7/5, 7/20, 8/3						
	Altacor 30WDG	4 oz	5/4, 5/18						
	Assail 30WD	5.0 oz	6/4						
3	Actara 25WDG	4.5 oz	3/27 (Pink)	0.0	0.0	1.0a	2.8ab	0.5	0.0
	Cyazypyr 10SE	16.9 fl oz	4/10 (PF), 4/20, 7/5, 7/20, 8/3						
	Altacor 30WDG	4 oz	5/4, 5/18						
	Assail 30WD	5.0 oz	6/4						
	Cyazypyr 10SE	13.5 oz							
4	Actara 25WDG	4.5 oz	3/27 (Pink)	0.8	0.0	2.0a	6.0bc	0.5	1.0
	Avaunt 30WDG	5 oz	4/10 (PF)						
	Cyazypyr 10SE	16.9 fl oz	4/20, 7/5, 7/20, 8/3						
	Altacor 30WDG	4 oz	5/4, 5/18						
	Assail 30WD	5.0 oz	6/4						
	Cyazypyr 10SE	16.9 fl oz							
5	Actara 25WDG	4.5 oz	3/27 (Pink), 4/10 (PF)	0.0	0.0	1.8a	2.0ab	0.0	1.0
	Altacor 30WDG	3 oz	4/20						
	Calypso 4SC	6 fl oz	5/4, 5/18						
	Delegate 25WDG	5.2 oz	7/5, 7/20, 8/3						
6	Control	—	—	1.0	0.0	9.3b	8.0c	0.8	1.8

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

Oriental Fruit Moth Mating Disruption Trials

In recent years, late-season populations of the oriental fruit moth (OFM) have increased considerably in many NC apple orchards that do not use mating disruption for codling moth and OFM. These late-season populations have generally been most intense form late July or early August through late September, and represent overlapping third and fourth generations (Fig. 1).

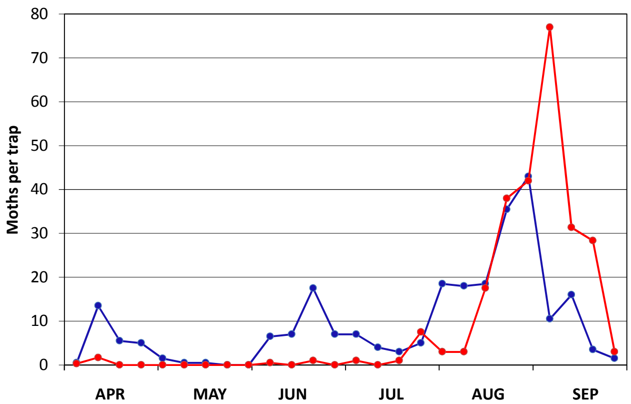


Fig. 1. Oriental fruit moth pheromone trap captures in two Henderson County, NC, apple orchards. 2011.

With the decline of codling moth populations in recent years, many growers now rely on a single insecticide application in August (usually early to mid-August) for lepidopteran control through September. However, additional applications in late August and/or early September are often necessary in those orchards where OFM is a late-season problem. Delegate and Altacor are the two materials that are most commonly used at this time.

Among those growers who do not currently use CM/OFM mating disruption, mating disruption for late-season control of OFM alone is an option that would preclude the need for a second application of Altacor or Delegate in late August or September. For mating disruption to be a viable option, however, it would need to be cost competitive with a single application of Delegate or Altacor, both of which are approximately $30-35 per acre. To achieve this cost, OFM mating disruption products would need to be applied at reduced rates. Previous studies with a diversity of mating disruption products has shown that the rate of pheromone deployed is more important than dispenser density for OFM mating disruption, and that rates as low as 20 gm of pheromone dispersed over about 150 days was sufficient for control of OFM. The objective of this study was to evaluate reduced rates of pheromone for mating disruption of late-season populations of OFM.

Materials and Methods

The experiment was originally designed to evaluate several different OFM mating disruption products and application timings. However, a widespread frost in mid-April resulted in loss of much of the NC crop in 2012, and we were therefore restricted to only a few sites with limited acreage where the OFM population was known to be problematic in 2011. Consequently, only four treatments (three mating disruption treatments and a control) were replicated in three different orchards.

Study sites: Studies were conducted in two Henderson County orchards where OFM was known to have been a problem in 2011, and one Polk County orchard where OFM was suspected of being a problem in 2011. Pheromone traps were placed in orchards in late March to gauge the intensity of first generation OFM populations, and early season peak trap captures in Hend-S and Hend-L were 197 and 172 moths per trap on 2 April, respectively. The Polk-L orchard was approximately 1200 ft lower elevation than either of the Henderson County orchards, and traps were placed in orchards after peak capture, so the intensity of first generation OFM in relation to the Henderson orchards was unknown. On 26 March, 34 moths/trap were captured in Polk-L, but OFM larvae were detected fruit sent to processors in 2011.

Pheromone Treatments: At each of the three orchards, four treatments were established: two Isomate OFM-TT treatments, one CheckMate OFM-F treatment, and a non-treated control. Treatments were partitioned in a contiguous block of trees at each site such that 4 to 8-acre treatments were adjacent to one another. All treatments, including the control, were sprayed with the same insecticide program targeting internal-feeding Lepidopteran pests (i.e., OFM and codling moth). Insecticide use varied among orchards. Hend-S received two applications of Altacor (1st and 2nd cover) and one Delegate application (9 July). Due to a low crop load, Hend-L received no insecticide applications until July, after which Altarcor (7/17), Imidan (7-26) were applied. Polk-L received two Altacor applications at 1st and 2nd cover, and Delegate on 7/18. Pheromone treatments are described below:

Isomate OFM-TT (100/A): Isomate OFM-TT applied in late May at 100 dispensers per acre. Isoamte-OFM TT is a 3-component blend of pheromone (88.54% Z-8-Dodecen-1-yl Acetate; 5.68% E-8-Dodecen-1-yl Acetate; 0.99% Z-8-Dodecen-1-ol; 4.79% other ingredients) that contains 479.52 mg of active ingredient per dispenser. The recommend rate is 100 dispensers per acre, which is equivalent to approximately 48 gm of pheromone per acre. The life of dispensers is 180 days.

Isomate OFM-TT (50/A): Isomate OFM-TT applied in late May at 50 dispensers per acre (24 gm a.i. per acre).

CheckMate OFM-F: One to two applications of CheckMate OFM-F (1.3 oz/Acre), the first in mid-to-late July and the second (in one orchard) in late August. CheckMate OFM-F is a sprayable formulation of a 3 component blend of pheromone (21.86% Z-8-Dodecen-1-yl Acetate; 1.47% E-8-Dodecen-1-yl Acetate; 0.27% Z-8-Dodecen-1-ol; 76.40% other ingredients) that contains 6.82 gm pheromone per oz. Hence, each application at 1.3 oz was equal to 8.9 gm of pheromone per acre.

Treatment efficacy was assessed by placing two OFM pheromone traps (Scentry LPD) in each treatment block and monitoring traps at weekly intervals. Trap bottoms were replaced as needed to maintain a clean trapping surface, and lures (Scentry L111) were replaced at 6-wk intervals. Fruit damage was assessed by harvesting 50 fruit per tree from a minimum of 5 trees per treatment. In addition to observing fruit for external entries, all fruit was also cut to detect damage. Orchards were harvested in late August to early September, with 'Golden Delicious' and 'Rome Beauty' varieties harvested in each orchard. The time necessary to hang pheromone at each location was recorded as man-hours of work.

Results

OFM populations were of low intensity at all orchards, with mean cumulative trap capture (June through September) in the control ranging from 7.5 to 40.3 moths per trap in the Hend-S and Polk-L orchards, respectively (Table 1). A total of four codling moth pheromone traps were also placed in each orchard study site, and cumulative trap capture in the Hend-S, Hend-L and Polk-L orchards was 0, 96.5 and 10.3, respectively. Codling moth was obviously a more serious issue than OFM in the Hend-L orchard.

Table 1. OFM pheromone treatment applications and cumulative OFM and codling moth pheromone trap captures form June through September. OFM numbers in parentheses represent cumulative captures from the time of CheckMate OFM-F application (mid July) through September.

			Cumulative trap capture	
Orchard	Treatment	Applic. date	OFM	Codling moth
Hend-S	Isomate OFM-TT (100)	5/31	1.5 (0)	–
	Isomate OFM-TT (50)	5/31	0.5 (0.5)	–
	CheckMate OFM-F (1.3 oz)	7/9	5.0 (4.5)	–
	Control	–	7.5 (5.0)	0
Hend-L	Isomate OFM-TT (100)	5/30	0	–
	Isomate OFM-TT (50)	5/30	0	–
	CheckMate OFM-F (1.3 oz)	7/17, 8/21	18.0 (1)	–
	Control	–	30.0 (19)	96.5
Polk-L	Isomate OFM-TT (100)	5/24	0	–
	Isomate OFM-TT (50)	5/24	0	–
	CheckMate OFM-F (1.3 oz)	7/18	11.0 (0)	–
	Control	–	40.3 (9.5)	10.3

Mean cumulative trap capture in each treatment averaged across all locations is illustrated in Fig. 2. Both Isomate OFM-TT applied at 100 and 50 dispensers per acre in late May were highly effective in suppressing OFM pheromone trap capture through September. CheckMate OFM-F, which was applied once in July at Hend-S and Polk-L and twice at the Hend-L site (July and August) were not as effective as Isomate OFM-TT in suppressing trap capture, but cumulative trap capture from mid-July through September was considerably lower than that of the control.

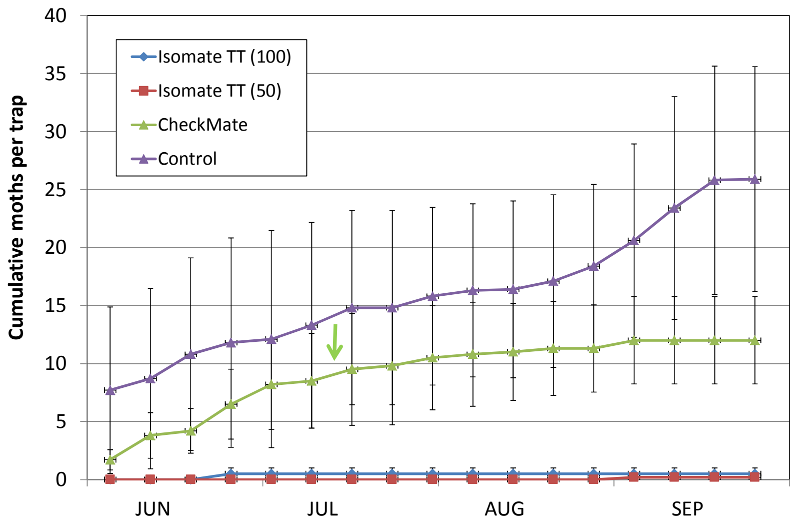


Fig. 2. Mean (±SEM) OFM pheromone captures in orchards treated with different mating disruption products. Isomate OFM-TT dispensers were hung in late May, and CheckMate OFM-F was sprayed in mid July (arrow).

The Hend-L orchard was the only site where significant levels of damage by internal-feeding lepidopterans was present (Table 2). Due to a very low crop load in this orchard, no insecticides were applied against the first codling moth generation, and only one application of Delegate and Imidan were subsequently applied. Evidence suggests that the majority of damage in the Hend-L orchard was due to codling moth, because codling moth trap captures were extremely high and worms collected from the few fruit containing with live worms were identified as codling moth. Damage in the remaining two orchards was non-existent or extremely low, suggesting that the OFM populations were not of sufficient levels to result in fruit damage.

Table 2. Mean percentage internal-lep damage to apples grown under different mating disruption programs.

	% internal lep damage			
Orchard	Isomate 100	Isomate 50	CheckMate	Control
Hend-S	0	0	0	0
Hend-L	1.0	2.5	0.5	1.5
Polk-L	0	0	0.5	0

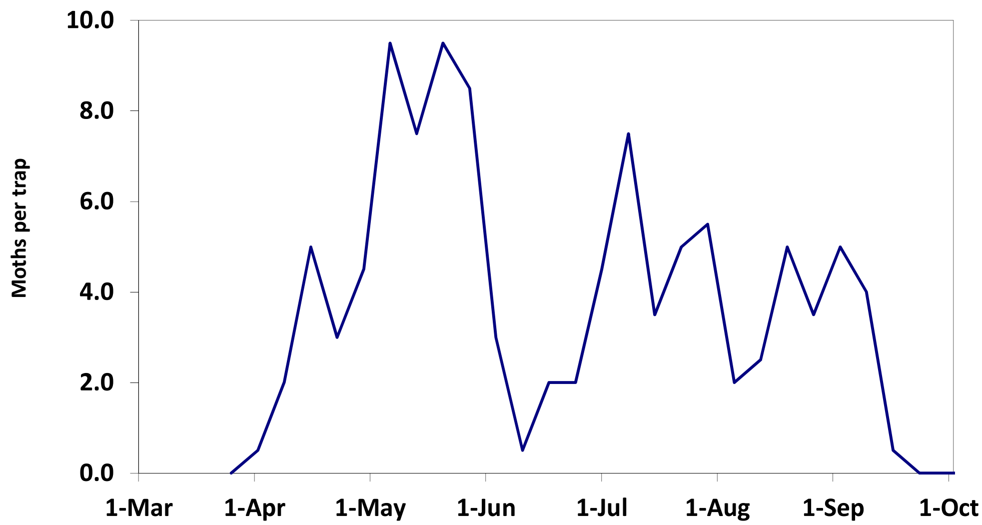
The total cost of the various treatments is shown in Table 3. Although OFM populations were low following the first generation, evidence from this and previous trials suggest that the 50 dispenser rate of Isomate OFM-TT should work well when applied in May. This reduced rate is estimated to cost about $35/acre, which is similar or slightly higher than a single application of

Altacor or Delegate. While a single application of CheckMate OFM-F worked well at Hend-S and Polk-L, two applications would likely be necessary under more intense OFM pressure, as previous studies have shown the residual activity of sprayable OFM pheromone to be 3 to 4 wks.

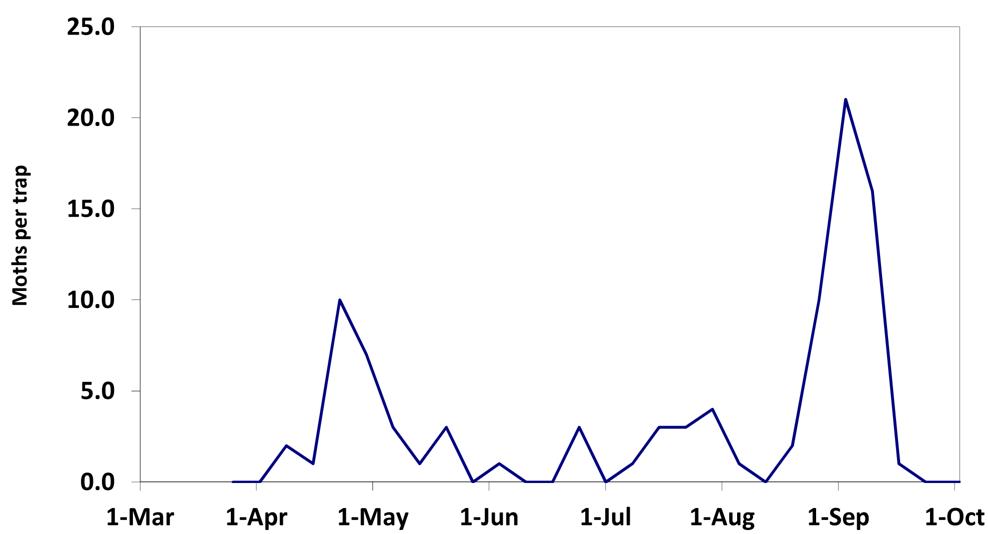
Table 3. Cost of various mating disruption treatments.

Product	Rate/A	Applic. cost ($10/hr)	Product cost	No. applications	Total Cost ($/A)
Isomate OFM-TT	100	5.10	62.50	1	67.60
Isomate OFM-TT	50	3.50	31.25	1	34.75
CheckMate OFM-F	1.32	—	17.30	1	17.30
				2	34.60

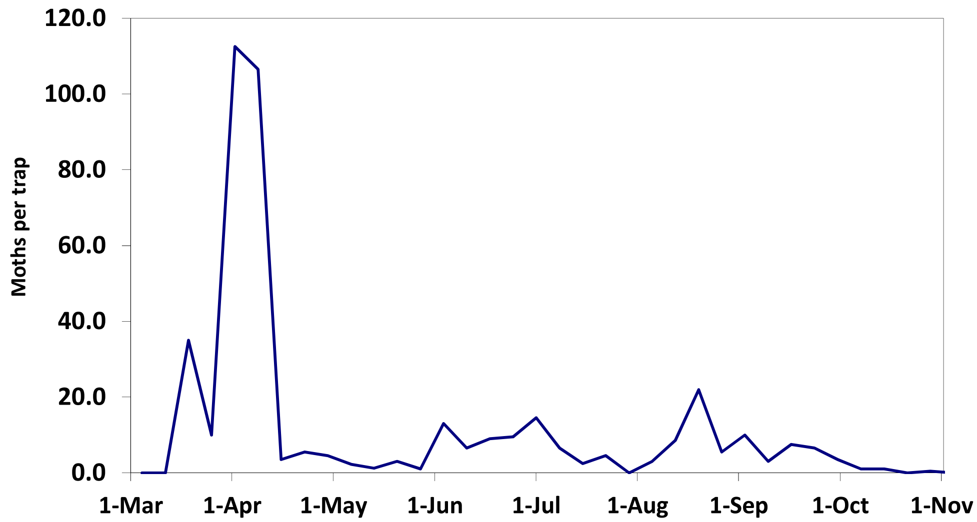
Codling Moth Trap Captures, MHCRS
Mills River, Henderson County, NC, 2012



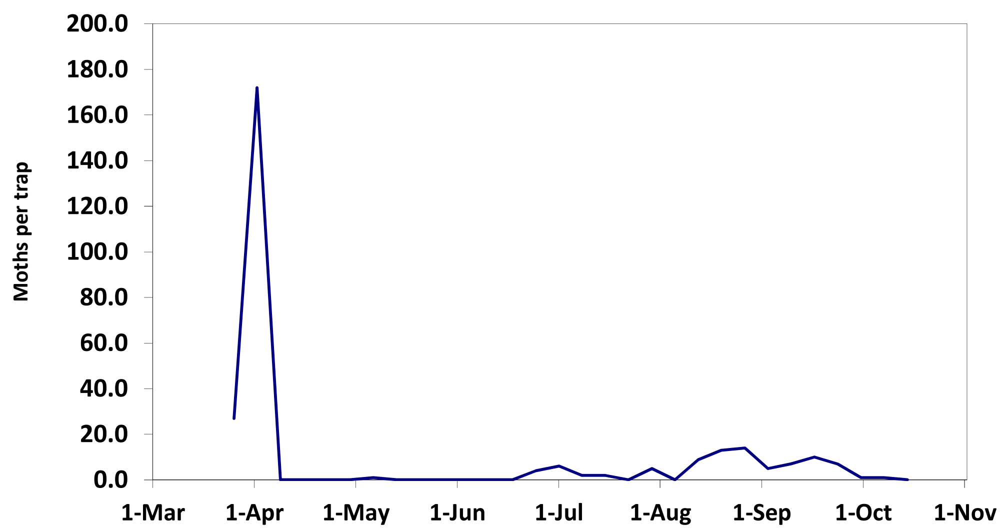
Codling Moth Trap Captures, Lynch - McGuinn Road
Mill Spring, Polk County, NC, 2012



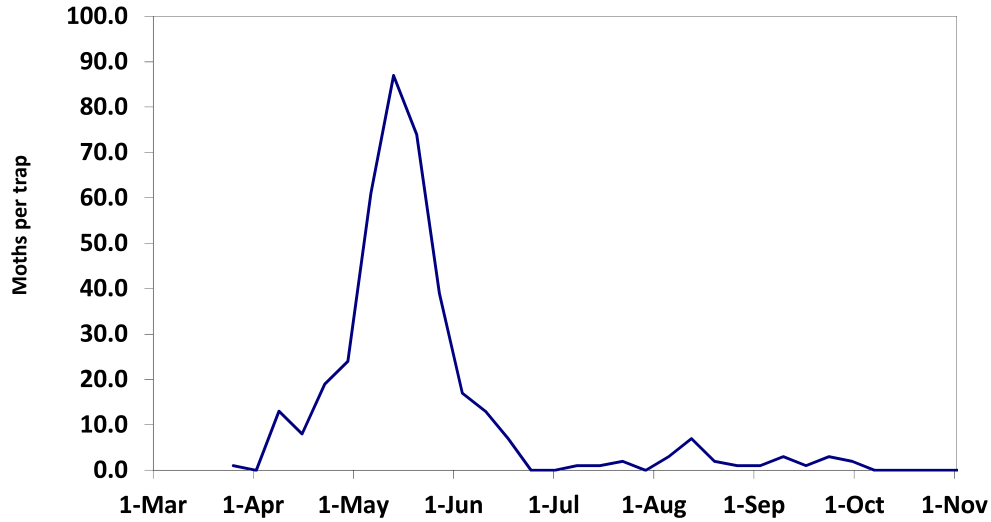
Oriental Fruit Moth Trap Captures, MHCRS Apples
Mills River, Henderson County, NC, 2012



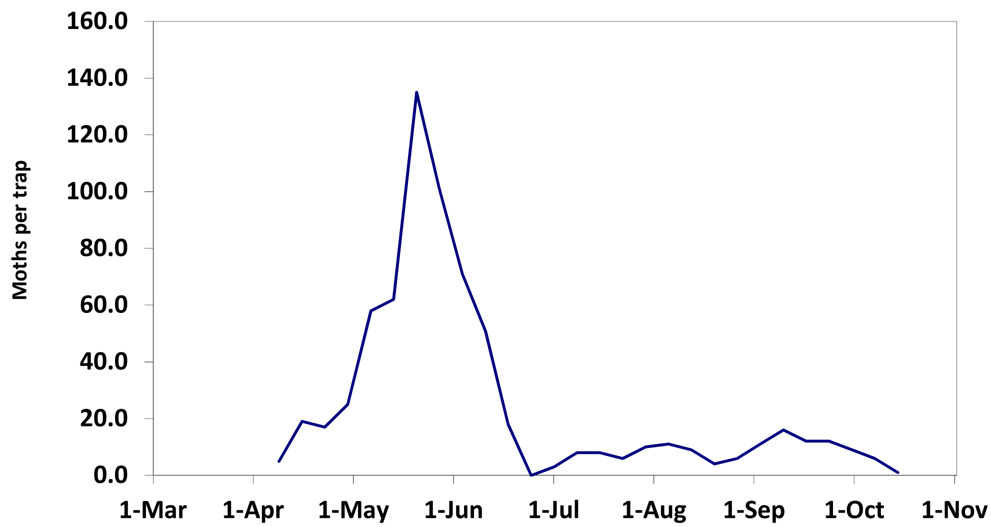
Oriental Fruit Moth Trap Captures, McCraw - Ridge Road
Edneyville, Henderson County, NC, 2012

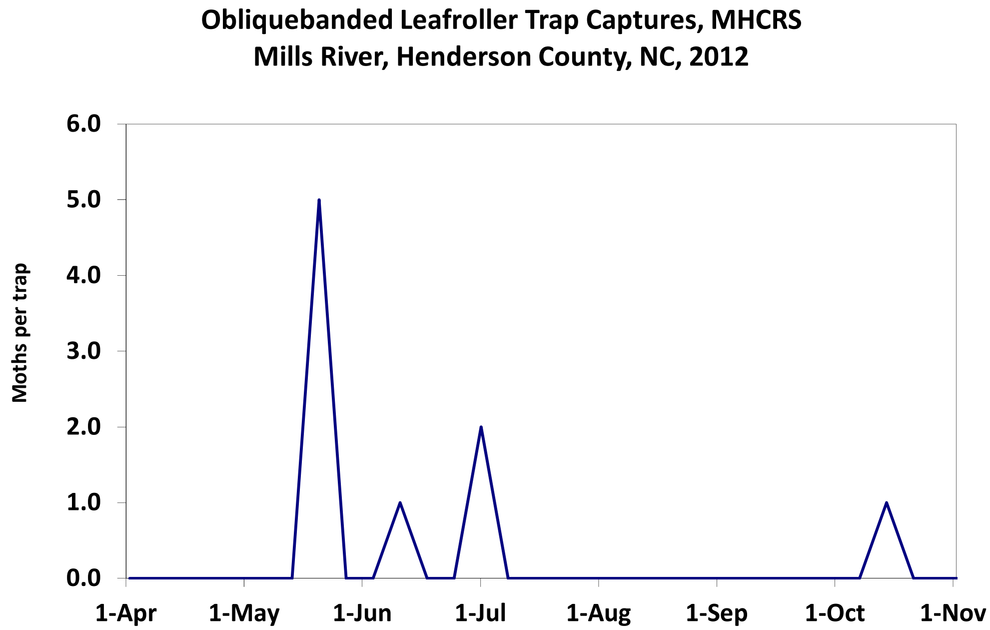


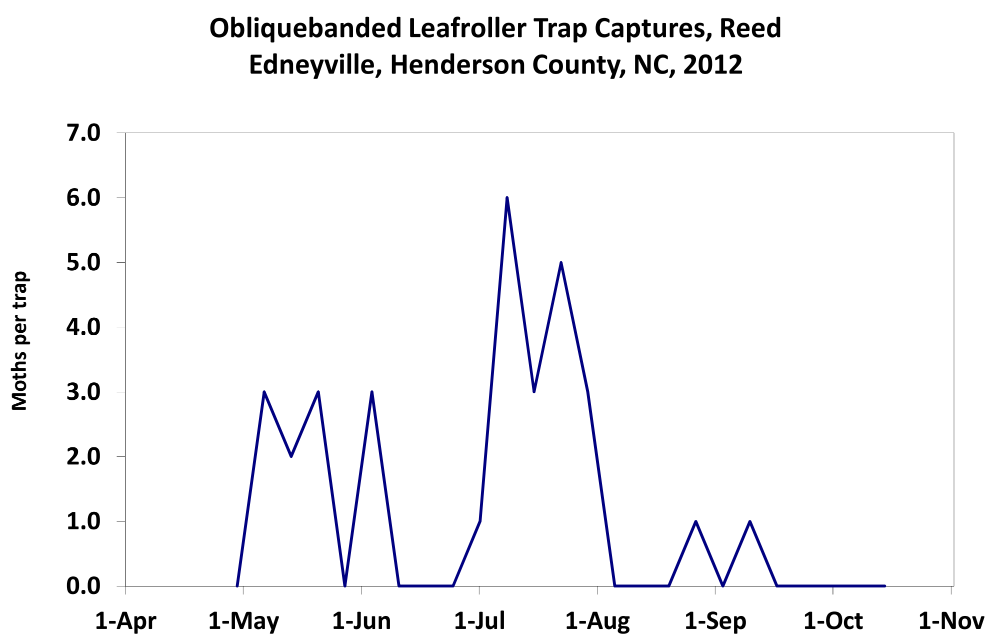
Tufted Apple Bud Moth Trap Captures, MHCRS
Mills River, Henderson County, NC, 2012



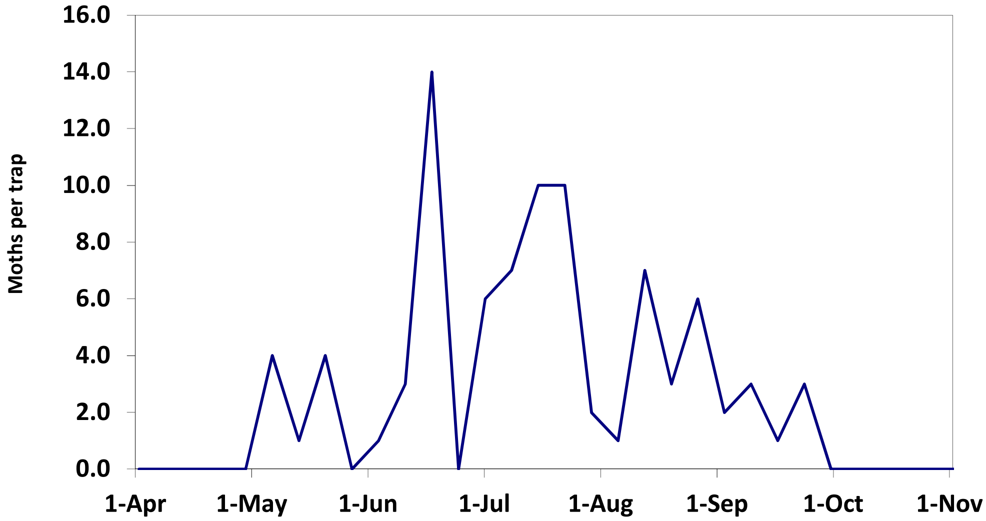
Tufted Apple Bud Moth Trap Captures, Clarence Laughter
Fruitland, Henderson County, NC, 2012



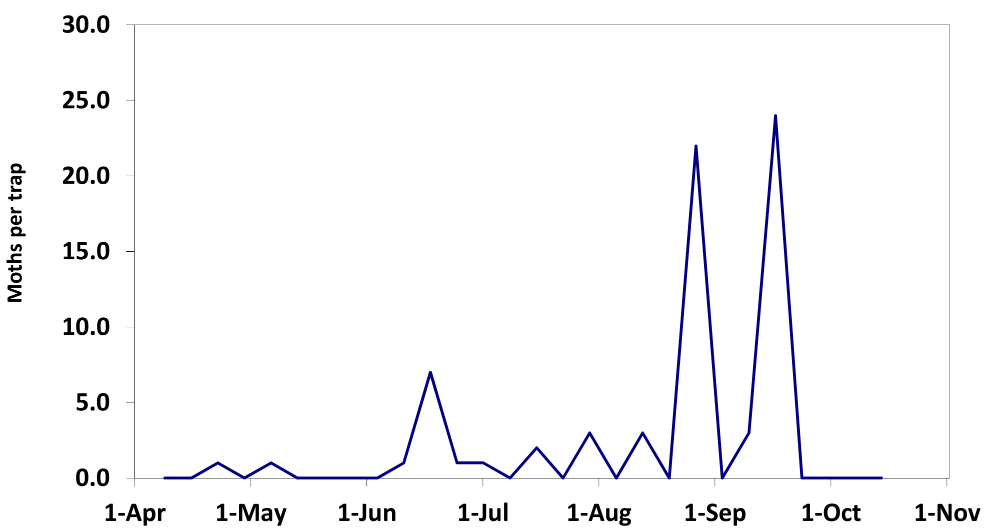

Obliquebanded Leafroller Trap Captures, MHCRS
Mills River, Henderson County, NC, 2012
Moths per trap
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1-Apr
1-May
1-Jun
1-Jul
1-Aug
1-Sep
1-Oct
1-Nov


Obliquebanded Leafroller Trap Captures, Reed
Edneyville, Henderson County, NC, 2012
Moths per trap
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1-Apr
1-May
1-Jun
1-Jul
1-Aug
1-Sep
1-Oct
1-Nov

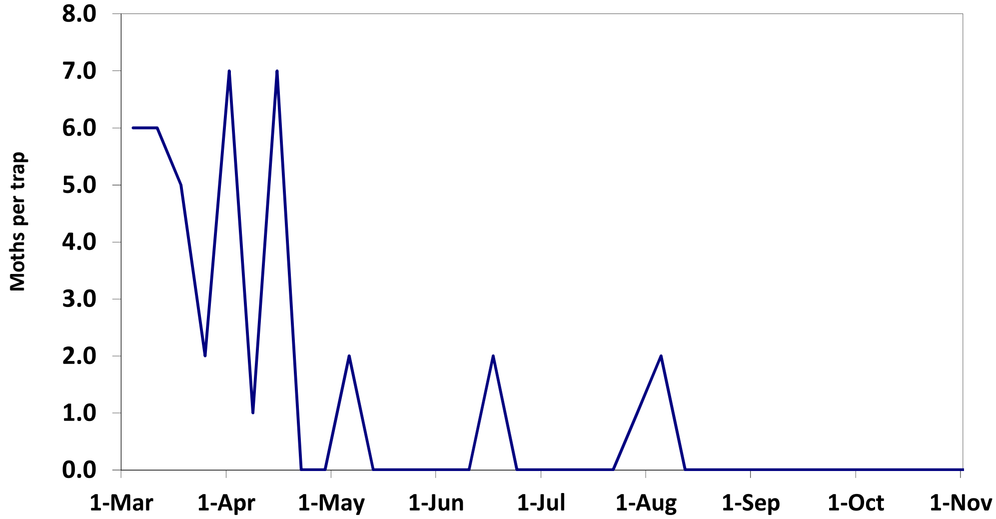
Lesser Apple Worm Trap Captures, MHCRS
Mills River, Henderson County, NC, 2012



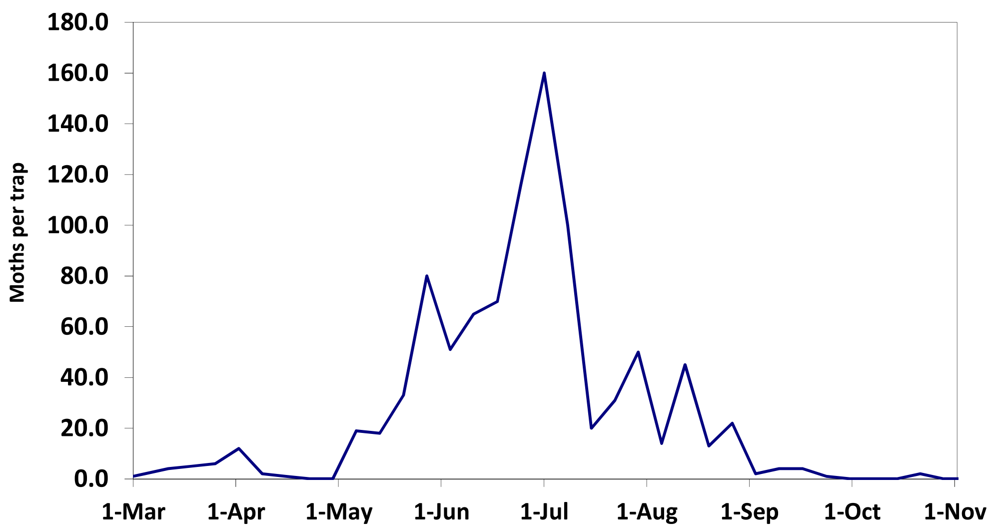
Lesser Apple Worm Trap Captures, Lynch - McGuinn Road
Mill Spring, Polk County, NC, 2012

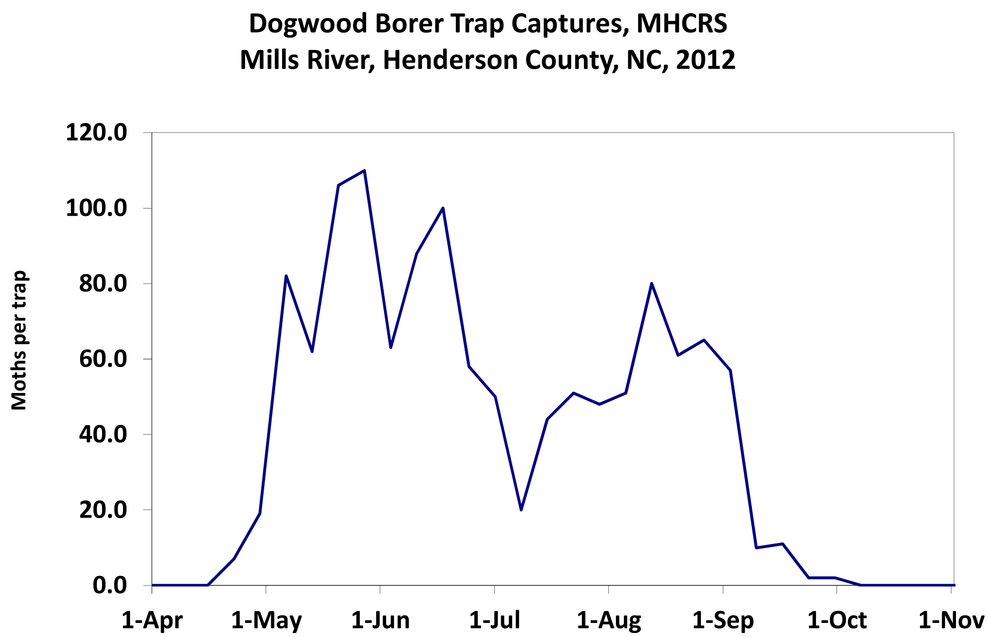


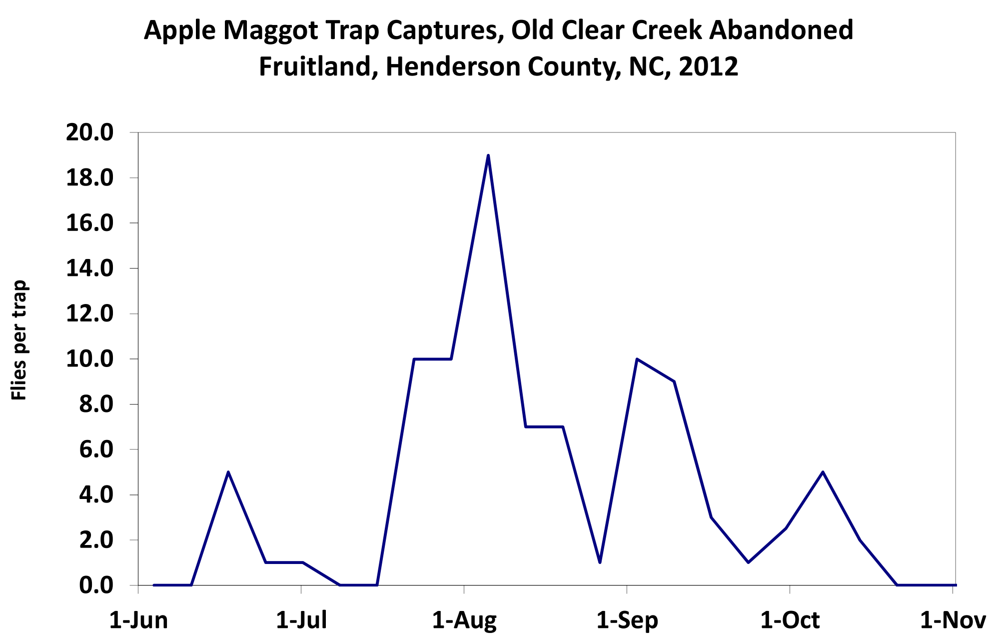
Redbanded Leafroller Trap Captures, MHCRS
Mills River, Henderson County, NC, 2012

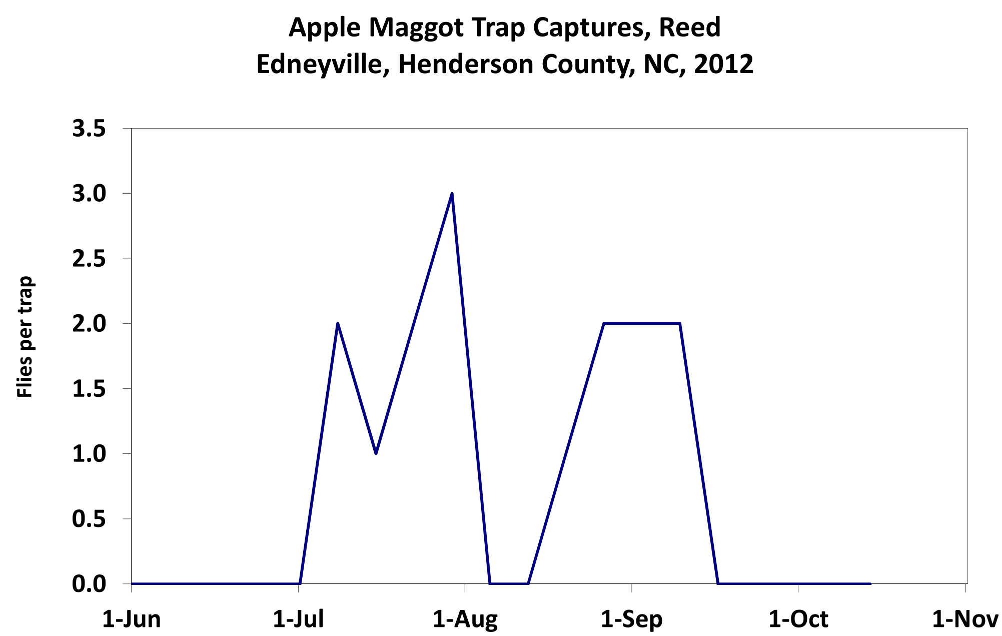


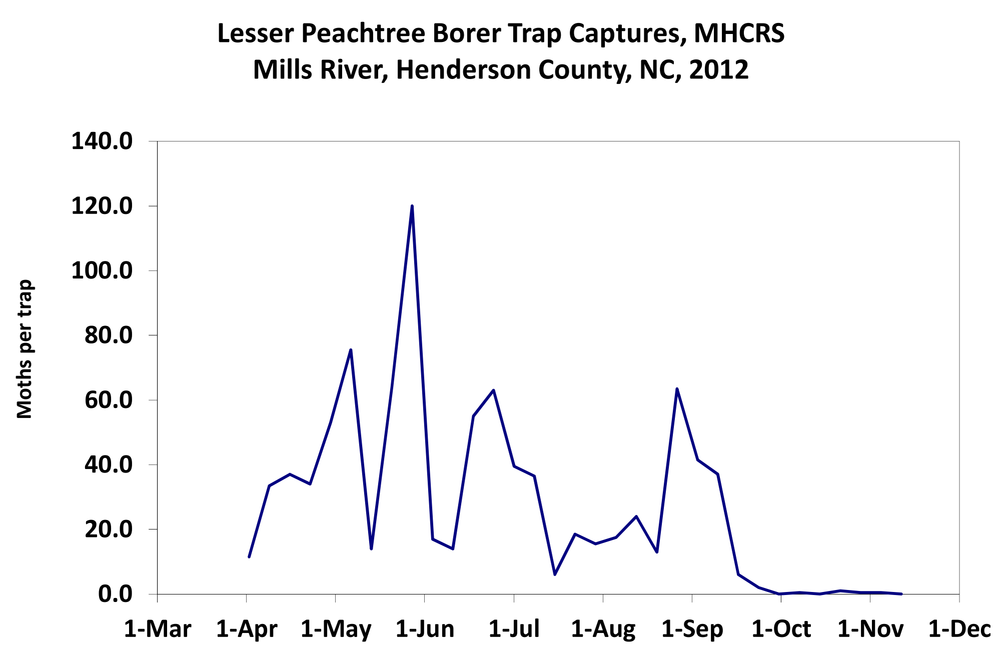
Spotted Tentiform Leafminer Trap Captures, MHCRS
Mills River, Henderson County, NC, 2012



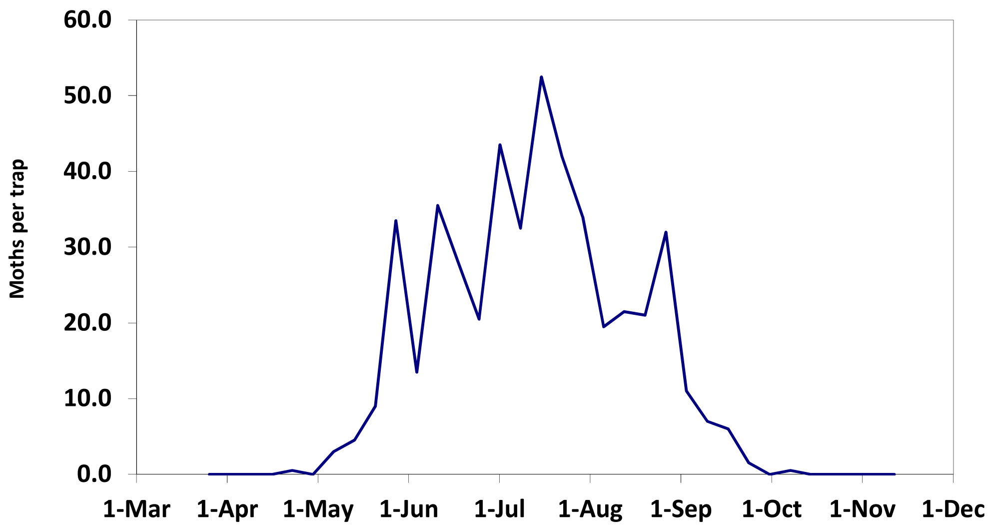

Dogwood Borer Trap Captures, MHCRS
Mills River, Henderson County, NC, 2012
Moths per trap
120.0
100.0
80.0
60.0
40.0
20.0
0.0
1-Apr
1-May
1-Jun
1-Jul
1-Aug
1-Sep
1-Oct
1-Nov


Apple Maggot Trap Captures, Old Clear Creek Abandoned
Fruitland, Henderson County, NC, 2012
Flies per trap
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
1-Jun
1-Jul
1-Aug
1-Sep
1-Oct
1-Nov

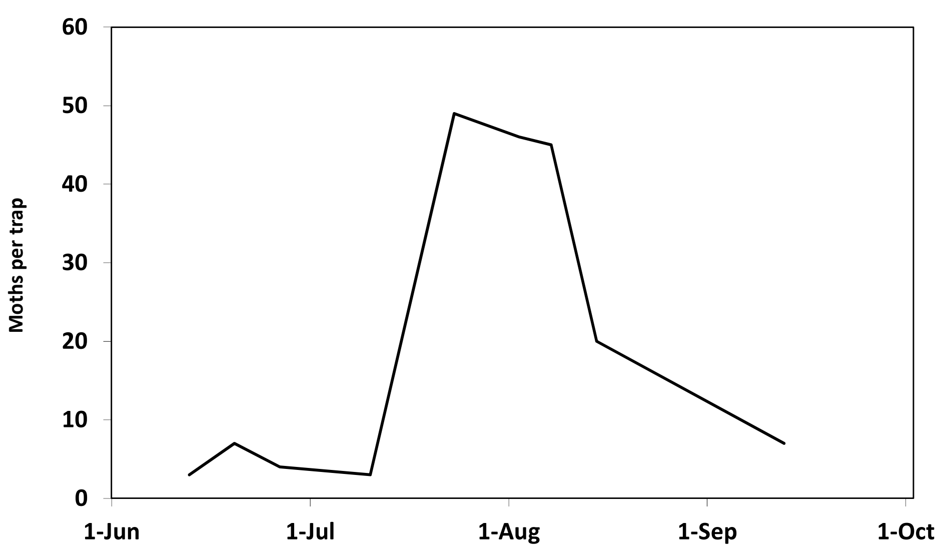

Apple Maggot Trap Captures, Reed
Edneyville, Henderson County, NC, 2012
Flies per trap
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1-Jun
1-Jul
1-Aug
1-Sep
1-Oct
1-Nov

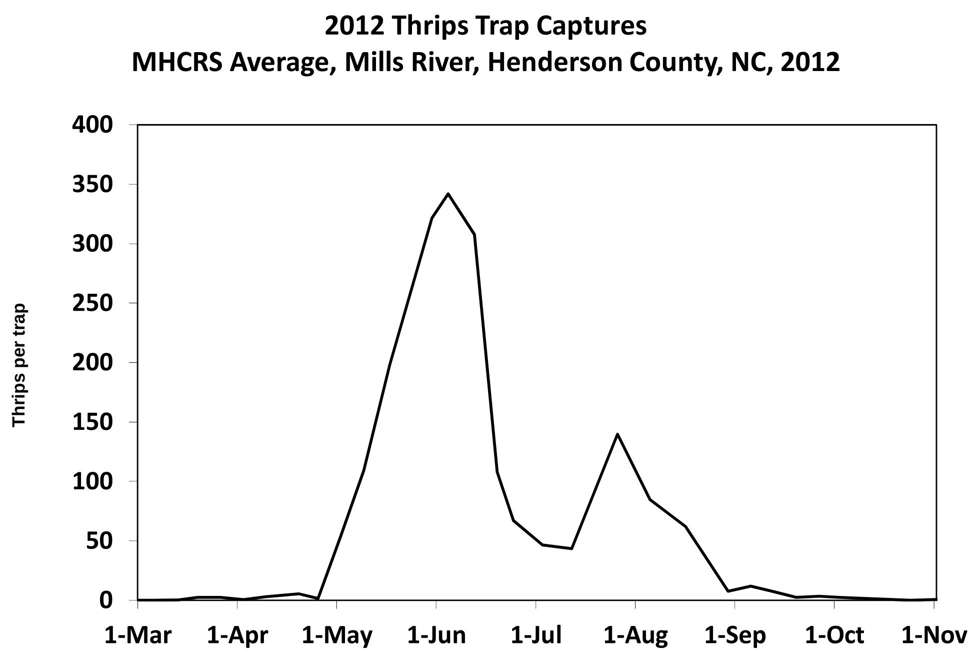

Lesser Peachtree Borer Trap Captures, MHCRS
Mills River, Henderson County, NC, 2012
Moths per trap
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
1-Mar
1-Apr
1-May
1-Jun
1-Jul
1-Aug
1-Sep
1-Oct
1-Nov
1-Dec

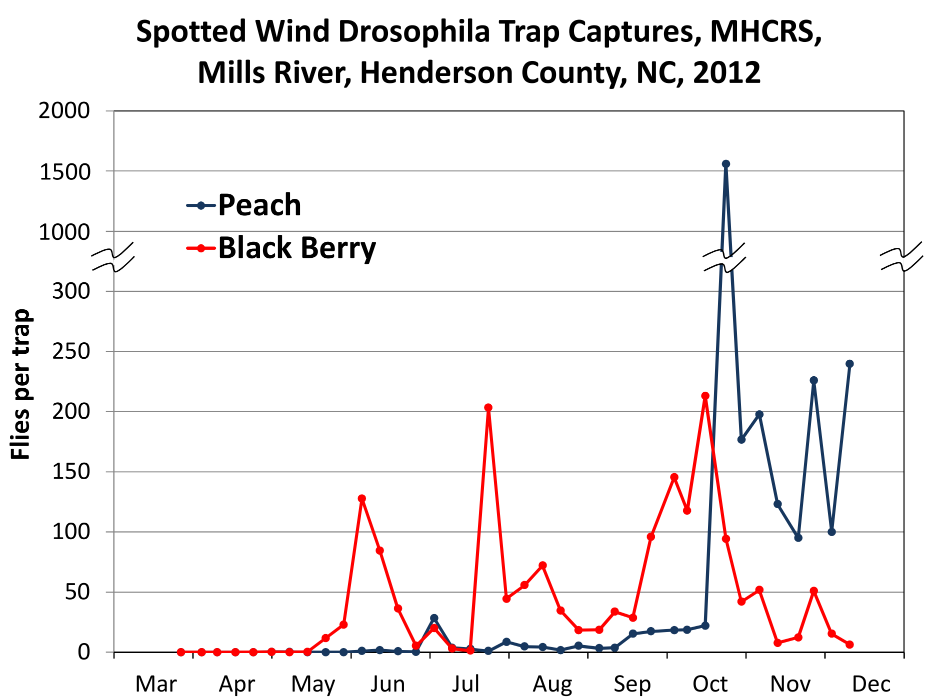
Peachtree Borer Trap Captures, MHCRS
Mills River, Henderson County, NC, 2012



2012 Tomato Fruitworm Trap Captures
MHCRS, Mills River, Henderson County, NC, 2012




2012 Thrips Trap Captures
MHCRS Average, Mills River, Henderson County, NC, 2012
Thrips per trap
400
350
300
250
200
150
100
50
0
1-Mar
1-Apr
1-May
1-Jun
1-Jul
1-Aug
1-Sep
1-Oct
1-Nov


Spotted Wind Drosophila Trap Captures, MHCRS,
Mills River, Henderson County, NC, 2012
Flies per trap
2000
1500
1000
300
250
200
150
100
50
0
Peach
Black Berry
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec