

## Bell pepper insecticide trial, Ohio, 2014

Final report to DuPont, ISK Biosciences, and Dow AgroSciences, 2/9/2015

Celeste Welty, Associate Professor of Entomology, The Ohio State University  
Rothenbuhler Laboratory, 2501 Carmack Rd., Columbus OH 43210-1065;  
e-mail: welty.1@osu.edu; phone: 614-292-2803; fax: 614-292-9783

**INTRODUCTION:** The objective of this trial was to evaluate insecticides for control of European corn borer (*Ostrinia nubilalis* (Hübner), Lepidoptera: Crambidae), which is the key pest of peppers. Red bell peppers were chosen because they are a popular crop that is more challenging to produce than green bell peppers because they takes longer to grow. Bell pepper production in Ohio in 2007 was valued at \$23 million and was ranked fourth in the nation. Ohio had 1,547 acres of bell and 1,046 acres of non-bell peppers in 2007. The standard control program for European corn borer is insecticide sprays at 7-day intervals during the time of second-generation activity; two sprays of acephate are used at peak egg hatch, followed by a pyrethroid.

### METHODS

The experimental design was randomized complete block with 12 treatments and 4 blocked replicates. Four of the treatments were confidential and not included in the analysis or results below. Each plot was one single row bed, 25 feet long. Each treatment bed was flanked by an untreated guard bed. Blocks were separated by 20-foot alleys. Plant spacing was 12 inches within rows and 5 feet between rows. Plants of cv 'Aristotle' were seeded in 200-cell plug trays in a greenhouse on 9 April and transplanted on 27 May in Sandusky County, near Fremont, Ohio at the North Central Agricultural Research Station (NCARS) of the Ohio Agricultural Research and Development Center (OARDC).

The European corn borer (ECB) population was monitored by a blacklight trap that was checked five days per week and a pheromone trap that was checked once per week. Insecticide treatments were applied seven times at 7-day intervals starting after traps indicated emergence of new adults that began the second generation of ECB. Spray dates were 8/12, 8/19, 8/26, 9/2, 9/9, 9/17, and 9/24. Sprays were applied by a CO<sub>2</sub> boom sprayer that delivered 44.9 gallons per acre with TwinJet nozzle tips. All treatments used a single product: Coragen 1.67SC (chlorantraniliprole) at 5 fl oz/A, Avaunt 30WG (indoxacarb) at 3.5 oz/A, Radiant 1SC (spinetoram) at 6 fl oz/A plus NIS 0.25%, Orthene 97SP (acephate) at 1 lb/A, IKI-3106 50SL (cyclaniliprole) at a low rate of 11 fl oz/A, a medium rate of 16.4 fl oz/A, and a high rate of 22 fl oz/A.

Fully mature red fruit from the center 20 plants per plot were harvested four times, on 8/25, 9/2, 9/16, and 9/29. Fruit too rotten to pick were not harvested. The total number of fruit harvested per plot was counted and weighed. All fruit were sorted into two categories: marketable, if free of external damage, or cull, if showing obvious insect injury, sunscald, blossom end rot, bacterial soft rot, mechanical injury, or cracks. All fruit in both categories were cut open to determine presence of damage by caterpillars. Insects found inside fruit were identified to species. Cutting all fruit was important because damage by European corn borer is often without external symptoms. In all harvests, fruit that were externally marketable but internally damaged were counted and weighed then subtracted from the marketable category. Percentage data were transformed by arcsine square root before analysis. Data were tested by analysis of variance using the general linear models procedure in the SAS 9.3 microcomputer statistics program, and Fisher-protected least significant difference (LSD) values were used for mean comparisons.

### RESULTS

-----  
Target: European corn borer (ECB), 2<sup>nd</sup> generation  
Other pests active: fall armyworm (FAW), corn earworm (CEW)  
Insects recovered in harvested peppers were: 79 ECB (81%), 5 FAW (5%), 1 CEW (1%), 12 unknown tortricid (12%).

Table 1. Population trends of European corn borer and corn earworm as detected in traps, Fremont, Ohio, 2014.

Date (end of 7-day period)	European corn borer				Generation (estimate)	Corn earworm: number of adults in pheromone trap
	Number of adults in pheromone trap (males only)	Number of adults in blacklight trap				
		Females	Males	Total		
5/13	-	-	-	-	-	-
5/20	-	0	0	0	-	-
5/27	-	6	2	8	1	-
6/3	-	12	8	20	1	-
6/10	-	11	6	17	1	-
6/17	-	15	10	25	1	-
6/24	0	1	1	2	1	0
7/1	8	3	2	5	1	0
7/8	2	0	2	2	1	0
7/15	5	2	1	3	1	3
7/22	2	1	2	3	1	2
7/29	3	0	0	0	-	1
8/5	1	5	4	9	2	0
8/12	6	10	5	15	2	1
8/19	4	9	7	16	2	1
8/26	18	17	22	39	2	5
9/2	30	4	4	8	2	65
9/19	11	3	6	9	2	25
9/16	0	0	0	0	-	21
9/23	0	0	0	0	-	4
9/30	1	0	0	0	-	0

Table 2. Cumulative yield of red bell peppers in four harvests from 8/25/2014 until 9/29/2014, at Fremont, Ohio; means per 20 plants.

Treatment	Total yield		Marketable yield		Yield infested or damaged by insects		% of total yield infested or damaged by insects <sup>a</sup>	
	Number	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)
IKI-3106, 16 oz	133.5	32.963	107.5 A	29.025	2.5 C	0.738 BC	1.9% C	2.2% BC
Coragen	125.5	31.438	102.8 AB	28.125	2.0 C	0.462 C	1.6% C	1.6% C
Avaunt	132.2	32.150	98.5 AB	27.113	6.2 B	1.488 B	4.7% B	4.6% B
IKI-3106, 11 oz	135.5	30.363	106.2 AB	26.463	3.5 C	0.875 BC	2.6% BC	3.0% BC
Radiant	136.5	31.075	98.5 AB	26.313	2.5 C	0.650 C	2.0% C	2.0% C
IKI-3106, 22 oz	114.0	29.400	92.0 BC	25.950	2.8 C	0.762 BC	2.4% BC	2.6% BC
Orthene	119.5	28.775	93.2 ABC	24.825	3.0 C	0.812 BC	2.3% C	2.6% BC
untreated	117.8	28.900	83.0 C	22.612	13.5 A	3.362 A	11.5% A	11.5% A
<i>P</i> value for treatment effect in ANOVA	0.1351	0.2565	0.0522	0.0822	<0.0001	<0.0001	<0.0001	0.0001

<sup>a</sup> Means shown are actual percentage values; ANOVA based on transformed values.

Table 3. Yield of red bell peppers in first harvest, 8/25/2014, at Fremont, Ohio; means per 20 plants.

Treatment	Total yield		Marketable yield		Yield infested or damaged by insects		% of total yield infested or damaged by insects <sup>a</sup>	
	Number	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)
Avaunt	30.0	6.375	14.8	4.450	0.5	0.150	1.1	1.4
IKI-3106, 16 oz	25.5	5.463	13.8	4.175	0.0	0.000	0.0	0.0
untreated	22.5	5.400	13.2	4.138	0.8	0.200	3.3	3.7
Radiant	30.0	6.013	14.0	4.025	1.0	0.300	5.5	6.3
IKI-3106, 22 oz	23.0	5.238	12.8	3.863	1.0	0.250	4.5	4.1
Orthene	18.0	4.288	11.2	3.463	0.5	0.162	3.4	3.9
IKI-3106, 11 oz	23.0	4.338	10.2	2.900	1.0	0.338	3.6	6.4
Coragen	16.5	3.138	7.2	2.038	1.0	0.288	7.4	10.2
<i>P</i> value for treatment effect in ANOVA	0.31	0.18	0.36	0.27	0.64	0.72	0.40	0.37

<sup>a</sup> Means shown are actual percentage values; ANOVA based on transformed values.

Table 4. Yield of red bell peppers in second harvest, 9/2/2014, at Fremont, Ohio; means per 20 plants.

Treatment	Total yield		Marketable yield		Yield infested or damaged by insects		% of total yield infested or damaged by insects <sup>a</sup>	
	Number	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)
IKI-3106, 22 oz	50.2	13.125	41.2	11.513	1.2 B	0.350	2.4% BCD	2.7% BCD
Coragen	50.0	12.663	41.2	11.400	0.5 B	0.075	0.7% D	0.5% D
Radiant	48.0	12.000	39.5	10.950	0.5 B	0.125	1.0% CD	1.0% CD
IKI-3106, 11 oz	51.8	12.288	42.8	10.888	1.2 B	0.312	2.7% BCD	2.7% BCD
untreated	50.8	12.625	37.5	10.113	6.0 A	1.612	11.7% A	11.6% A
Avaunt	45.5	11.675	35.2	9.988	2.8 B	0.662	7.0% AB	6.5% AB
IKI-3106, 16 oz	44.0	11.088	36.5	9.725	2.0 B	0.612	4.5% ABC	5.6% ABC
Orthene	47.8	10.975	36.8	9.438	1.0 B	0.250	1.7% CD	1.8% CD
<i>P</i> value for treatment effect in ANOVA	0.95	0.93	0.89	0.87	0.0197	0.0766	0.0086	0.0224

<sup>a</sup> Means shown are actual percentage values; ANOVA based on transformed values.

Table 5. Yield of red bell peppers in third harvest, 9/16/2014, at Fremont, Ohio; means per 20 plants.

Treatment	Total yield		Marketable yield		Yield infested or damaged by insects		% of total yield infested or damaged by insects <sup>a</sup>	
	Number	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)
IKI-3106, 16 oz	35.2	9.263	30.8	8.325	0.5 B	0.125 B	1.4% BC	1.3% B
Coragen	30.8	8.288	26.8	7.375	0.2 B	0.075 B	0.6% C	0.6% B
Avaunt	27.5	7.188	23.5	6.300	1.8 B	0.425 B	6.0% B	5.7% B
IKI-3106, 22 oz	23.8	6.413	21.5	6.125	0.2 B	0.088 B	0.9% BC	1.1% B
Radiant	33.8	7.538	22.5	5.988	0.8 B	0.212 B	2.5% BC	3.1% B
IKI-3106, 11 oz	31.2	6.875	24.5	5.925	1.0 B	0.150 B	3.0% BC	1.9% B
Orthene	25.8	6.525	19.2	5.263	0.8 B	0.238 B	3.1% BC	3.7% B
untreated	26.0	6.600	17.8	4.713	4.8 A	1.188 A	18.0% A	18.0% A
<i>P</i> value for treatment effect in ANOVA	0.62	0.61	0.34	0.33	0.0008	0.0005	0.0022	0.0024

<sup>a</sup> Means shown are actual percentage values; ANOVA based on transformed values.

Table 6. Yield of red bell peppers in fourth harvest, 9/29/2014, at Fremont, Ohio; means per 20 plants.

Treatment	Total yield		Marketable yield		Yield infested or damaged by insects		% of total yield infested or damaged by insects <sup>a</sup>	
	Number	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)
Coragen	28.2	7.350	27.5	7.313	0.2 BC	0.025 BC	0.6%	0.3%
IKI-3106, 16 oz	28.8	7.150	26.5	6.800	0.0 C	0.000 C	0.0%	0.0%
IKI-3106, 11 oz	29.5	6.863	28.8	6.750	0.2 BC	0.075 BC	1.2%	1.4%
Orthene	28.0	6.988	26.0	6.663	0.8 BC	0.162 ABC	2.0%	1.6%
Avaunt	29.2	6.913	25.0	6.375	1.2 AB	0.250 AB	4.3%	3.6%
Radiant	24.8	5.525	22.5	5.350	0.2 BC	0.012 BC	0.9%	0.2%
IKI-3106, 22 oz	17.0	4.625	16.5	4.450	0.2 BC	0.075 BC	1.2%	1.4%
untreated	18.5	4.275	14.5	3.650	2.0 A	0.362 A	8.9%	6.8%
<i>P value for treatment effect in ANOVA</i>	<i>0.19</i>	<i>0.16</i>	<i>0.0759</i>	<i>0.0745</i>	<i>0.0239</i>	<i>0.0521</i>	<i>0.0649</i>	<i>0.0558</i>

<sup>a</sup> Means shown are actual percentage values; ANOVA based on transformed values.