How to grow worm-free sweet corn

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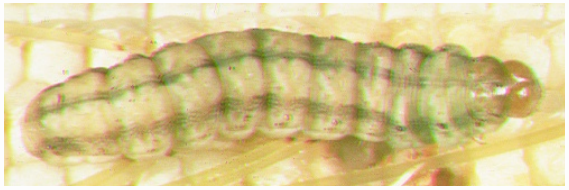
THE OHIO STATE UNIVERSITY

Topics

- Caterpillar i.d.
- Monitoring
- Insecticide timing
  - before silking
  - during silking
- Insecticide trials, 2007-2014
- Alert: western bean cutworm

Caterpillars in Sweet Corn

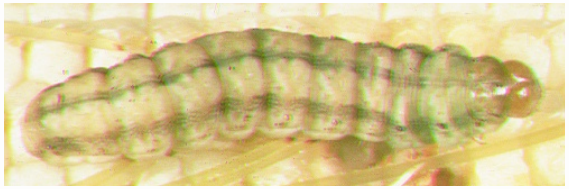


Corn Earworm

European Corn Borer

Fall Armyworm

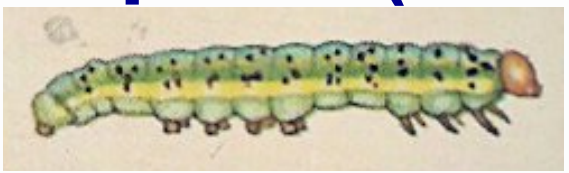
Caterpillars in Sweet Corn



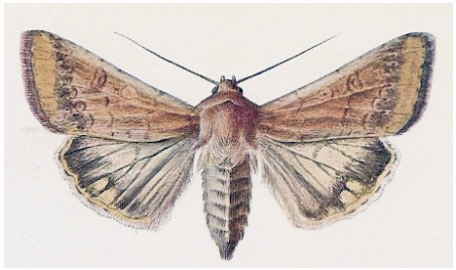
- Key pests; can ruin the crop
- Pest management is complex
  - Several insect species
  - Sequential plantings
- The need to control them varies through the season
  - No control
  - Low intensity control
  - High intensity control

Life Cycle

Caterpillar (Larva)



Pupa



Moth (Adult)

Egg

Sweet Corn Development

- Seedling
- Whorl stage
- Emerging tassel stage **
- Fresh silk ***
- Dry silk

Key features of 5 pests

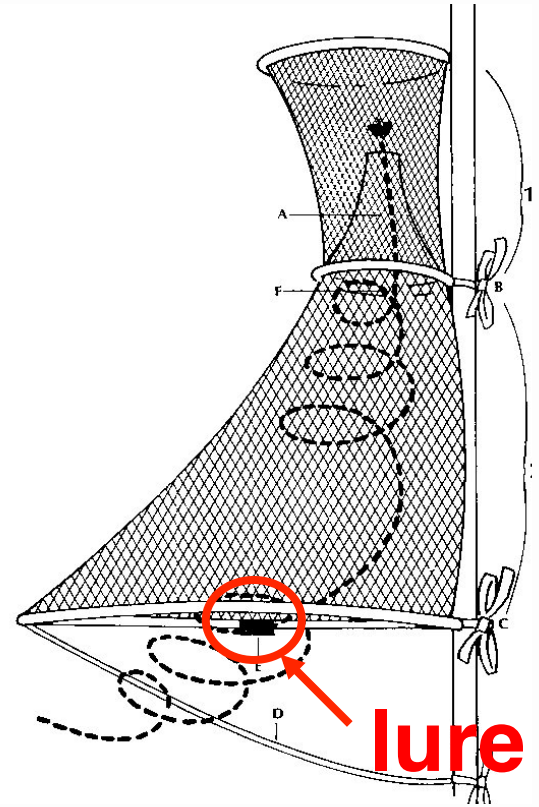
1. Corn earworm
2. European corn borer
3. Fall armyworm
4. Silk-clipping beetles
5. Sap beetles

1. Corn Earworm

- **Moths migratory from South**
- **Arrival time varies**
- **Eggs laid on silk**
- **Eggs hatch in 48 hrs**

Trap to Monitor Corn Earworm

- Pheromone lure
- Attracts male moths
- Highly effective



Corn Earworm Insecticide Spray Schedule

Number moths per pheromone trap per day	*Spray interval*	
	Maximum daily temp. <80 F	*Maximum daily temp. >80 F*
< 0.2	No spray	No spray
0.2 - 0.5	Every 6 days	Every 5 days
0.5 - 1	Every 5 days	Every 4 days
1 - 13	Every 4 days	Every 3 days
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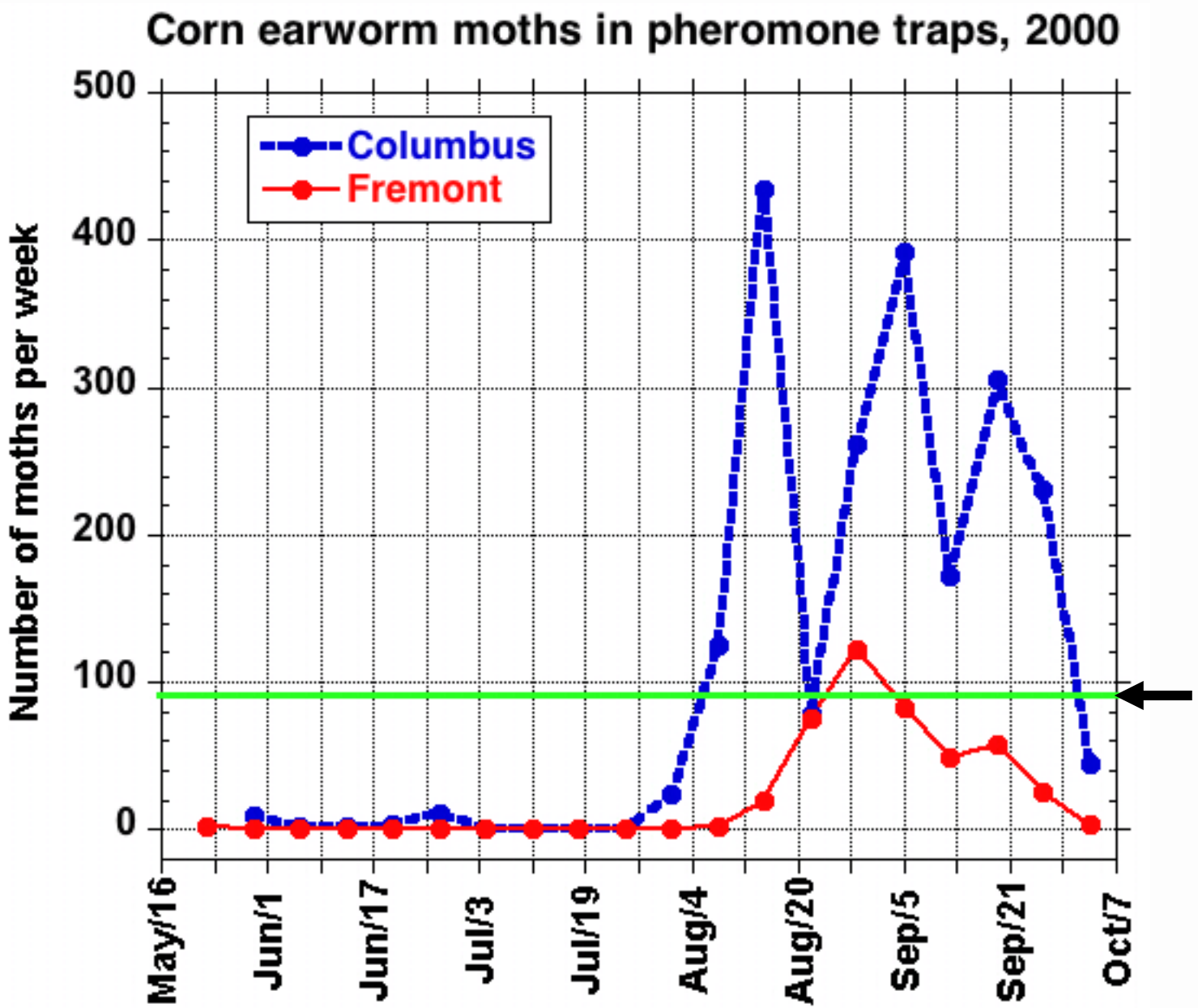


intensive schedule when >13 moths per day (>90 moths per week)

2. European Corn Borer

- **Moths active:**
  - **1st flight:**
    - Late May to late June
    - Most eggs on whorls
    - Move to tassel to ear
    - Control <u>before</u> silking
  - **2nd flight:**
    - Late July to late August
    - Most eggs near ear
    - Control <u>during</u> silking
- **Monitor moths with pheromone traps**

European corn borer: generations per year

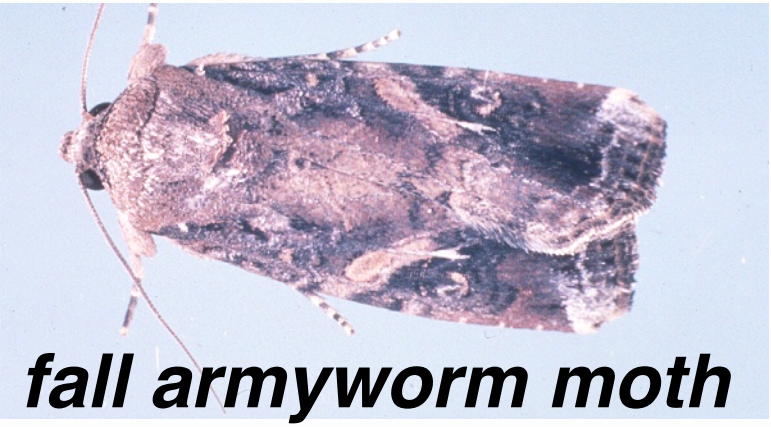
- 2 generations
  - when summer has average temperatures (60% of years in Ohio)
- 3 generations
  - when summer has high temperatures (40% of years)

3. Fall Armyworm

- Also migratory from South
- Arrival time varies
- Harder to kill

Fall Armyworm During Silking

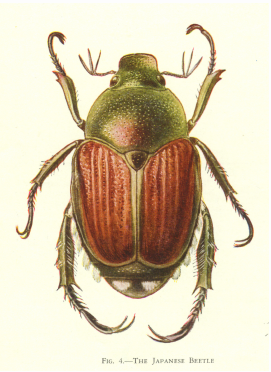
- Pheromone trap
  - All-green unitrap
- Spray every 5-7 days during silking if more than 3 moths per week in trap



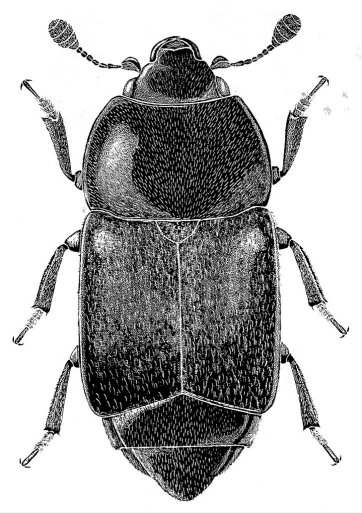
fall armyworm moth

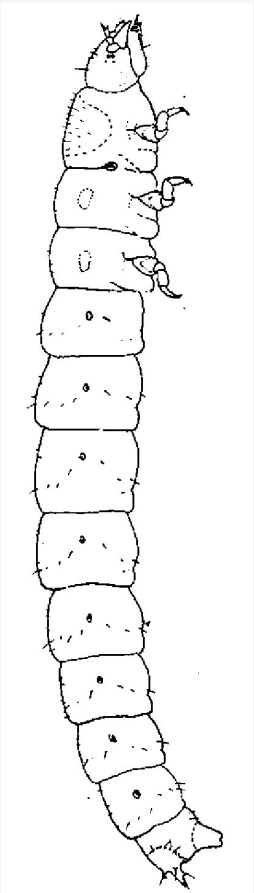
4. Silk-Clipping Beetles

- **Several species:**
  - **Japanese beetle**
  - **corn rootworm beetles**
    - **western**
    - **southern**
    - **northern**



- **Treat once, early-silk, if:**
  - **>2 Jap. beetles per ear or**
  - **>5 rootwm beetles per ear**



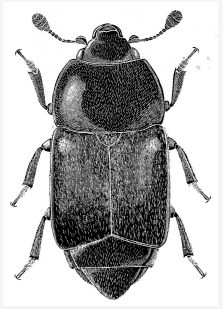


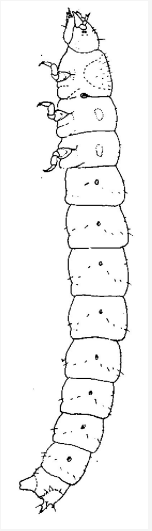
5. Dusky Sap Beetle

- Adults & larvae in kernels
- Often follow caterpillars
- Can infest uninjured ears
- Eggs hatch in 2-3 days
- Larvae feed for 14 days, first on silks or frass, then kernels

Sap Beetle Management

- **Scout (examine ears)**
  - **50 ears in small plantings (<2A)**
  - **100 ears in large plantings (>2A)**
  - **Record # infested with adult or larval sap beetles**
- **Action threshold**
  - **Treat every 4-5 days during silking if sap beetles in >10% of ears**

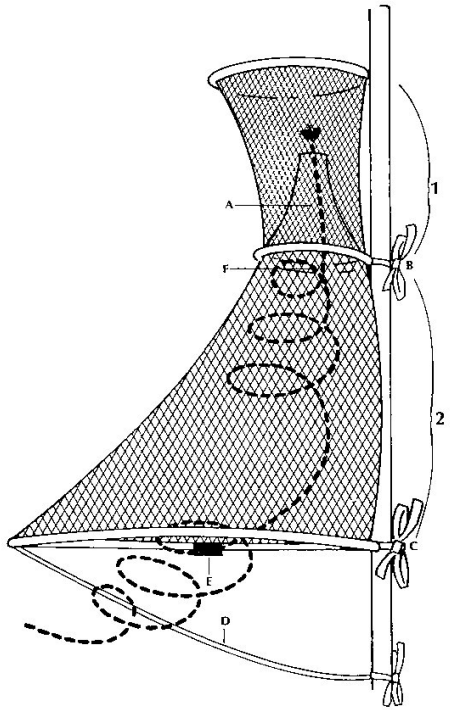




Monitoring summary

Traps for Corn Earworm & European Corn Borer

- **Set up:**
  - **At edge of corn field**
  - **June: near earliest corn**
  - **July-Sept.: near fresh silking**
  - **ECB: over long grass is best**
- **Maintenance:**
  - **Count moths 2 to 3 times per week**
  - **Replace lure every 2 weeks**



Traps for Corn Earworm & European Corn Borer

Suppliers:

- **Great Lakes IPM (Vestaburg, Mich.)**
- **Gempler's (Madison, Wisconsin)**
- **GreenStar Cooperative, Inc.** (formerly Salem Fruit Growers Co-op; **Salem, Ohio)**

Traps for Corn Earworm or European Corn Borer

	Trap	*Lures*	
Manufacturer:	**Scentry**	**Hercon**	**Trécé or Scentry**
Life span:	**2 - 5 yrs**	**2 wks**	**2-3 wks**
# per season:	**1 (minimum)** **2 (preferred)**	**10**	**7**
Cost:	**@ $56 - 85** ***(plus optional spare tops @ $17 – 28)***	**$17**	**$13**

Pheromone Lures for European Corn Borer

Two lure types available:

- **'Iowa' strain:**
  - **Also known as *'Z'* -strain**
  - **Best for most of Ohio (exception in far NE corner)**
- **'New York' strain:**
  - **Also known as *'E'* -strain**
  - **Not needed in most of Ohio**

Managing Worms
Before Silking

Emerging-Tassel Stage

- Scout (examine plants)
  - 50 plants in small plantings (<2A)
  - 100 plants in large plantings (>2A)
  - Record # with fresh feeding damage
- Action threshold
  - Spray if fall armyworm and/or European corn borer on >10% of plants

Managing Worms
During Silking

Insecticides during silking

- For 3-week period before harvest
- Start spray schedule when fresh silk begins to show, IF moths active
- Use traps to monitor moths

Insecticide Issues During Silking in Main Season & Late Season Corn

** Spray interval

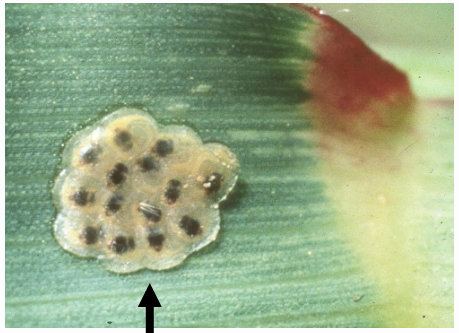
** Coverage of ear zone

* Choice of insecticide

Relative importance of pests during silking

Rank	Pest	Spray Interval
1	Corn earworm	2-6 d
2	Eur. corn borer	5-7 d
3	Fall armyworm	5-7 d
4	Sap beetles	4-5 d
5	Silk clip. beetles	(1 spray)

Difference in ‘Worm’ Invasion



	Corn earworm	European corn borer
Egg location	silks	ear leaf
Egg hatch	2-3 days	3-5 days
Moth source	migratory	local

Spray Interval During Silking

Moths active?		*Insecticide need to control larvae*
Corn earworm	*Eur. corn borer*	
+	+ or -	More intensive
-	+	Less intensive
-	-	None

Corn Earworm Insecticide Spray Schedule

Number moths per pheromone trap per day	*Spray interval*	
	Maximum daily temp. <80 F	*Maximum daily temp. >80 F*
< 0.2	No spray	No spray
0.2 - 0.5	Every 6 days	Every 5 days
0.5 - 1	Every 5 days	Every 4 days
1 - 13	Every 4 days	Every 3 days
> 13	Every 3 days	Every 2 days

European Corn Borer on Sweet Corn: spray during silking if moths active (> 1 moth per night = 7 moths per week in pheromone trap)

- 1st spray when 10-20% of plants silking
- Spray every 5 - 7 days
  - 5-day during peak egg hatch
  - 5-day when temperatures hot (>80 F)

Spray Coverage

- Direct spray to ear zone
- Drop nozzles effective

Worm management with B.t. sweet corn

- If corn earworm pressure low
  - No insecticide sprays needed during silking
- If corn earworm pressure moderate or high
  - Use 2 sprays
  - First spray: 75% fresh silk
  - Second spray: 4 days later

Organic Alternative for Earworm & Borer on Sweet corn: B.t. + Oil

(Ruth Hazzard, Univ. Mass.)

- **'Zea-later II' applicator**
  - **Hand-held**
  - **$109 (Johnny's Selected Seeds)**
- **Mix:**
  - **900 ml food-grade corn oil**
  - **Lecithin 5% (emulsifier)**
  - **28.6 grams DiPel DF (a B.t.)**
  - **100 ml water**
- **Treat:**
  - **Once, 5 days after silking begins**
  - **Squirt 0.5 ml of oil mix into each ear tip**

Corn earworm control, sweet corn field trials 2007-2014

Jim Jasinski & Celeste Welty

- Concern about pyrethroid resistance
- Start spray program at 1st silk
- 6 sprays at 3- to 4-day intervals

Target pests

- **Primary:**
  - **Corn earworm**
- **Other caterpillars:**
  - **European corn borer**
  - **Fall armyworm**
- **Other pests**
  - **Silk-clipping beetles**
  - **Corn leaf aphid (in husks)**

Treatments

- Older a.i.s:
  - Pyrethroids: Brigade (= Capture), Warrior, Hero, Asana, MustangMax
  - Carbamates: Lannate, Larvin
  - Virus: Gemstar
- Newer a.i.s:
  - Radiant
  - Coragen
  - Belt
  - Blackhawk
- Pre-mix:
  - Voliam Xpress
- Hybrids
  - BT corn 'Attribute BC 0805'
  - 'Providence' isoline

Evaluation

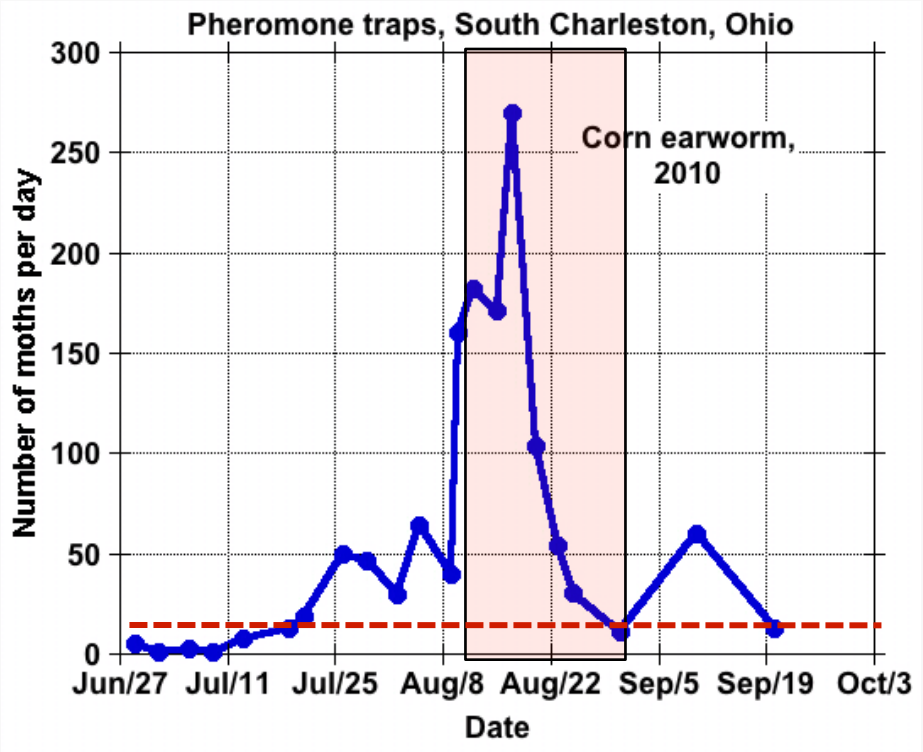
- 20 ears/plot

Worm species in field trial

Year	# larvae per ear in untreated plots		
	Corn earworm	Eur. corn borer	Fall army-worm
2007	2.7	0.9	0.01
2008	0.1	0.6	0.01
2009	1.3	0.1	0.10
2010	0.8	0.9	0.1
2011	0.1	0.04	0.01
2012	0.2	0.1	0
2013	0.1	1.1	0.05
2014	1.8	0.9	0

Corn earworm seasonal activity

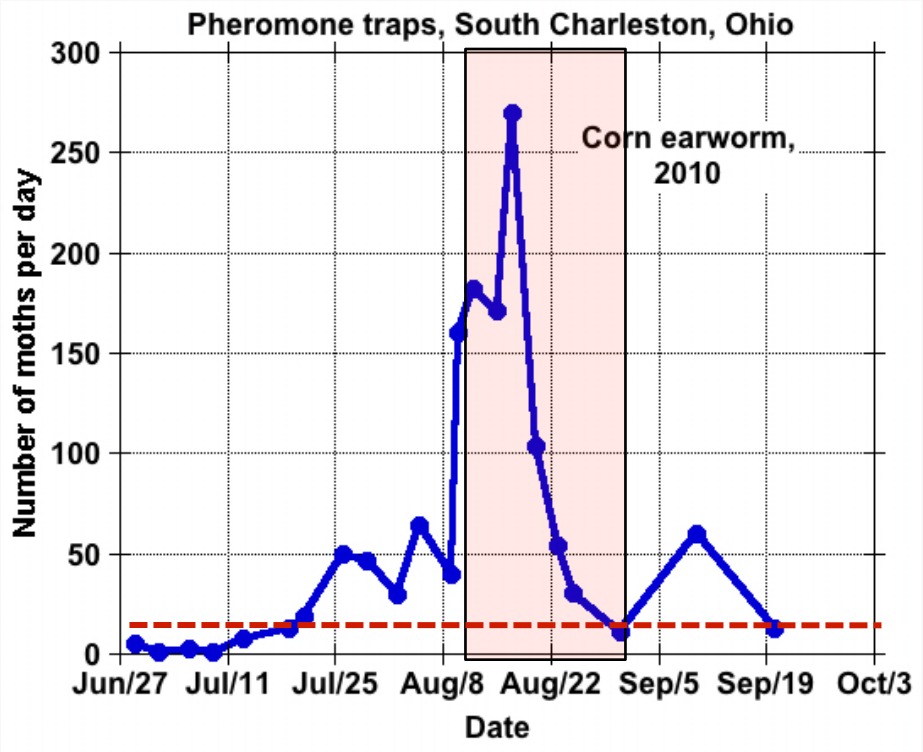
- red shading = spray period
- red dashed line = “high” moth density, 13 moths/trap/day



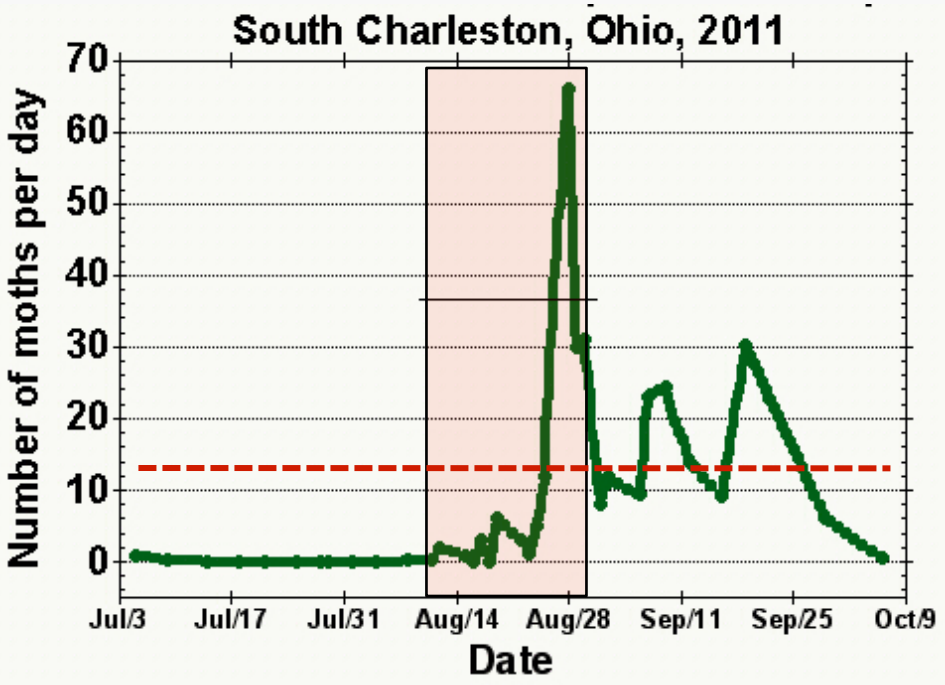
2010

Corn earworm seasonal activity

- red shading = silking = spray period
- red dashed line = “high” moth density, 13 moths/trap/day



2010



2011

Corn earworm in field trials

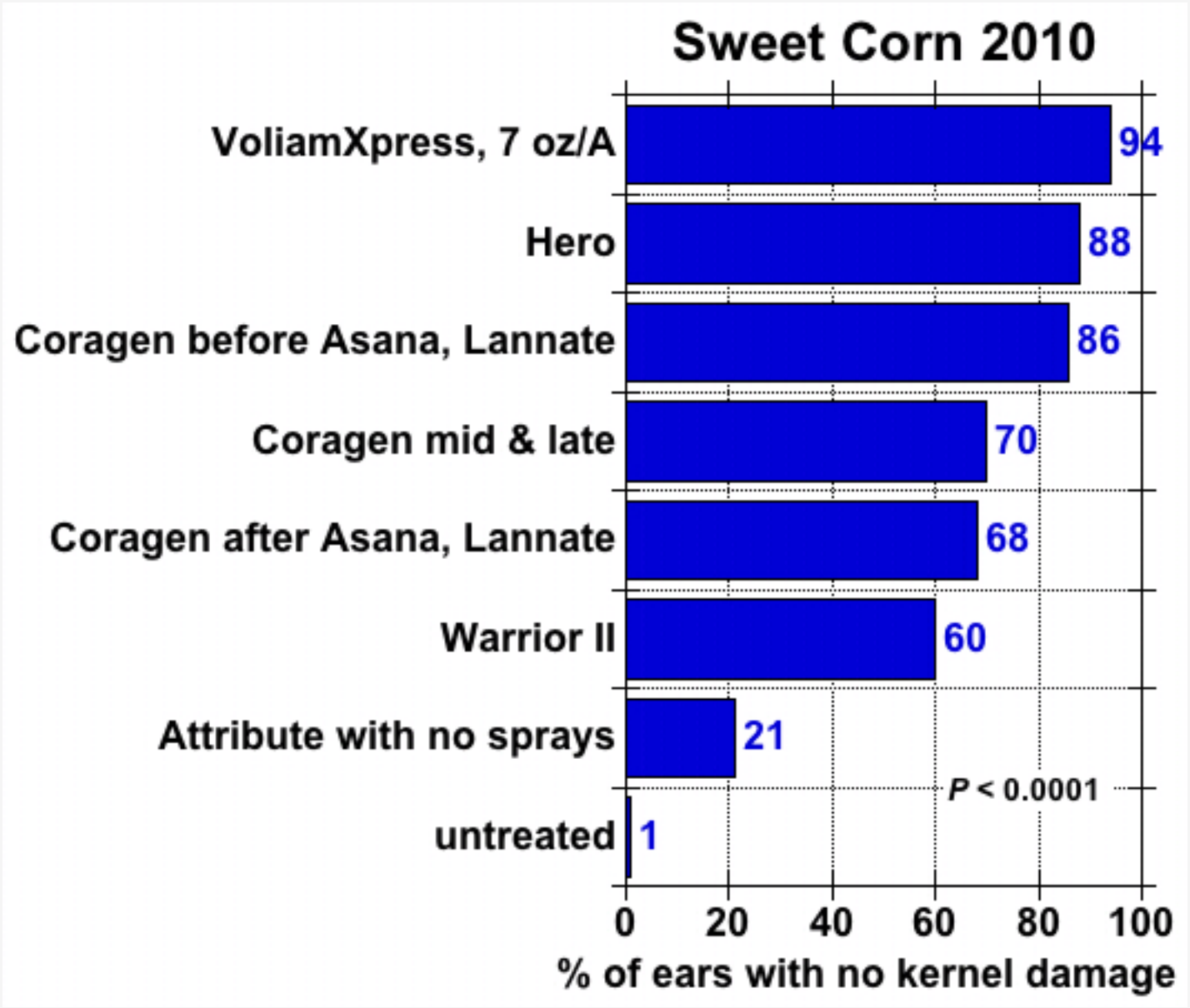
Year	Corn earworm pressure	Number of moths/day in trap at peak
2007	Very high, prolonged	388
2008	Low/Moderate	5
2009	High but quick	63
2010	Very high	270
2011	High but late	66
2012	Moderate	37
2013	Low/Moderate	5
2014	Moderate but late	15

Year-to-year differences in damage

Year	CEW pressure	% of ears with no kernel damage	
		Untreated	
2007	Very high	3%	
2008	Low/mod	59%	
2009	High	9%	
2010	Very high	1%	
2011	High, late	82%	
2012	Moderate	61%	
2013	Low/mod	51%	
2014	Mod., late	0%	

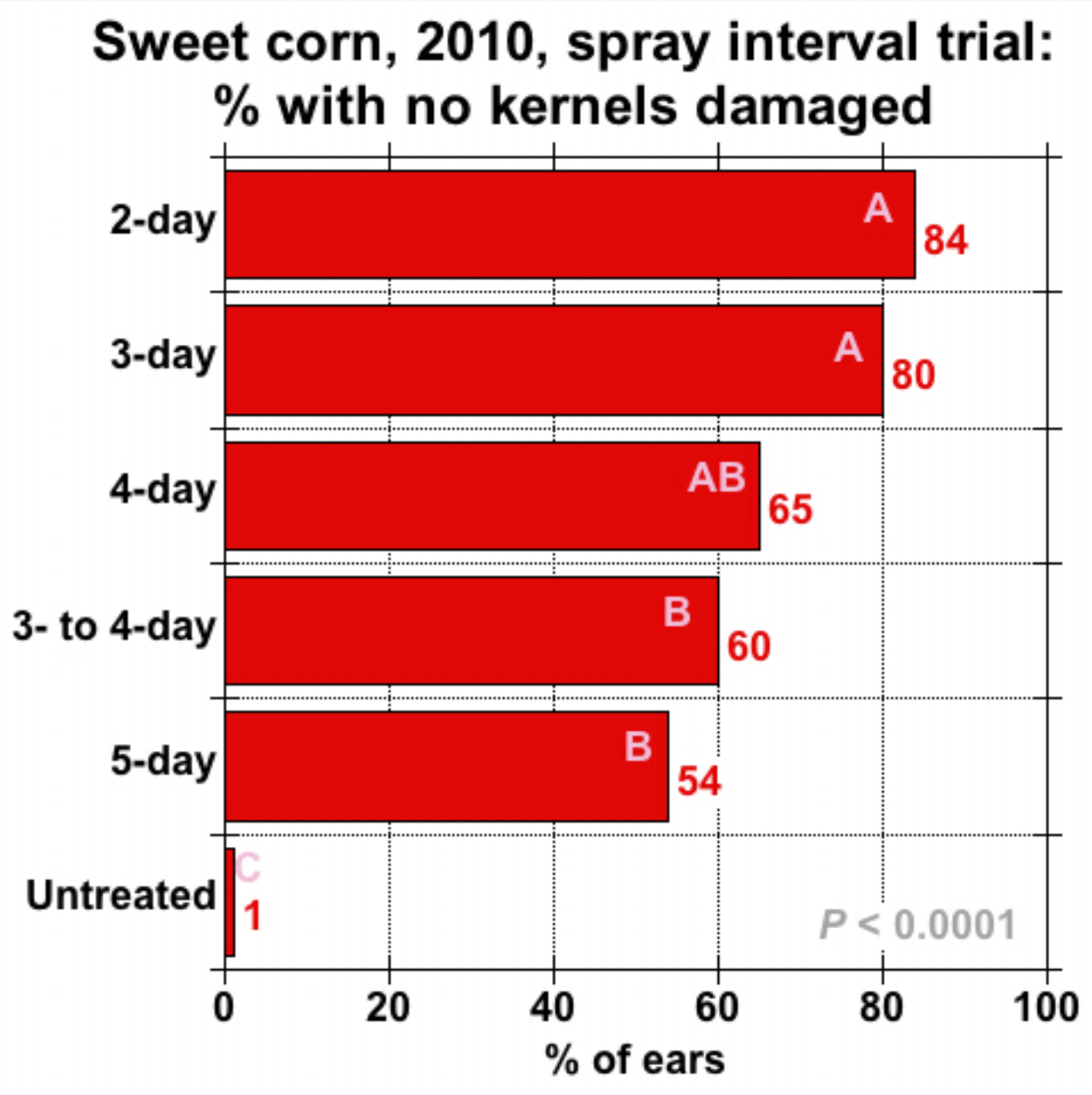
Year-to-year differences in damage

Year	CEW pressure	% of ears with no kernel damage	
		Untreated	Warrior (max rate)
2007	Very high	3%	49%
2008	Low/mod	59%	96%
2009	High	9%	94%
2010	Very high	1%	60%
2011	High, late	82%	99%
2012	Moderate	61%	96%
2013	Low/mod	51%	99%
2014	Mod., late	0%	18%


Sweet Corn 2010
VoliamXpress, 7 oz/A
94
Hero
88
Coragen before Asana, Lannate
86
Coragen mid & late
70
Coragen after Asana, Lannate
68
Warrior II
60
Attribute with no sprays
21
P < 0.0001
untreated
1
0
20
40
60
80
100
% of ears with no kernel damage

Comparison of spray schedule intensity, 2010

- One product: Warrior, at max rate
- Treatments (during silking):
  - Spray every 2 days (11 times)
  - Spray every 3 days (7 times)
  - Spray every 4 days (6 times)
  - Spray every 5 days (5 times)
  - Usual: start 3-day, then 4-day (6 times)


Sweet corn, 2010, spray interval trial:
% with no kernels damaged
2-day
A
84
3-day
A
80
4-day
AB
65
3- to 4-day
B
60
5-day
B
54
Untreated
C
1
P < 0.0001
0
20
40
60
80
100
% of ears

Conclusions from 8 years of field trial data

- Relief that pyrethoids still ok
  - but max rates needed
- Relief that new a.i.s now available

Conclusions from 8 years of field trial data

- Relief that pyrethoids still ok
  - but max rates needed
- Relief that new a.i.s now available
- Concern about variability in performance of new a.i.s
  - but whole-field better than small plot
- Worry about whether efficacy of pyrethroids will suddenly drop

Western bean cutworm

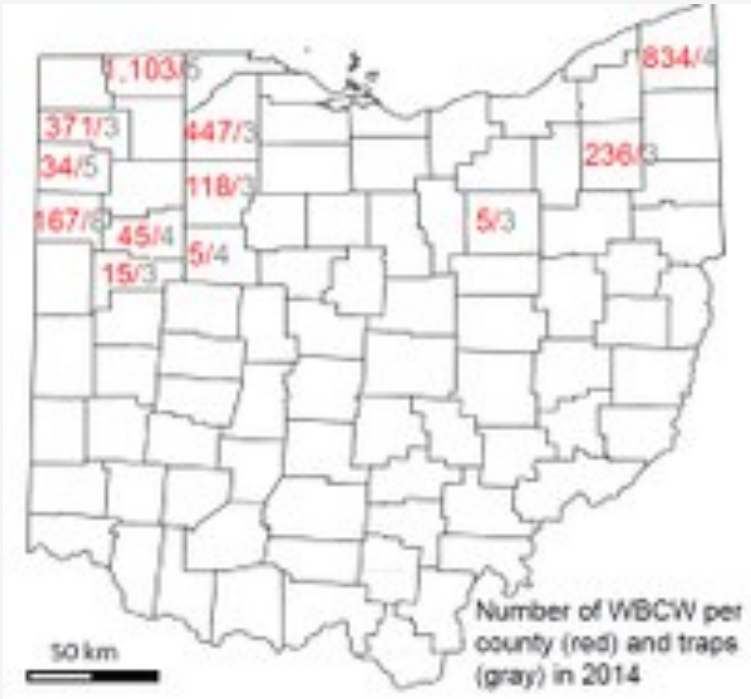
- Long-time pest of corn & dry beans in Colorado & Nebraska
- Moving eastward (Iowa) starting 2000
- Now common in Illinois & Wisconsin
- Pest of sweet corn ears

How to monitor it?

- **Pheromone lure in trap**
  - **Milk jug or unitrap**
  - **One generation per year**
  - **Adults active in July**
  - **Trap mid-June to mid-August**

Where is it?

- **Confirmed catches**
  - **NW Ohio: 2007**
  - **Central Ohio: 2009**
  - **NE Ohio**



The end