

# 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)*

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

# Current Situation

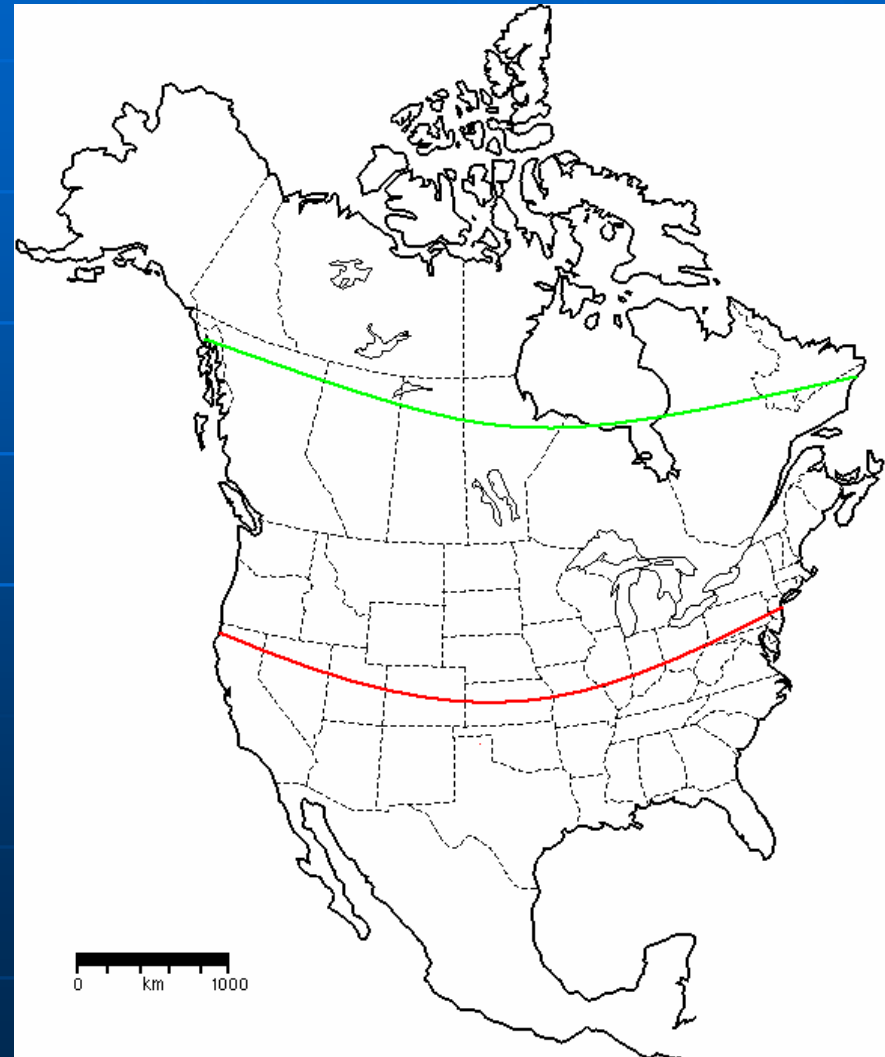
- CEW only overwinters as far north as southern Illinois and Indiana
- Usually a minor first generation – moths fly in June
- CEW migrates to most of the Midwest each year
- Arrive each year; High/Low Pressure Jets...
- Ex: Northern Illinois/Indiana: ... Aug. 18<sup>th</sup> (“ +/- 3 days”)
- Texas and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

# Hypothesis

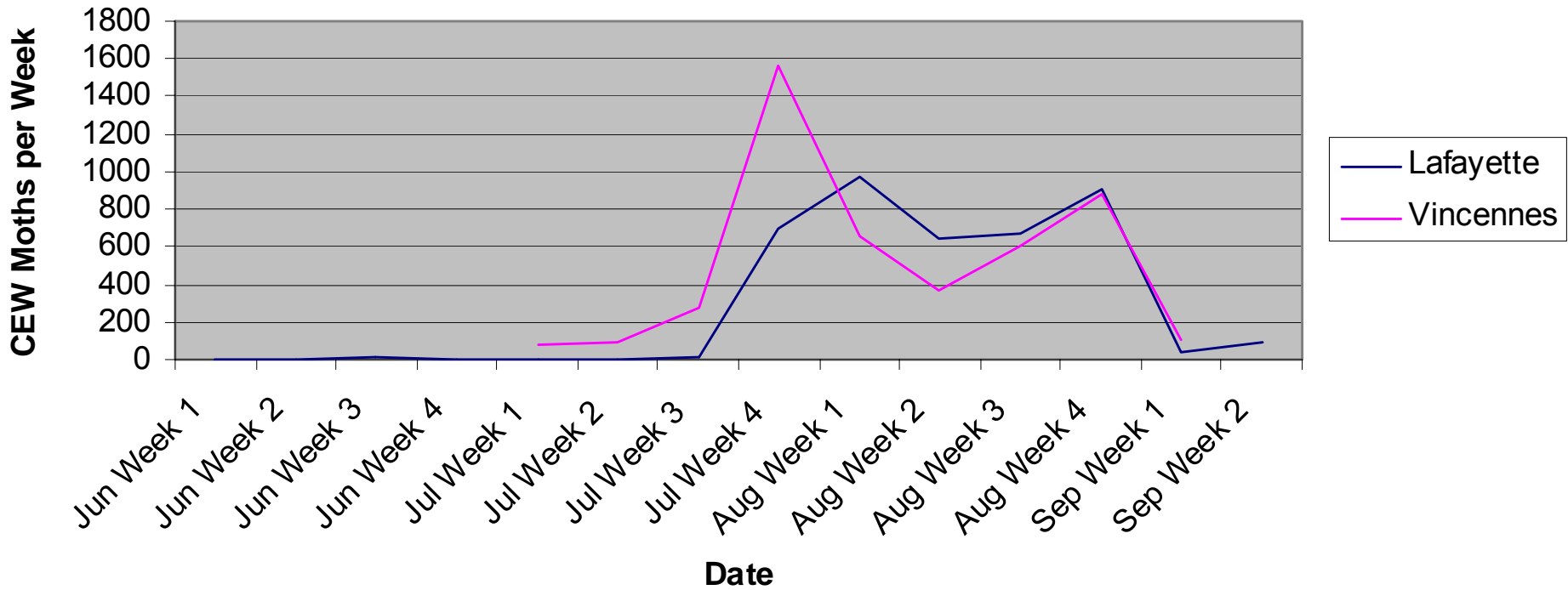
- CEW is significant pest of corn, soybeans, cotton, and sorghum in source regions
- Pyrethroid insecticides are widely used in source regions
- Resistance has begun to develop in source regions
- Resistant CEW migrate to Midwest each year

# Corn Earworm Range

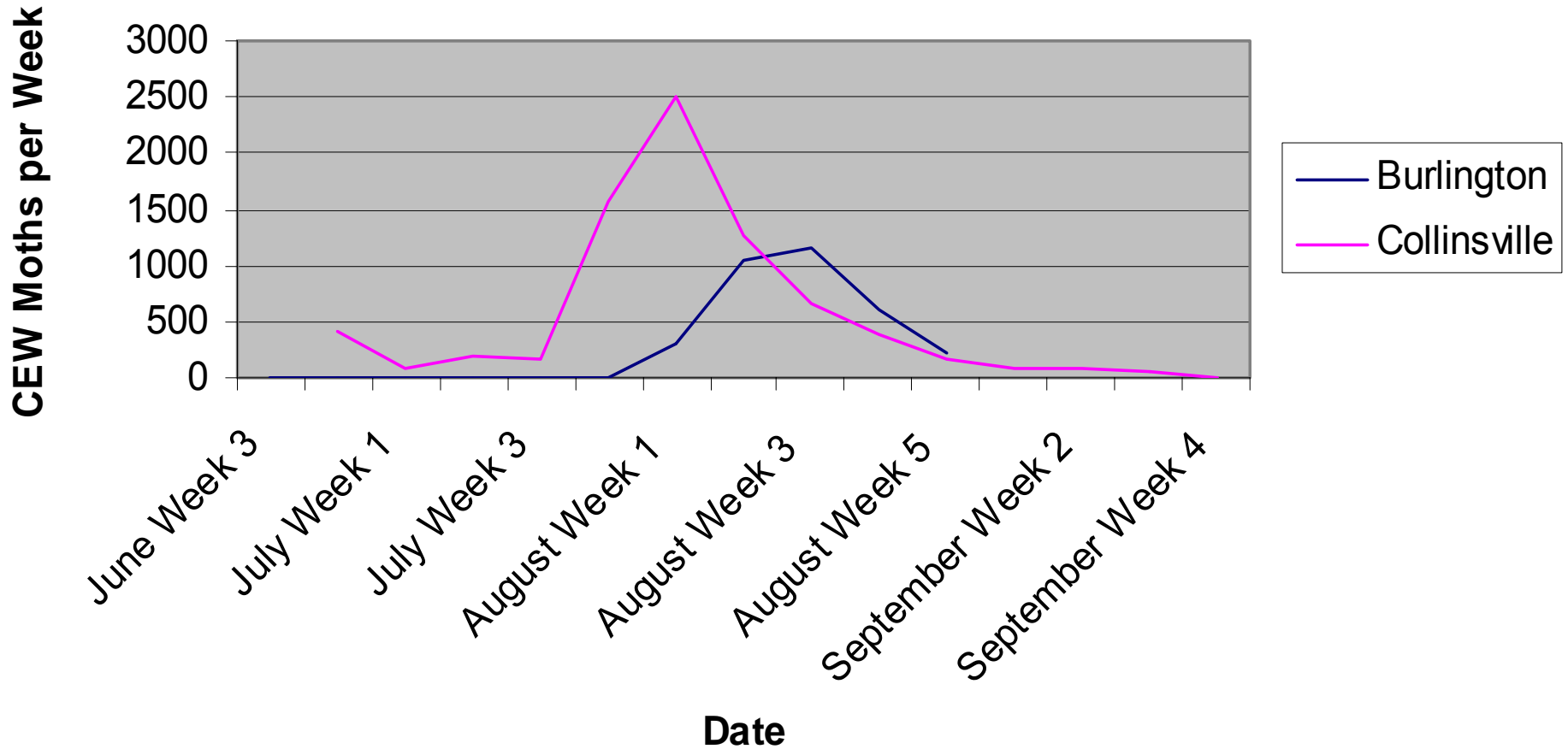
- Usually doesn't overwinter north of  $40^{\circ}\text{N}$
- Migrate up to  $59^{\circ}\text{N}$



## Indiana CEW Pheromone Trap Catches



# Illinois CEW Pheromone Trap Catches



***The Trend: Pyrethroid Efficacy in CEW Declines:***  
**% Larval Control (all instars)**  
**Sweet corn (Capture/Warrior pooled; States: WI, MN)**

<u>Year</u>	<u>Mean</u>
1997	93
1998	88
1999	81
2000	49
2001	17
2002	41
2003	40
2004	69
2005	40

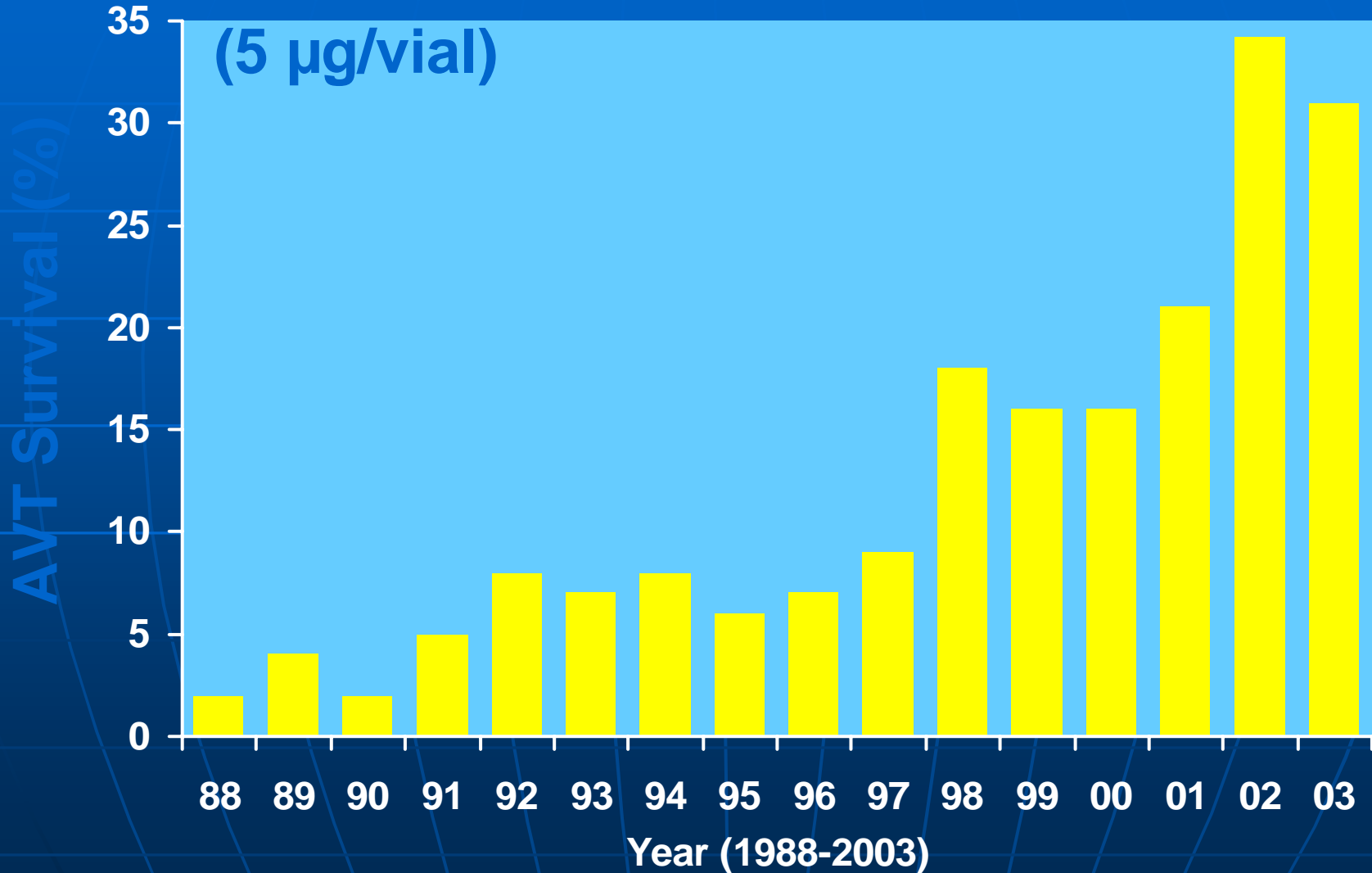
# 2005 CEW Pyrethroid Efficacy Multi-state Midwest Summary

(Foster, Hutchison, Jensen, Rabaey, Weinzierl)

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

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

# Trend for Resistance Continues in the Southern States- CEW Survival – Louisiana: Adult Vial Test (AVT): Cypermethrin



Roger Leonard, D. Cook, et al. (LSU) -- Southern U.S. --

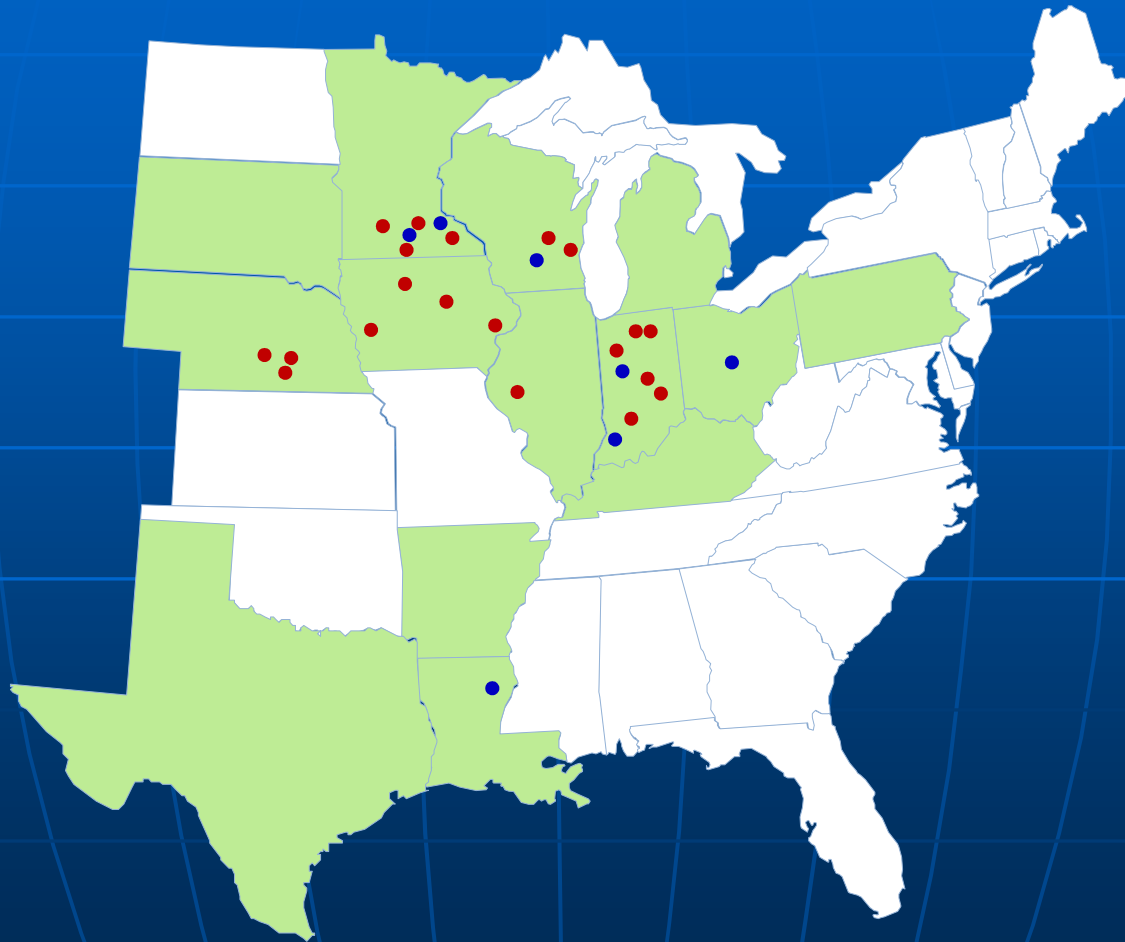
# Assessing Midwest Level of CEW Resistance

- 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)

# LD<sub>50</sub> Response of CEW Larvae to Cypermethrin – 2006 – (J. Temple, R. Leonard; LSU)

<u>Location</u>	<u>N</u>	<u>LD50</u>	<u>95% CL</u>	<u>Slope</u>	<u>X2</u>	<u>RR</u>
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.

# LD<sub>50</sub> Response of CEW Larvae to $\lambda$ -Cyhalothrin – 2004- *Resistance response higher with Warrior* (R. Leonard, LSU)

Colony	n	LD <sub>50</sub>	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 LD<sub>50</sub> data (0.002  $\mu$ g/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.)

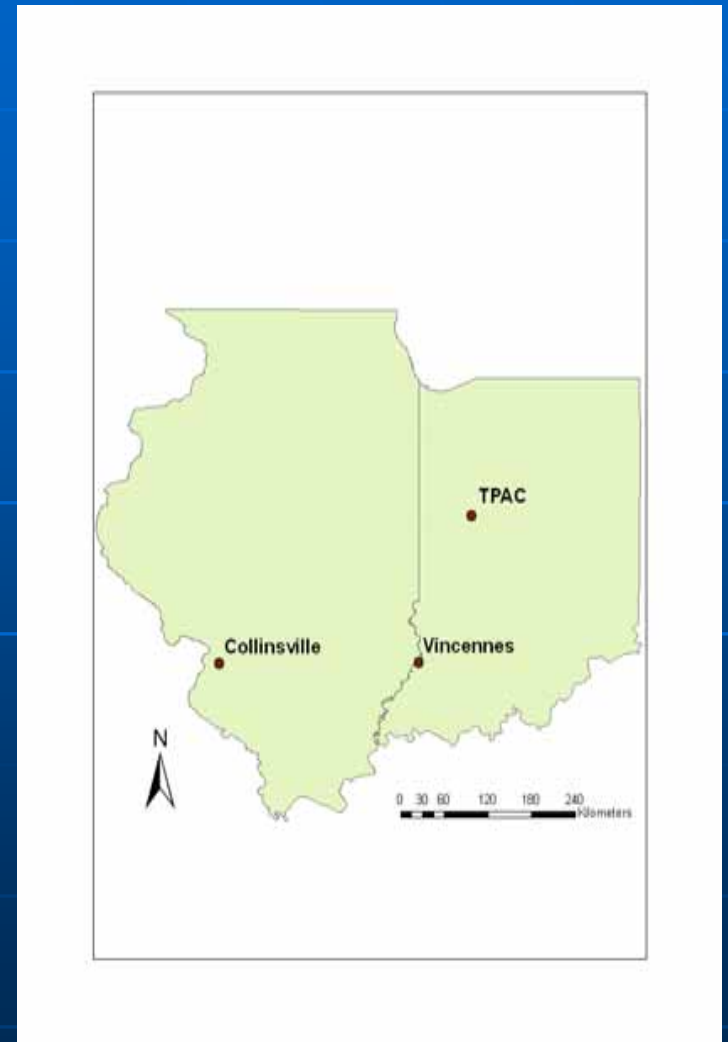
# 2006 Results - Illinois

## % 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  $\sim 1\mu\text{l}$  onto thoracic tergum
- Mortality assessed after 48 hours
- Dead = unable to make coordinated movement



# Larval Toxicity Trials

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

# Adult Vial Test



# Adult Vial Tests - Lafayette



Dose (ug/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