

# Updates on Insect Resistance: Corn Rootworm & Western Bean Cutworm

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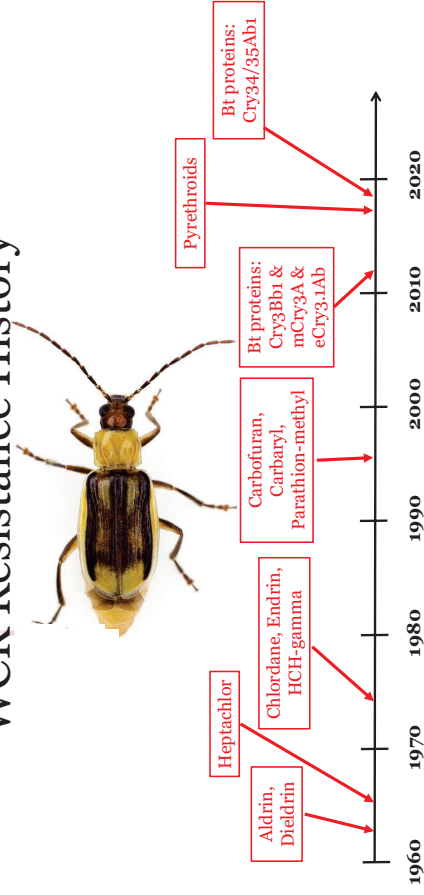


# Western Corn Rootworm

- Crop rotation
- Bt traits and seed treatments
- At-plant insecticides targeting larvae
- Aerial insecticide applications for adults
- Biological controls

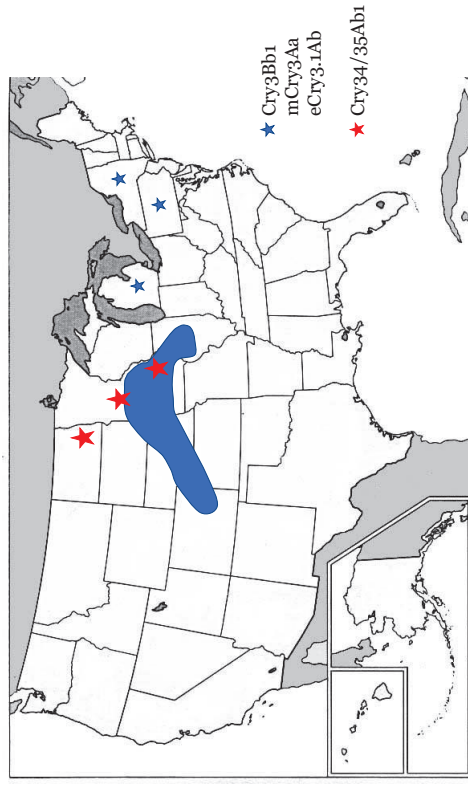


# WCR Resistance History



Arthropod Pesticide Resistance Database

# Areas with Confirmed Bt Resistance

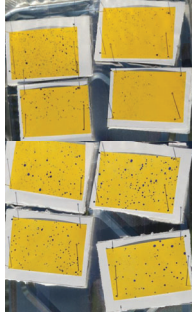






## Measuring Spray Deposition in the Field

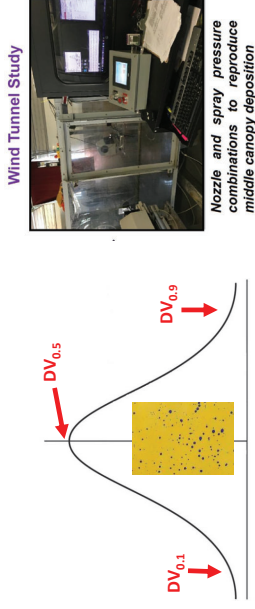
- Water sensitive papers placed at Top, Middle, and Bottom canopy
- Aerial applications made with AirTractor at 2 and 5 GPA



Souza et al. 2019, Scientific Reports

## Deposition at the Middle Canopy

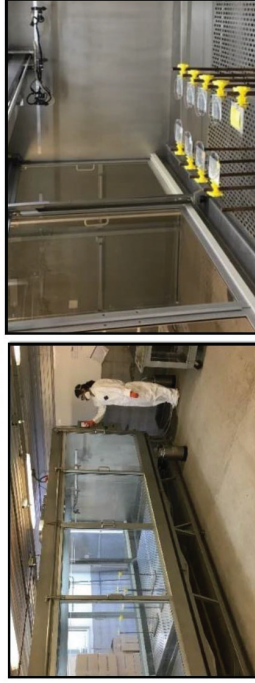
- For 2 GPA application = 1.17 GPA
- For 5 GPA application = 1.76 GPA
- 50<sup>th</sup> percentile droplet size = 299-346  $\mu\text{m}$  (1/100 of an inch)



Souza et al. 2019, Scientific Reports

## Reproducing Aerial Application in the Spray Chamber

### Aerial Application Simulation



- Spray chamber simulating middle canopy deposition*
- ✓ Brigade 2EC lowest and highest label rates (2.1 and 6.4 oz/ac)
  - ✓ 2GPA and 5GPA
  - ✓ Petri dishes were sprayed

Souza et al. 2019, Scientific Reports

## Assessing Mortality to Rootworm Beetles

### Infestation and Mortality Evaluation



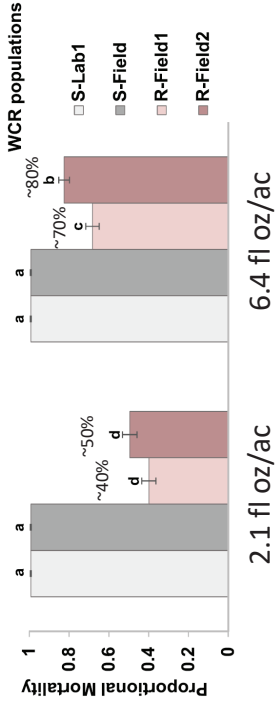
- Treated Petri dishes infested with mixed-age WCR beetles*
- ✓ Mortality after 24h

- Tested against two resistant and two susceptible beetle populations

Souza et al. 2019, Scientific Reports

## Results

- Carrier volume (2 vs. 5 GPA) did not affect results
- Insecticide rate was a significant factor:



Souza et al. 2019, Scientific Reports

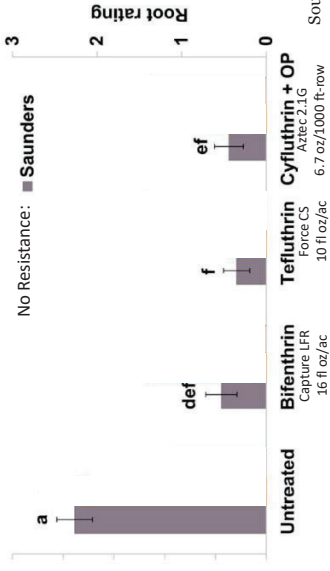
## Corn Rootworm Take-Home Points

- Resistance to Cry3 Bt proteins is present in western NE and KS
- Pyrethroid insecticides no longer highly effective against WCR adults and larvae in southwest NE & KS
  - Rotate MOA!
  - Check AI on labels, especially for adults/larvae
- Rootworm management is not a “what is the best single trait or insecticide” situation
  - Use of multiple tactics and rotation: crop rotation, planting effective Bt traits, judicious use of insecticides for adult or larval control, biological control
- The broad goal should be to limit both rootworm economic injury & limit the evolution of resistance



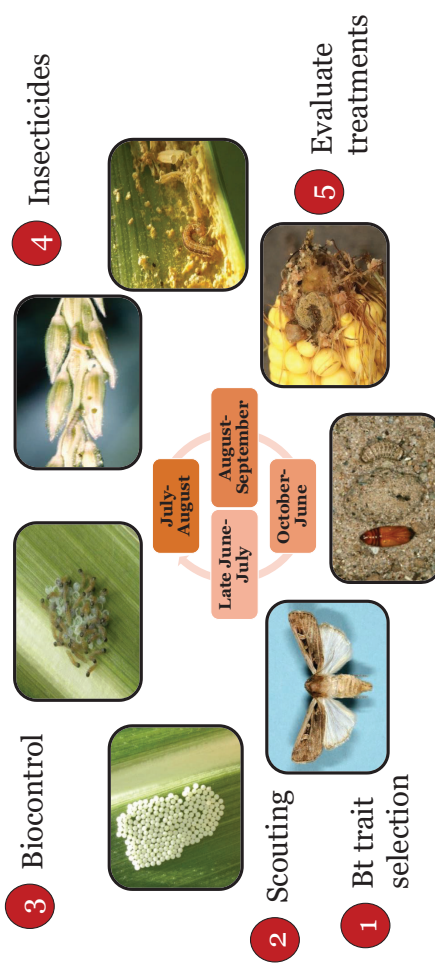
## Pyrethroids In-Furrow for Larvae

- So far, experiments looked only at the adults (beetles)
  - But is pyrethroid resistance passed on to the larvae?
  - Unfortunately, yes— pyrethroid in-furrow at-plant products performed worse in areas with resistant adult rootworms

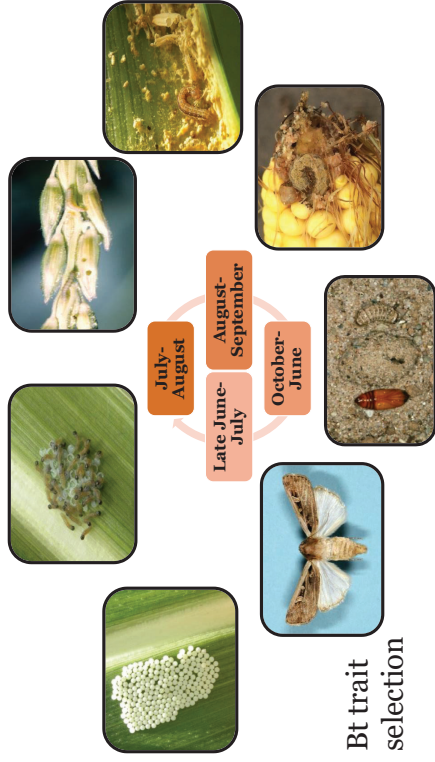


Souza et al. 2020, Pest Management Science

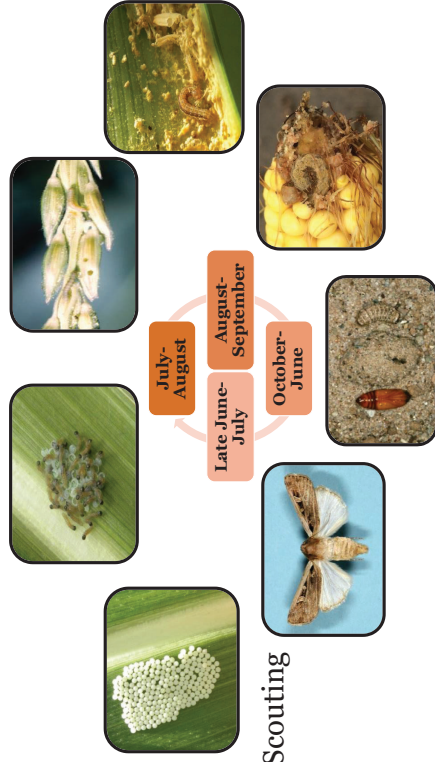
## Western Bean Cutworm



# Western Bean Cutworm

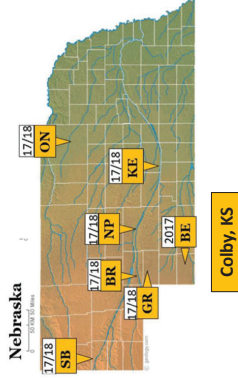


# Western Bean Cutworm



# Bt Trait Updates

- Not all caterpillar traits will affect WBC
- Cry1F: Herculex, SmartStax
  - 88% of NE crop consultants reported that Cry1F Bt corn is providing less control (2014-2016)
  - Confirmed resistance to Cry1F in Nebraska (2017-2018)
  - WBC removed from label of all Cry1F products
- Vip3A: Viptera, Leptra, Trecepta
  - Traits provide very good control, but resistance is always on the horizon



Colby, KS

## [Handy Bt Trait Table](#)

Archibald et al. 2017, *Journal of IPM*

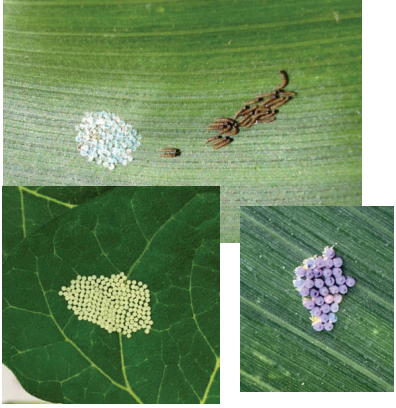
Coates et al. 2020, *Journal of Economic Entomology*

# When to Start Scouting

- Be informed about moth flight predictions from the degree-day model:
  - CropWatch article
  - [AgriTools App](#)
- Monitor moth flights through trapping:
  - UNL black light trap data [online](#)
  - Green bucket and pheromone

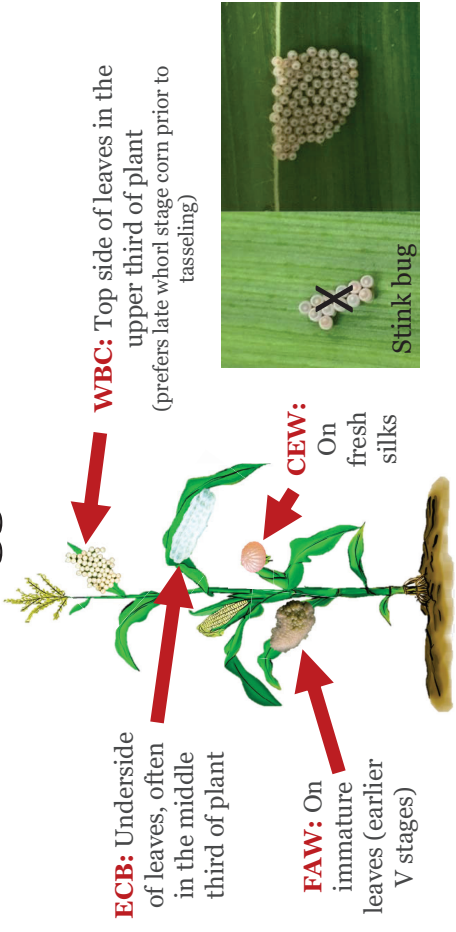
Threshold	2021 Actual	Record
5% Flight	6670	614
10% Flight	715	616
25% Flight	786	619
50% Flight	790	623
75% Flight	773	627
90% Flight	717	71
95% Flight	720	73
		81

# Western Bean Cutworm Scouting



- Select 20 plants in 5 different parts of each field (100 plants)
  - ❖ Or reduce # of plants using [WBC Speed Scout App](#)
- Examine the surface of corn leaves in the upper third of the plant for egg masses and the tassel, leaf axils, and ear tips for larvae
- Treatment is recommended if 5-8% of plants are infested with eggs or larvae
- If corn is at milk stage (R3) before eggs are laid, no treatment is needed

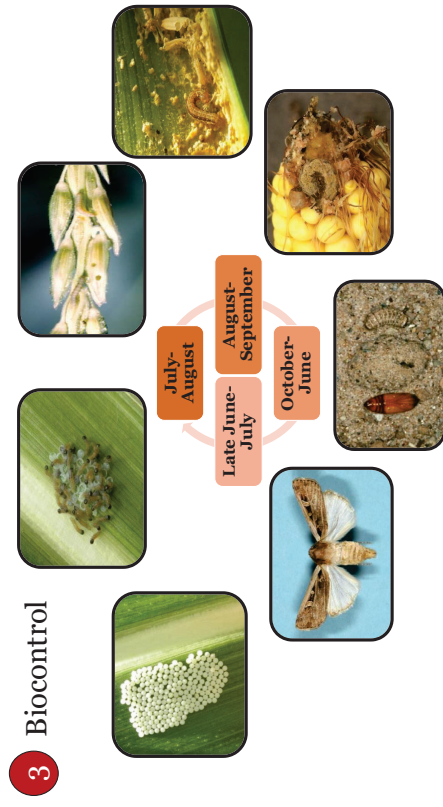
# WBC Egg Identification



# How Often Should You Scout?

- A lot of the older recommendations say that eggs hatch in approximately 5-7 days
- Egg hatching time highly dependent on temperature:
  - 4.6 days at average 79.9 °F
  - 5.9 days at average 75.6 °F
- Scouting once per week may be missing a lot of egg masses; every 4-5 days can be more accurate
- Crop growth stage is critical
  - Moths prefer late whorl to early tasseling plants
  - Larvae that hatch and have access to fresh tassel survive the best

# Western Bean Cutworm



## 3 Biocontrol

## The Good Guys At Work!



## Spying on Egg Masses in the Field

- Larvae may stay near the egg mass for 12 h
- Hatching not synchronized, may take 10 h
- Neonates not disrupted by a rainstorm
- Minute pirate bugs feed on egg masses

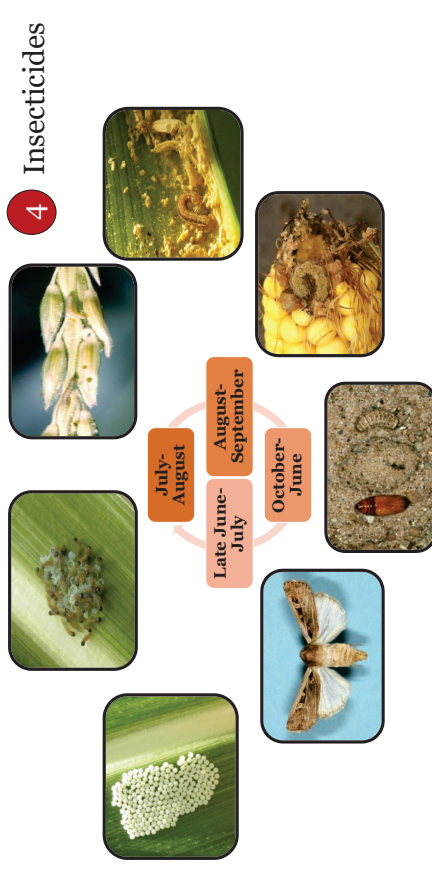


## How Can You Support the Good Guys?

- Plant non-crop, perennial, diverse habitat around crop fields
- Use thresholds to avoid unnecessary insecticide spraying; choose products that are less toxic to beneficials



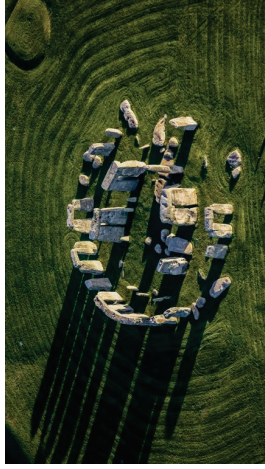
## Western Bean Cutworm





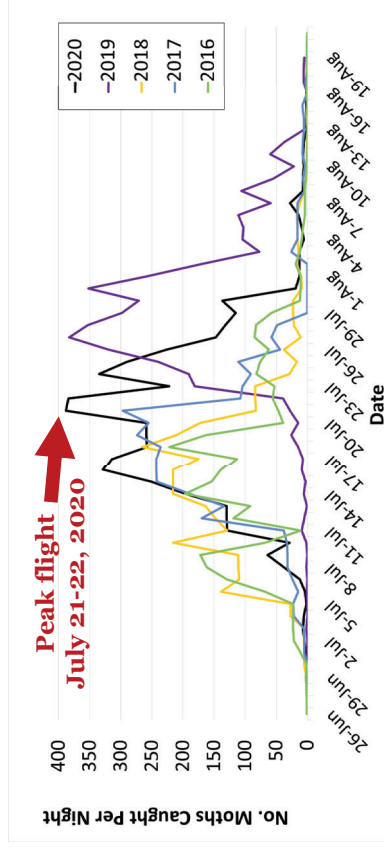
## Insecticides: Timing

- Threshold of >5-8% of plants infested has been met through scouting
- Plants are at ~95% tassel
- Egg masses are purple to hatching
- Peak of moth flight has been reached
- Favorable environmental conditions



*Perfect alignment of the stars?? Does the "perfect" timing actually exist?*

## North Platte Moth Flight Over Time:



## Insecticides: Product Choice

- Between 2014-2016, 88% of NE crop consultants treated at least once for WBC
- Pyrethroids comprise 80% of insecticides used
  - Bifenthrin and zeta-cypermethrin most common AI's: Brigade, Hero, Mustang Maxx, Capture
- 51% of crop consultants reported decreased pyrethroid efficacy



## WBC Pyrethroid Study Results

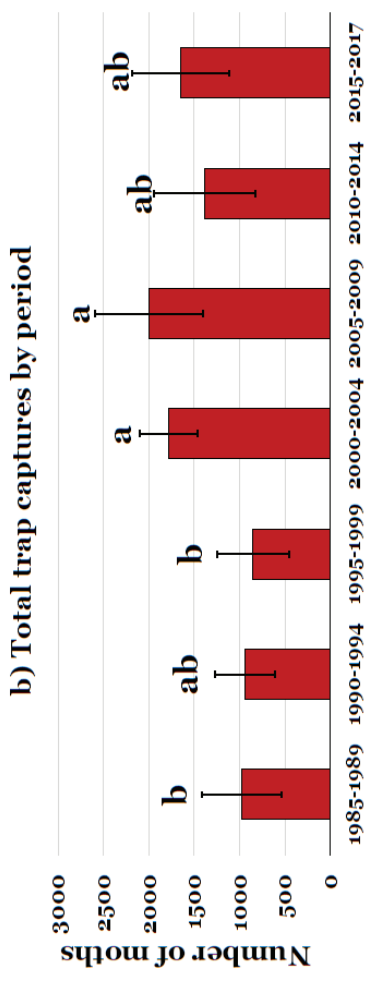
- Nebraska WBC less susceptible to bifenthrin than Canadian population
- No differences between NE locations
- Resistance ratios reflect partial resistance or resistance in progress
- When applications are "ideal" they are effective
- Resistance not the whole story:
  - Application timing and technique
  - Temperature or other environmental conditions
  - Pest and crop phenology



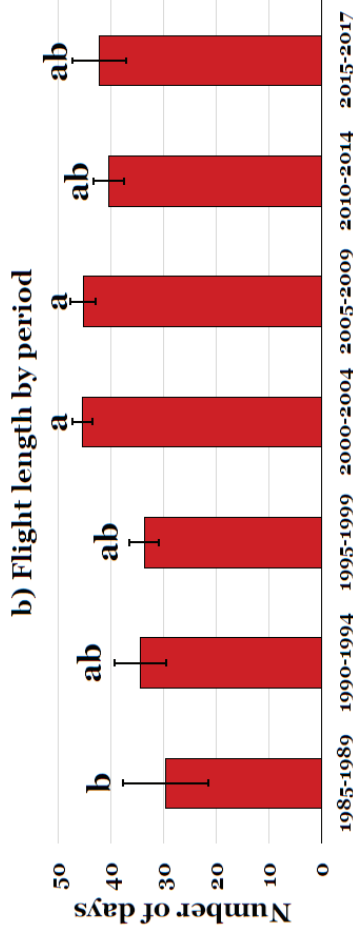
# 30 Years of Light Trap Data!



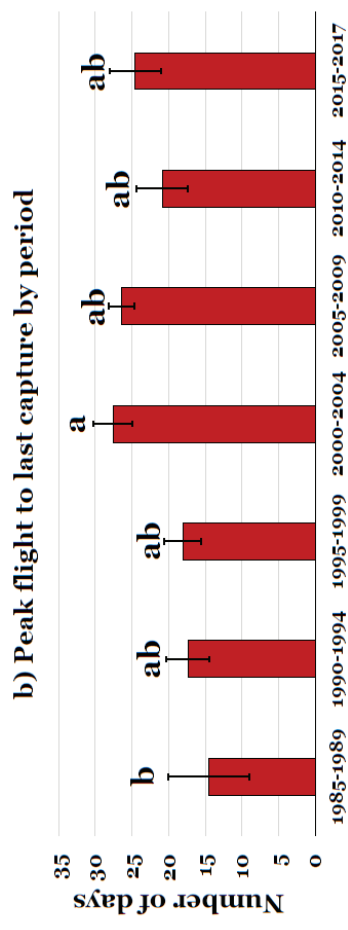
# WBC Flights: Total # Increasing



# WBC Flights: Length Increasing



# WBC Flights: 2nd Half Longer



# Why Does the 2<sup>nd</sup> Half of Flight Have Greater Impact?

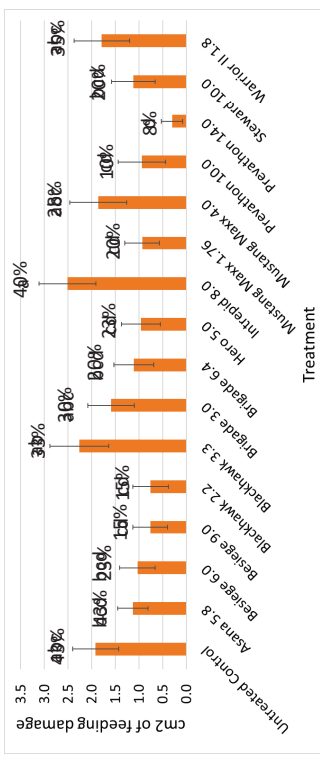


Corn tissue	Larval survival (%)
Leaf only	3.6 (± 3.0)
Leaf + Tassel	74 (± 17)
Pollen	31 (± 8)
Silk	45 (± 10)
Silk + Pollen	56 (± 10)

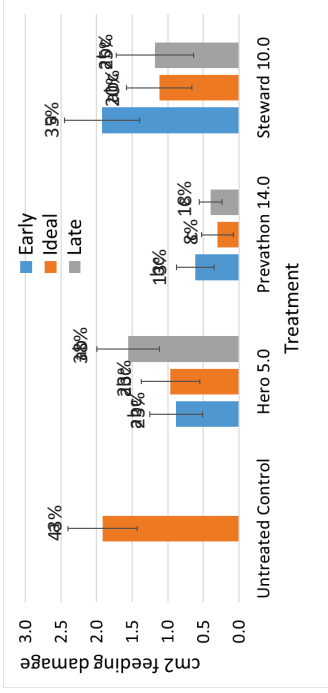
Paula-Moraes et al. 2012, *Environmental Entomology*

# Insecticide Trials: Grant 2018

- Medium pressure (17% egg masses)
- Mixed population of WBC (72%) and CEW (28%) upon assessment of ear damage



- Early: July 17 (<50% tasseled)
- Ideal: July 24 (90% tasseled)
- Late: July 31 (100% tasseled)



# Can insecticides kill WBC eggs?



- No evidence for ovicidal effects at the low and high label rates of:
  - Mustang Maxx
  - Brigade
  - Hero
  - Prevathon
  - Steward
- But, after hatching larvae died quickly in all treatments but Steward (needs ingestion for higher efficacy)
- Lab conditions were ideal for up to 5 days of insecticide residual
- Lady beetles that ate eggs sprayed with Mustang Maxx did not die, but were severely disoriented compared to eating eggs sprayed by Prevathon



## Western Bean Cutworm Take-Home Points

- Western bean cutworm has evolved resistance to the Cry1F Bt protein (a trait found in Herculex and SmartStax), leaving Vip3A as the sole highly effective protein
- There are many beneficial insects that help out by eating WBC eggs and larvae
- Insecticide applications should be made only when the economic threshold has been met and timing is carefully considered
- Insecticide product choice is important to minimize resistance and risk to beneficial insects

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