

Corn Earworm: Is It Resistant to Pyrethroids?

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Collaborative Effort

- Purdue University
- University of Illinois
- University of Minnesota
- University of Wisconsin
- Louisiana State University
- Del Monte
- Green Giant
- FMC
- Penn State University
- Texas A&M University
- Northern Illinois University
- Michigan State University
- Ohio State University

Crops at Risk: Midwest Values (2004)

Crop	Acres (harvested)	Value (\$)
Sweet Corn		
-Processing	214,000	99.2 M
-Fresh Market	42,400	75.3 M
Snap Beans		
-Processing	107,300	59.2 M
-Fresh Market	4,100	8.3 M
Tomatoes		
-Processing	18,000	46.3 M
-Fresh Market	10,500	96.9 M
Bell Peppers		
-Proc/Fresh Market	3,700	23.7 M
Total	400,000	408.9 M

Current Situation

- CEW only overwinters as far north as southern Illinois and Indiana
- Usually a minor first generation – moths fly in June
- CEW migrates to most of the Midwest each year
- Arrive each year: High/Low Pressure Jets...
- Ex: Northern Illinois/Indiana: ... Aug. 18th (" +/- 3 days")
- Texas and Louisiana are likely source regions for Illinois and Indiana

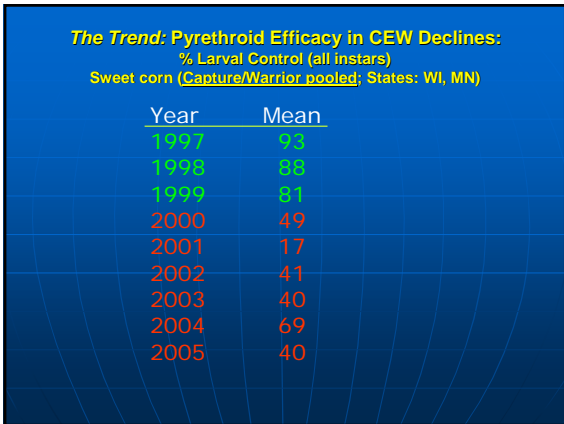
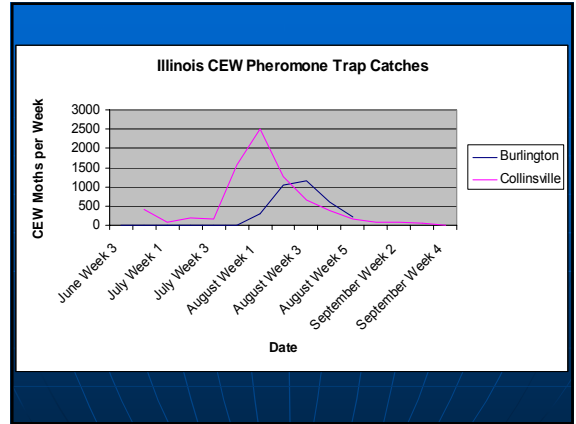
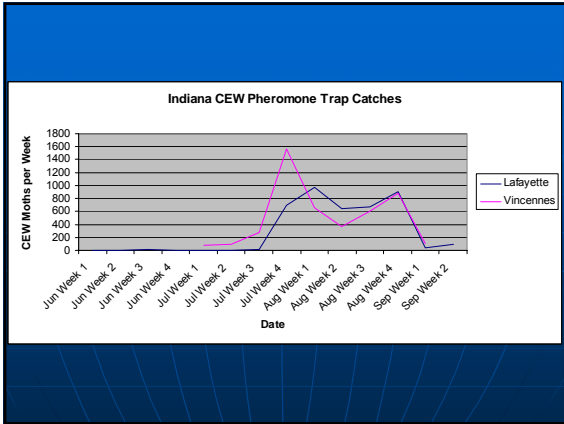
Hypothesis

- CEW is significant pest of corn, soybeans, cotton, and sorghum in source regions
- Pyrethroid insecticides are widely used in source regions
- Resistance has begun to develop in source regions
- Resistant CEW migrate to Midwest each year

Corn Earworm Range

- Usually doesn't overwinter north of 40°N
- Migrate up to 59°N



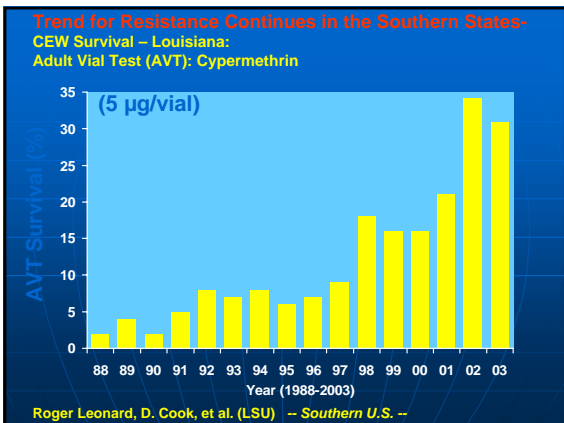


2005 CEW Pyrethroid Efficacy Multi-state Midwest Summary

(Foster, Hutchison, Jensen, Rabaey, Weinzierl)

Insecticide	Rate (oz/ac)	Overall efficacy (% control)	n
Warrior 1CS	2.56-3.2 oz	19.3	6
Capture 2EC	2.1-2.56 oz	37.3	4
Mustang Max 0.8 EC	3.4-4 oz	33.4	5
Baythroid 2EC	1.6-2.8 oz	19.8	3
Untreated check - CEW/ear	--	0.13 - 1.41	

NOTE: Slightly better results in 2006; Overall Mean of ca. 40-55% control



- ### Assessing Midwest Level of CEW Resistance
- Currently, resistance remains variable, but trend is major concern...
 - "Diversity in susceptibility"
 - Within a colony (R. Leonard):
 - a) some show avg. resistance,
 - b) some high susceptibility,
 - c) some express very high resistance
 - (e.g., 50% survival at 20 ug/vial)

Assessing Midwest Level of CEW Resistance (cont.)

- So far, few major control failures, Processing Sweet Corn, (*Snap Beans* ?)
- "Process Out" CEW; but how much?
- Lack of problem in Commercial fields? May be due to unique mortality effects in large fields (vs. small plot trials)
- Commercial Fields: allow for adult control
- Adult control helps; but adults are not fully susceptible

CEW Single and Multi-dose AVT sites-2006



Resistance Monitoring Results – 2006 'Standard AVT' Method (moths from traps) ("initially promising")

State*	Mean % survival (ug cypermethrin)	
	5ug (n)	10ug (n)
MN	11 (170)	6.5 (170)
IN	14 (151)	2 (151)
WI	15 (100)	3 (100)
FMC, SD**	---	0.5 (4,760)

*Multi-dose AVT (0-30ug)

**Single dose AVT (IA, IL, IN, MI, MN, NE, WI)

LD₅₀ Response of CEW Larvae to Cypermethrin – 2006 – (J. Temple, R. Leonard; LSU)

Location	N	LD50	95% CL	Slope	X2	RR
Wisconsin	271	0.104	0.081-0.140	2.26±0.24	5.6 0	1-8
Minnesota	220	0.088	0.071-0.108	2.24±0.27	2.3 7	1-6
Winnsboro LA	220	0.087	0.069-0.109	2.04±0.25	1.4 6	1-6
Pennsylvania	239	0.036	0.025-0.046	1.60±0.21	1.9 9	0-3
Illinois	221	0.043	0.029-0.057	1.50±0.22	0.6 2	0-3
Indiana	200	0.036	0.024-0.049	2.11±0.29	5.3 8	0-3

Response of field-collected larvae for MN, WI locations show significant level of resistance; RRs > 5 generally reflect a significant genetic shift in resistance to an insecticide.

LD₅₀ Response of CEW Larvae to λ-Cyhalothrin – 2004- Resistance response higher with Warrior (R. Leonard, LSU)

Colony	n	LD ₅₀	RR
SC-ESTILL-99	100	0.062	31
Champaign	189	0.061	30
Wisconsin	180	0.099	49
Ontario	180	0.020	10
St. Joseph	150	0.032	16

Resistance Ratio (RR) calculated from LD₅₀ data (0.002 µg/larva) derived from SC Lab 1999.

Conclusions to date: The more elevated resistance ratios for Warrior may be due to response to a more "refined" pyrethroid isomer; also supports previous work of cross-resistance among pyrethroids. (Results with larvae may be deemed more conclusive than adult assays.)

2006 Results - Illinois % Control

Insecticide	St. Charles	Urbana
Capture	94	72
Larvin	92	78
Entrust	91	71
Coragen	98	99
Warrior	--	71
Mustang Max	--	67

Methods – Insect Collection

- Throckmorton Purdue Agricultural Center, Lafayette, IN
- Southwest Purdue Agricultural Experiment Station, Vincennes, IN
- Fournie Farms, Collinsville, Illinois



Larval Toxicity Trials

- Third instar
- Five doses of bifenthrin (Capture)
- 50 individuals/dose
- Susceptible population obtained from Monsanto

Larval Toxicity Trials

- Dispense ~1 μ l onto thoracic tergum
- Mortality assessed after 48 hours
- Dead = unable to make coordinated movement



Larval Toxicity Trials

Colony	LD ₅₀	Resistance Ratio = $\frac{\text{Resistant}}{\text{Susceptible}}$
Lafayette	0.51888 μ g	14
Vincennes	0.81294 μ g	22
Collinsville	0.60506 μ g	17
Monsanto	0.03654 μ g	1

Adult Vial Test



Adult Vial Tests - Lafayette



Dose (μ g/vial)	Percent Mortality
1.25	49
2.5	67
5	84
7.5	89
10	98
20	99
30	100

Are CEW Resistant to Pyrethroids?

- Small plot trials indicate that resistance is occurring
- Commercial field observations are mixed
- Adult vial tests with cypermethrin indicate only low levels of resistance in Indiana and Illinois
- Tests with lambda cyhalothrin (Warrior) indicate fairly high levels of resistance in Illinois
- Tests with bifenthrin (Capture) indicate fairly high levels of resistance in Illinois and Indiana

Recommendations for 2007

- Use Bt sweet corn if possible
- Make pyrethroid application at row tassel to control corn borers and rootworm beetles – (Warrior or Mustang Max)
- Monitor CEW flights with pheromone traps



Recommendations for 2007

- When moth flights are heavy (>10 / night), apply Capture at 6.4 fl. oz. /A at 50% silk and three days later
- Make 1 or 2 applications of the high rate of Warrior or Mustang Max at 3 day intervals if significant numbers of moths are active
- Stop spraying 7 days before harvest for fresh market sweet corn

Recommendations for 2007

- Watch newsletters for in-season updates
- If problems with pyrethroids arise, we will advise on alternative strategies