Susceptibility of Cry1F Resistant Fall Armyworms, *Spodoptera frugiperda*, to Cotton Expressing Pyramided Bt Toxins

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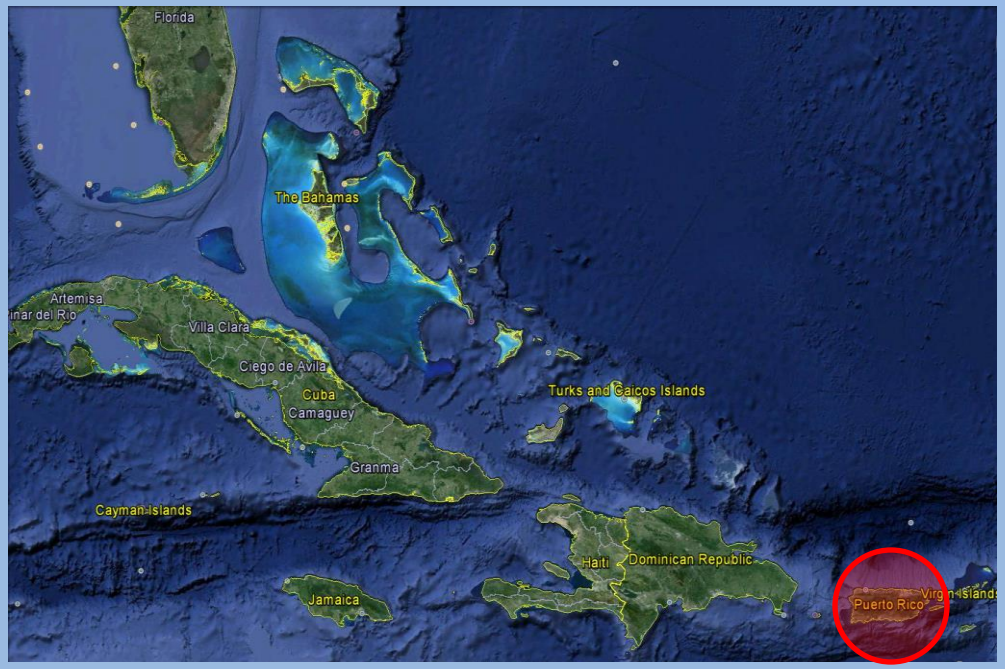
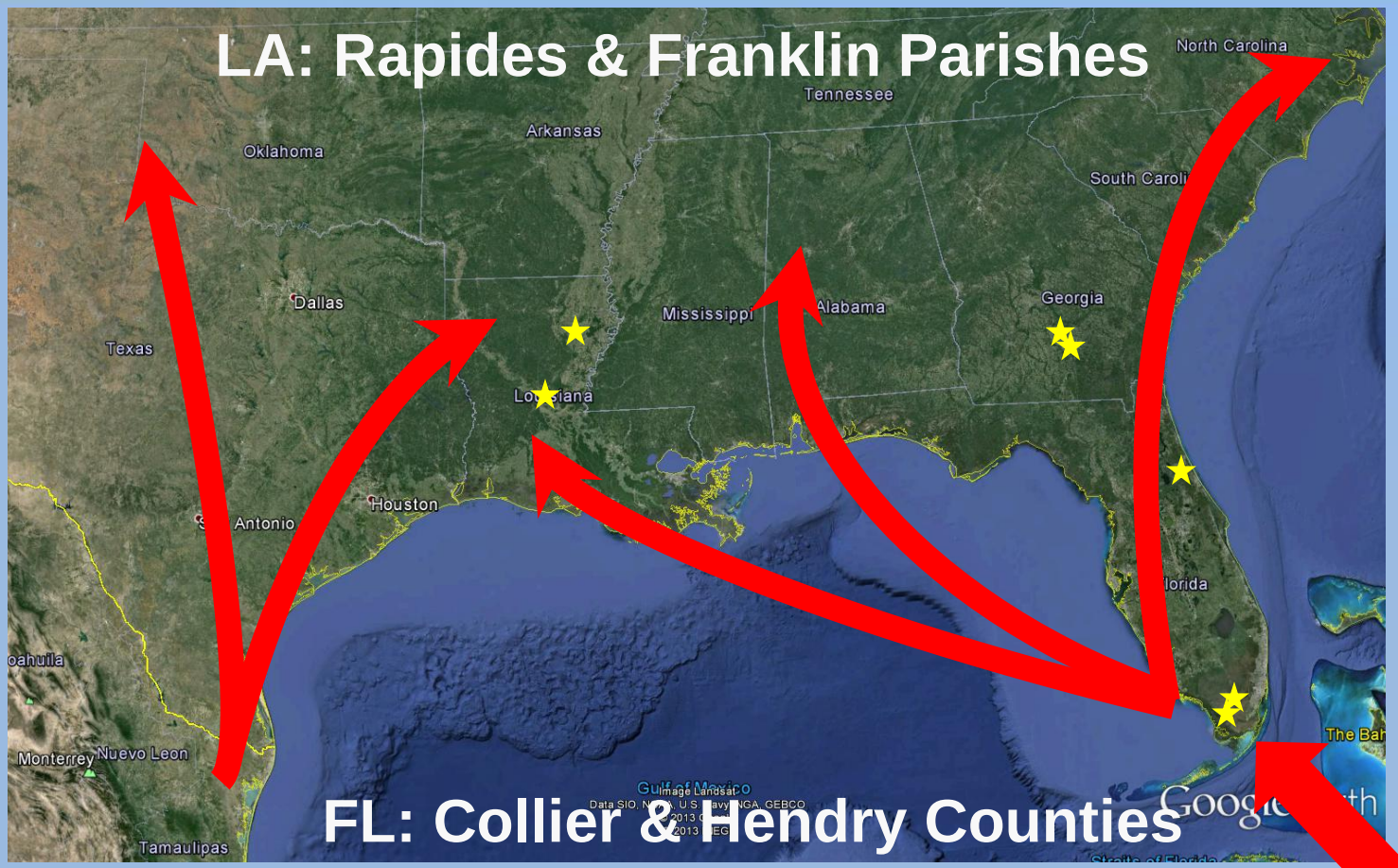
LSU AgCenter Research & Extension

Detection of Cry1F Resistance in FAW



- Cry1F resistance was first reported in 2006 in Puerto Rico (Storer et al. 2010)
  - Resistance was shown to be autosomally inherited and recessive
  - Was found to be moderately less sensitive to Cry1Ab and Cry1Ac
  - No evidence that Cry1F resistance had spread to U.S. mainland, 2006-2011 (Storer et al. 2012)

Field Collections

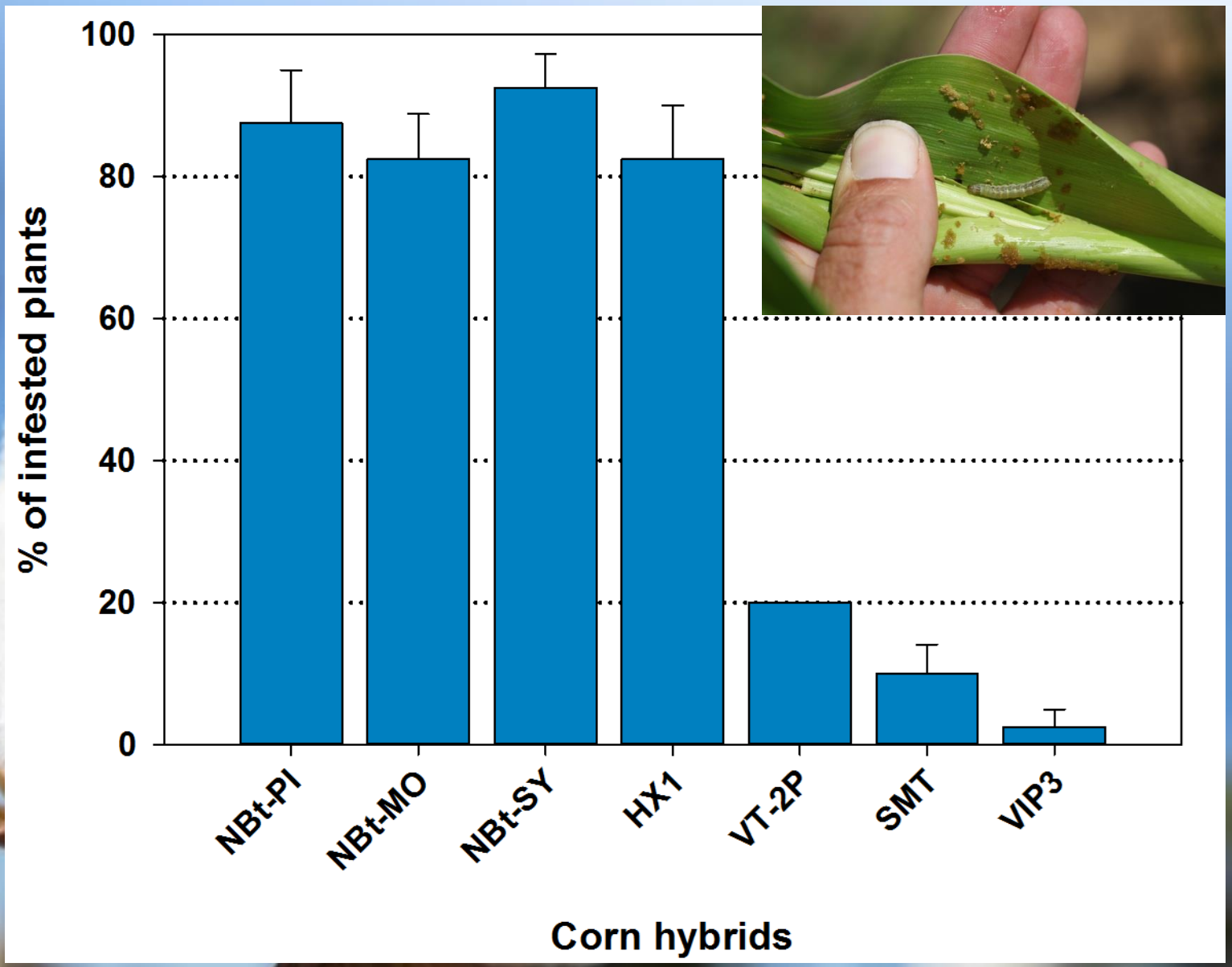


Susceptibility of Field Populations Collected in 2012 to Cry1F Protein

FAW Population	Sources	LC_{50} (µg/g)	RR ratio
Cry1F-SS	Non-Bt corn	0.17	---
LA-DL	Non-Bt corn	22.3	131
LA-Win	Non-Bt corn	10.7	63
FL-CL	Non-Bt corn	7.0	41
GA-A	Non-Bt corn	4.9	29
GA-B	Non-Bt corn	1.3	8
FL-GS	Bt corn	>>31.6	>>186
FL-HD	Bt corn	>>31.6	>>186
FL-CL	Bt corn	>>31.6	>>186

(Huang, 2012)

Field trials (Qureshi, Collier, FL-2013)

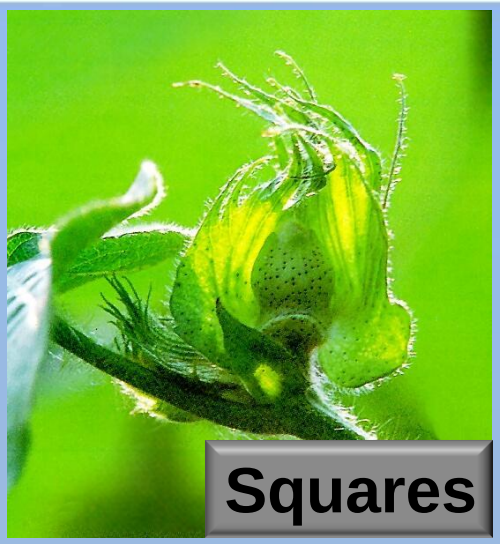


(Huang, 2012)

Objective

Evaluate survival of resistant and susceptible FAW on cotton cultivars that are currently planted and those expected to be planted in the near future of U.S. cotton production

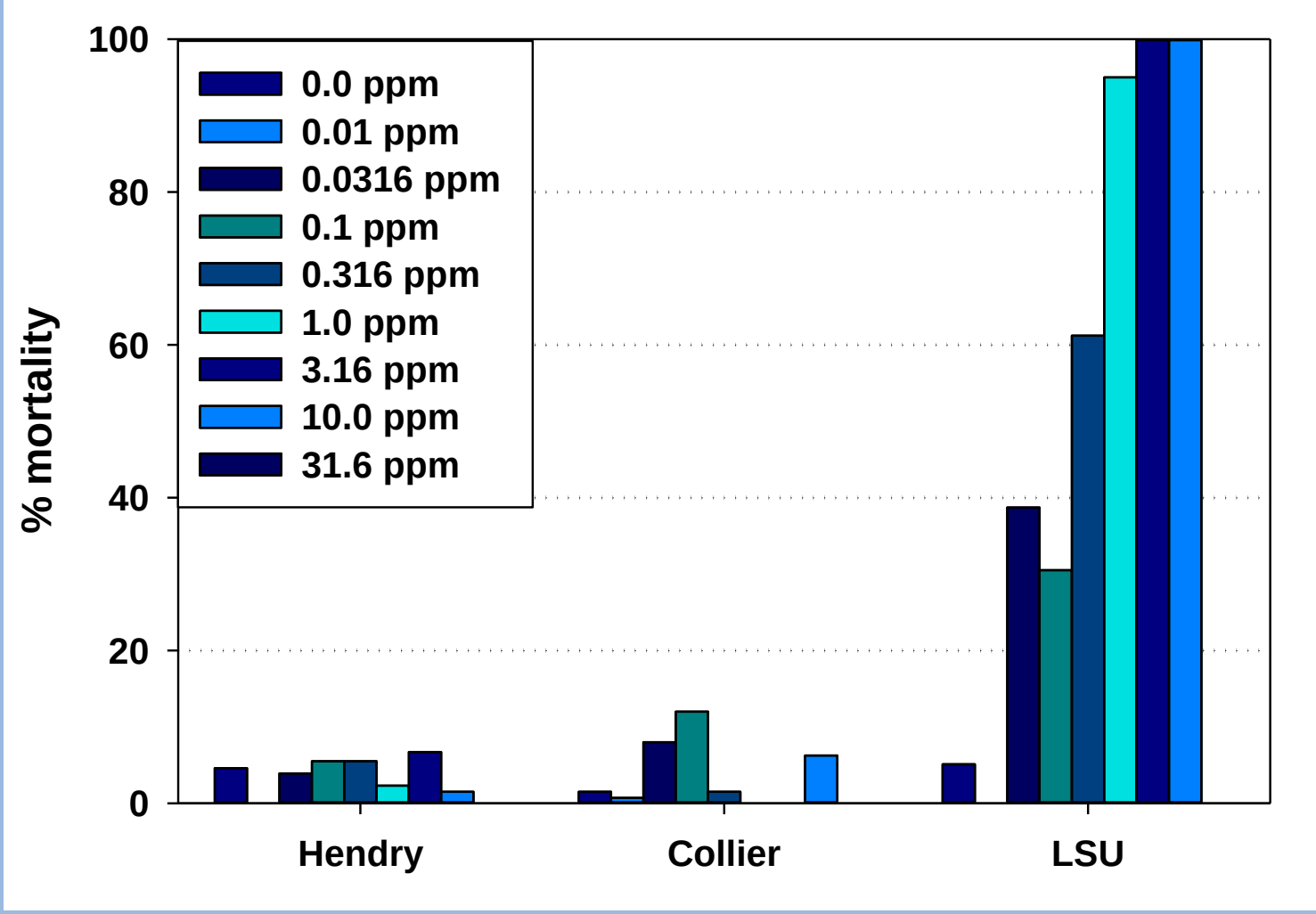
Tissue to be Bioassayed



Fall Armyworm Populations

- Three populations evaluated
  - Two known Cry 1F resistant FAW colonies
    - Collier Co. FL (Collier)
    - Hendry Co. FL (Hendry)
  - One known susceptible FAW colony
    - LSU Susceptible (LSU)

Response of FAW Populations to Diet Incorporated Cry1F



(Huang, 2012)

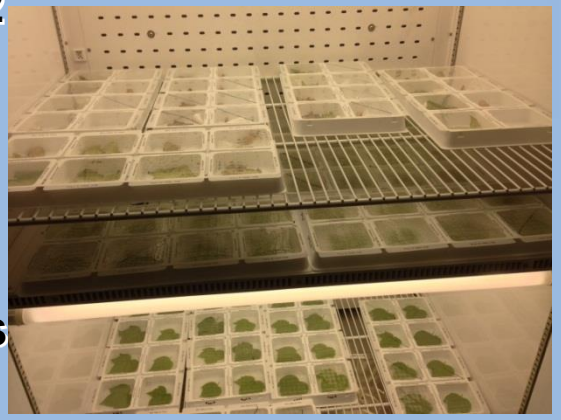
Cotton Varieties Evaluated

Supplier	Variety	Designation	Bt Proteins
Bayer	FM 966 LL	Non-Bt	None
	TwinLink™	TL	Cry1Ab, Cry2Ae
	TwinLink™Plus	TL+	Cry1Ab,Cry2Ae,Vip3A
Monsanto	DP 0912 B2RF	BG2	Cry1Ac , Cry2Ab
Dow	PHY 375 WRF	WS	Cry1Ac, Cry1F
	WideStrike™ 3	WS3	Cry1Ac, Cry1F, Vip3A

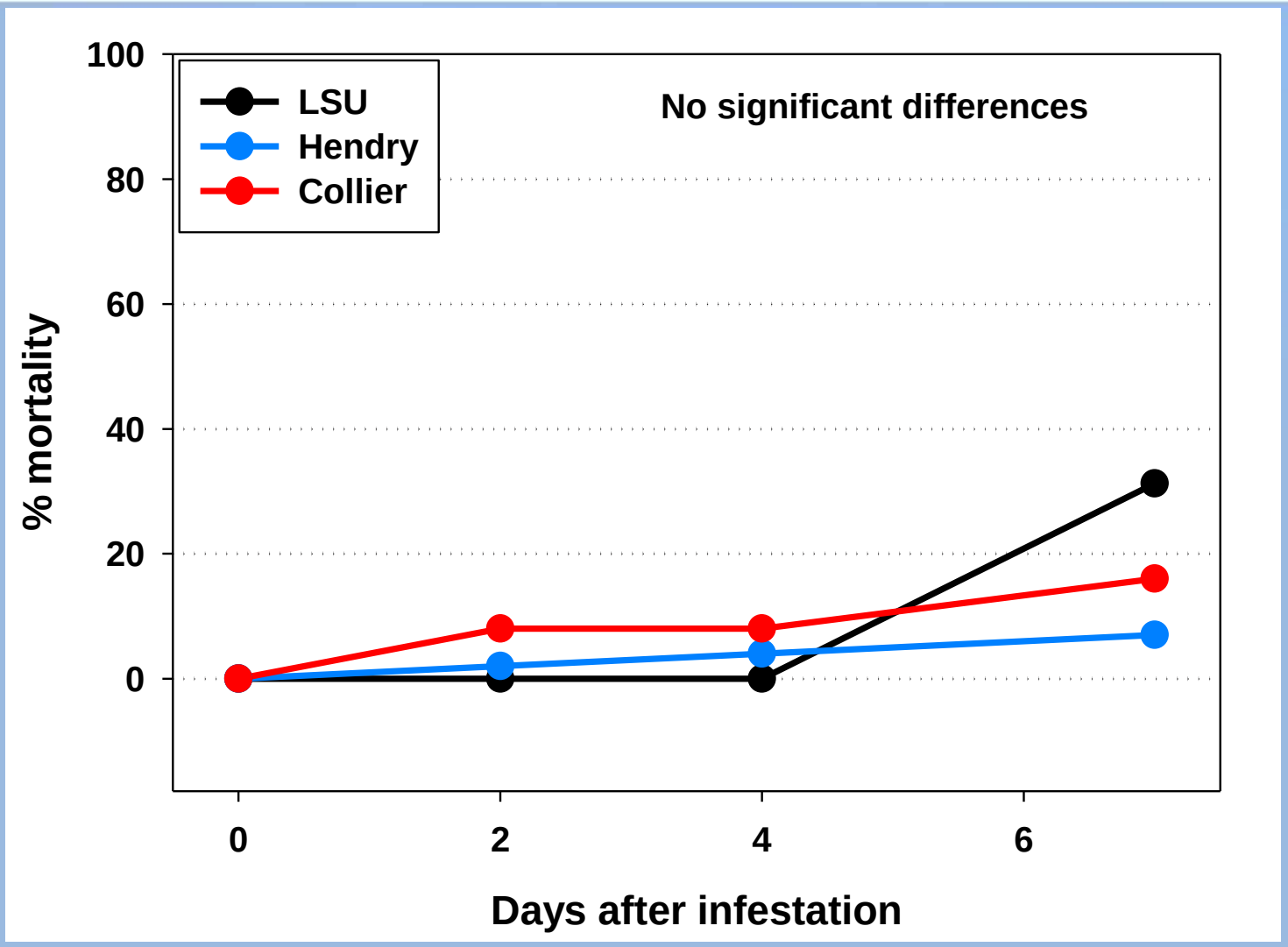
**All cotton entries were grown in the greenhouse*

Bioassays

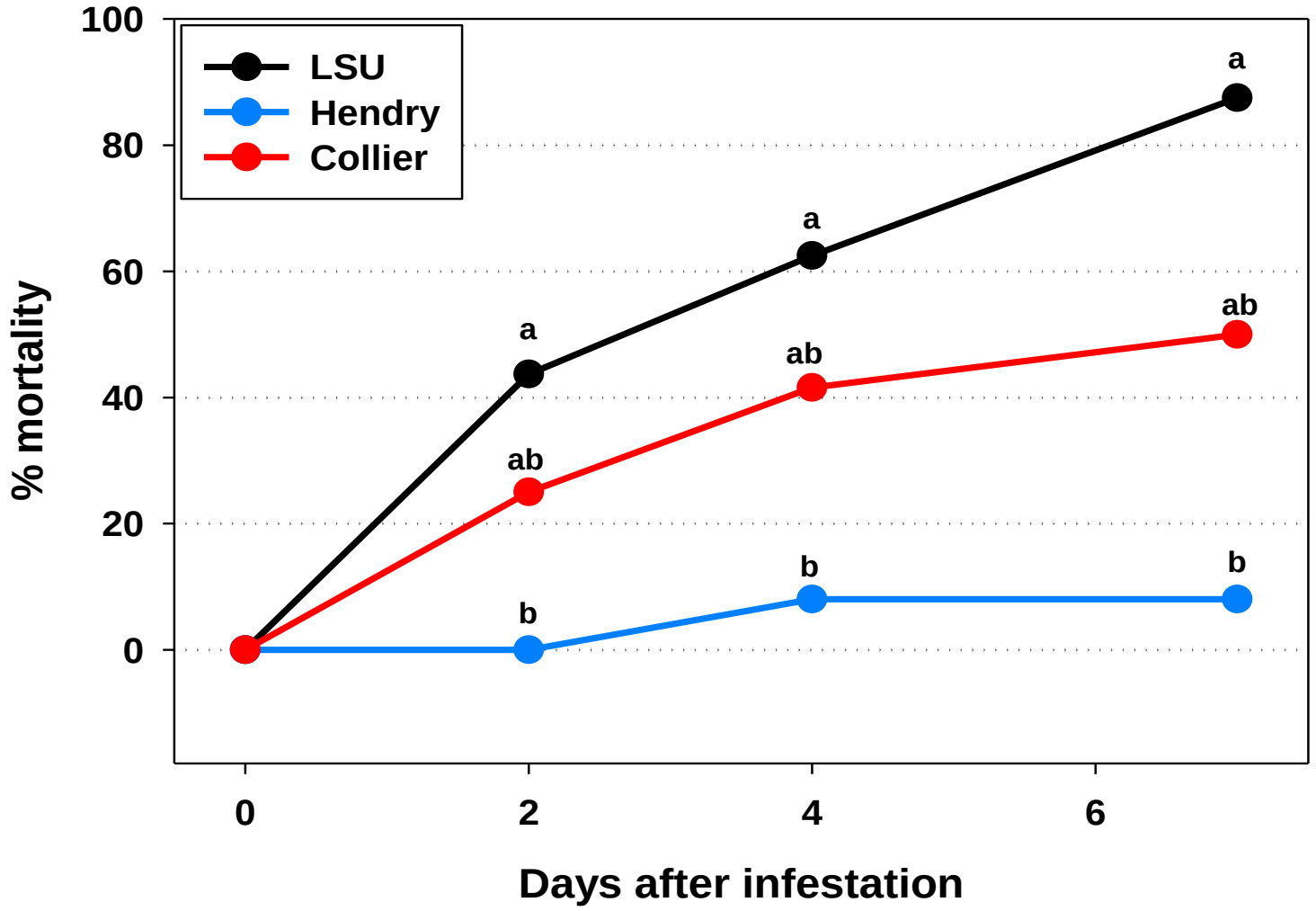
- **Leaf tissue bioassay**
  - **Single leaves placed in 8 well bioassay trays with the base filled with agar for moisture**
  - **1 neonate(~24 h old) placed on each leaf**
  - **12 leaves/neonates per treatment and population**
  - **Trays placed in growth chamber set to ~23°C, 12/12 L/D Photoperiod**
  - **Mortality recorded at 2, 4 and 7 days after infestation**
  - **Data analyzed using a 1way ANOVA, Kruskal-Wallis test; Pairwise comparison were made using a Dunn's multiple comparison test ($P < 0.05$)**



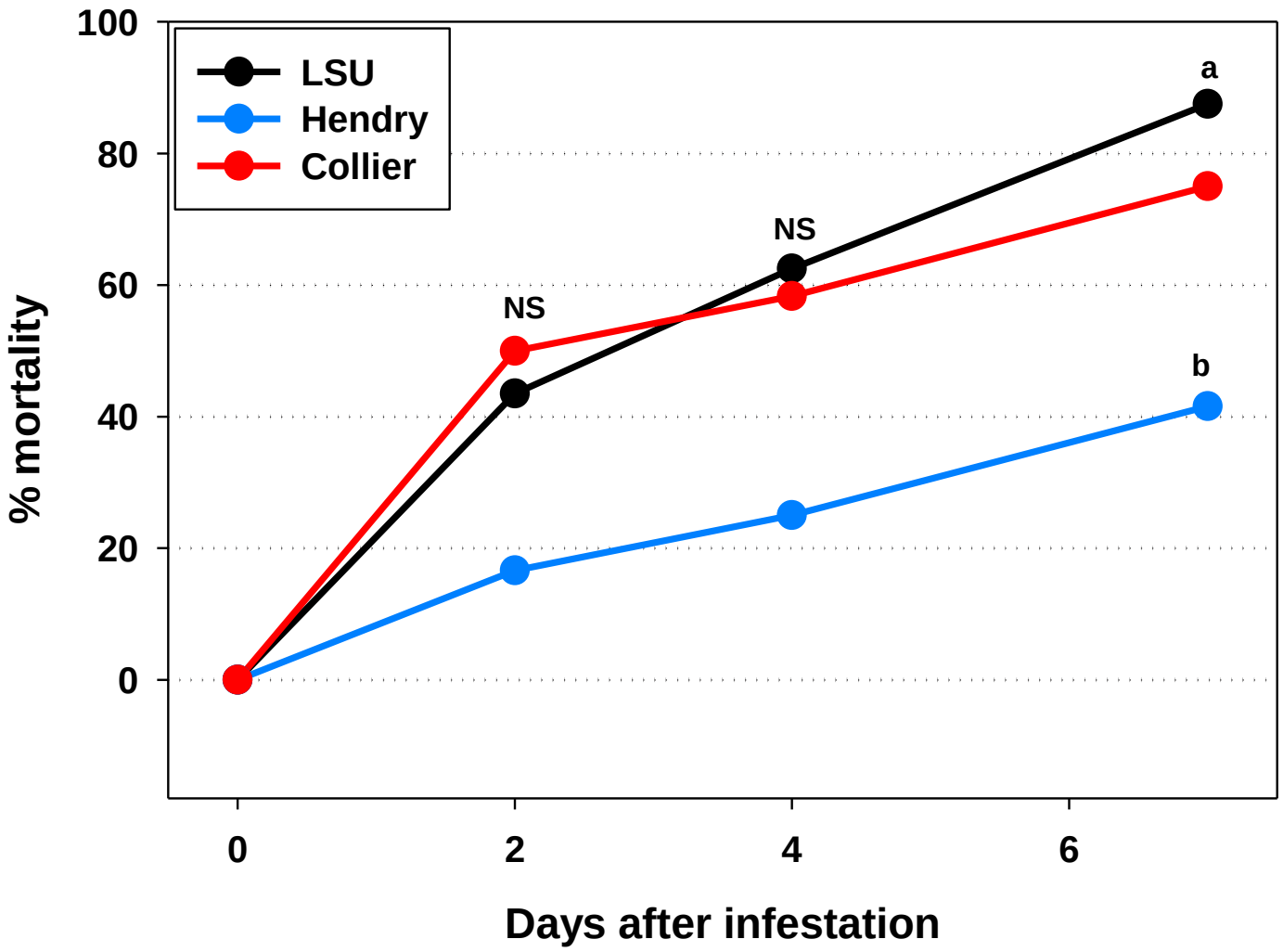
Non-Bt


LSU
Hendry
Collier
No significant differences
100
80
60
40
20
0
% mortality
0
2
4
6
Days after infestation

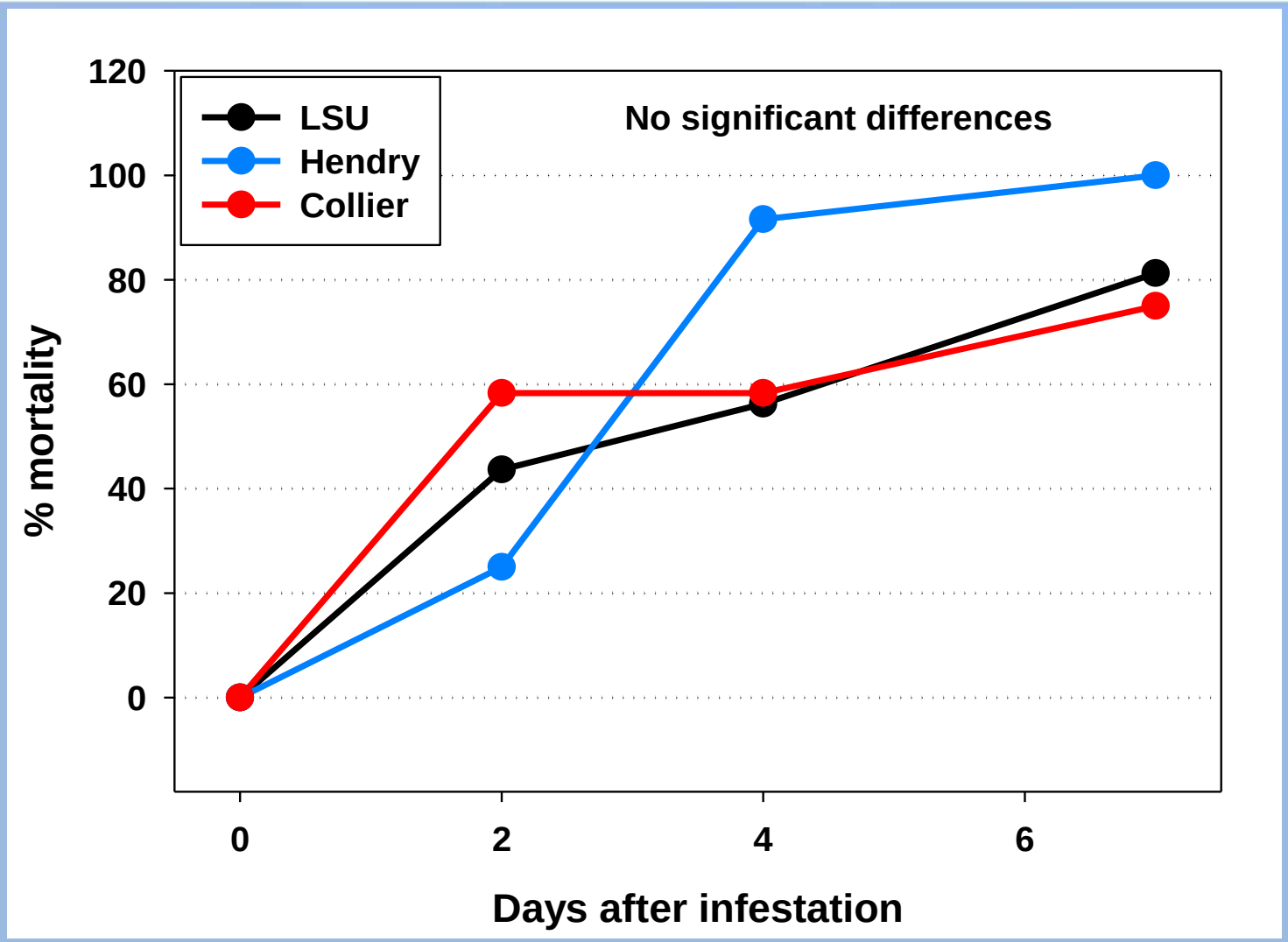
WideStrike (Cry1Ac, Cry1F)



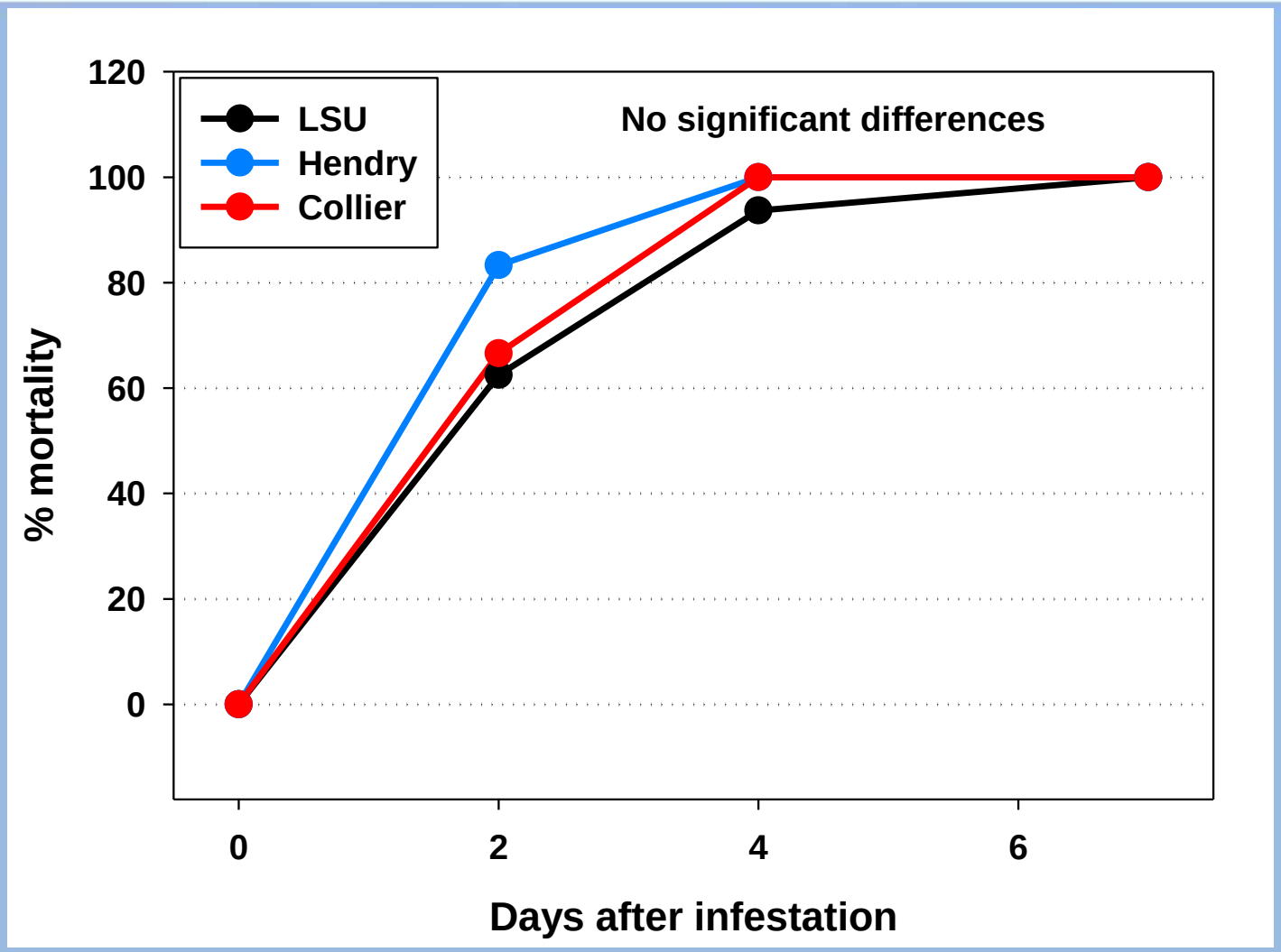
Bollgard 2 (Cry1Ac, Cry2Ab)



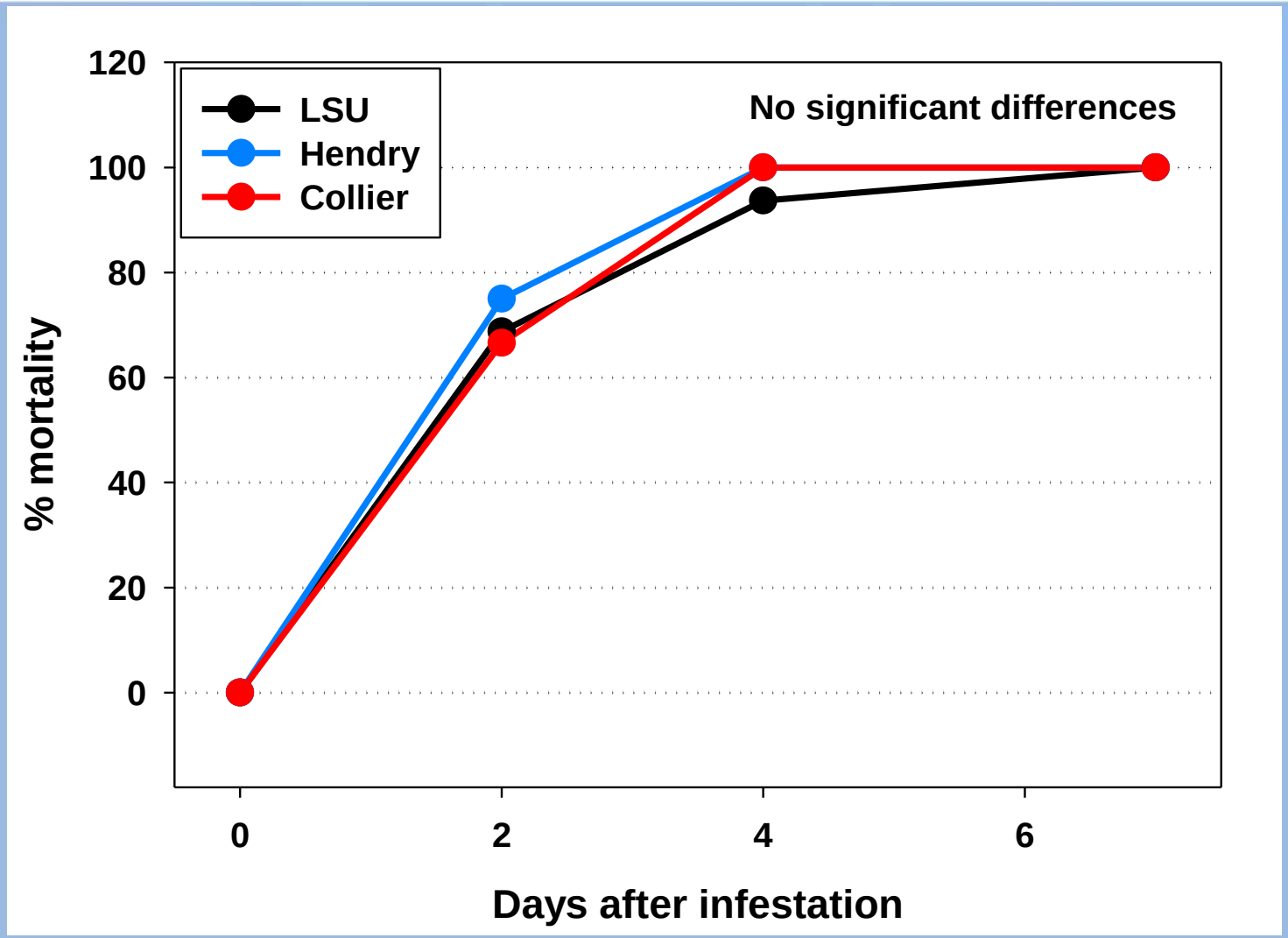
TwinLink (Cry1Ab, Cry2Ae)



TwinLink+
(Cry1Ab, Cry2Ae, Vip 3A)



WideStrike 3 (Cry1Ac, Cry1F, Vip3A)



Summary

- The LSU-susceptible population was highly susceptible to all Bt entries
- The Hendry population appears highly resistant to WideStrike cotton and moderately resistant to Bollgard 2 cotton
  - May posses cross or multiple resistance to Cry2Ab
- The Collier population responded intermediately between the LSU and Hendry populations to WideStrike but was sensitive to Bollgard 2
  - Most likely represents error in bioassays
- The TwinLink entry was moderate to highly toxic to all populations tested
- The Widestrike 3 and TwinLink+ entries were highly toxic to all populations tested

Research supported by:

- DOW AgroSciences
- Bayer CropScience
- Monsanto
- Cotton Incorporated

cotton

Dow AgroSciences

MONSANTO
imagine

BAYER

Bayer CropScience

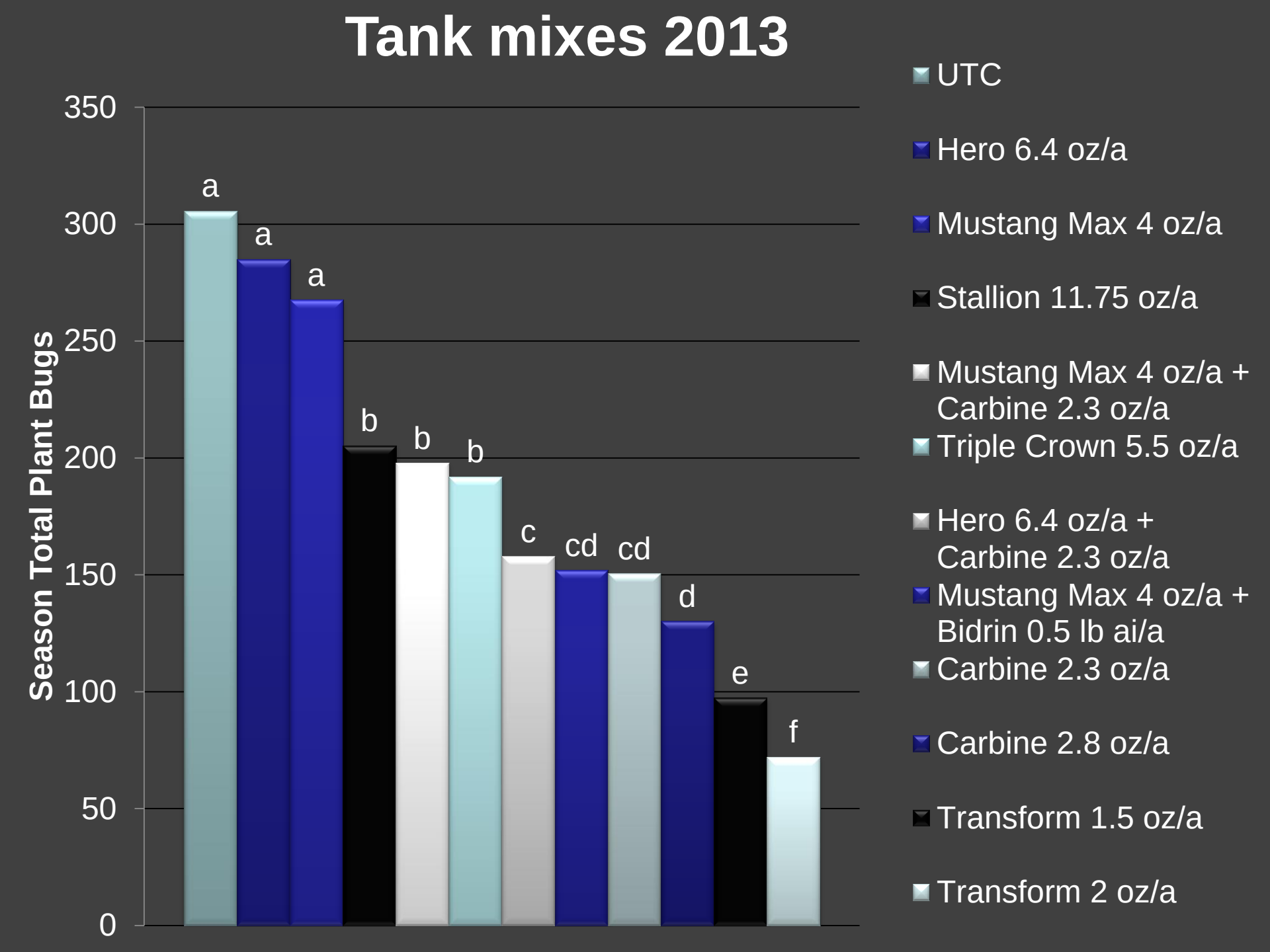
Selecting the Right Insecticides for Managing Plant Bugs

I QUESTION THE VALUE OF MOST INSECTICIDE PRE-MIXES/MIXES WHEN USED SOLELY FOR PLANT BUG CONTROL IN COTTON

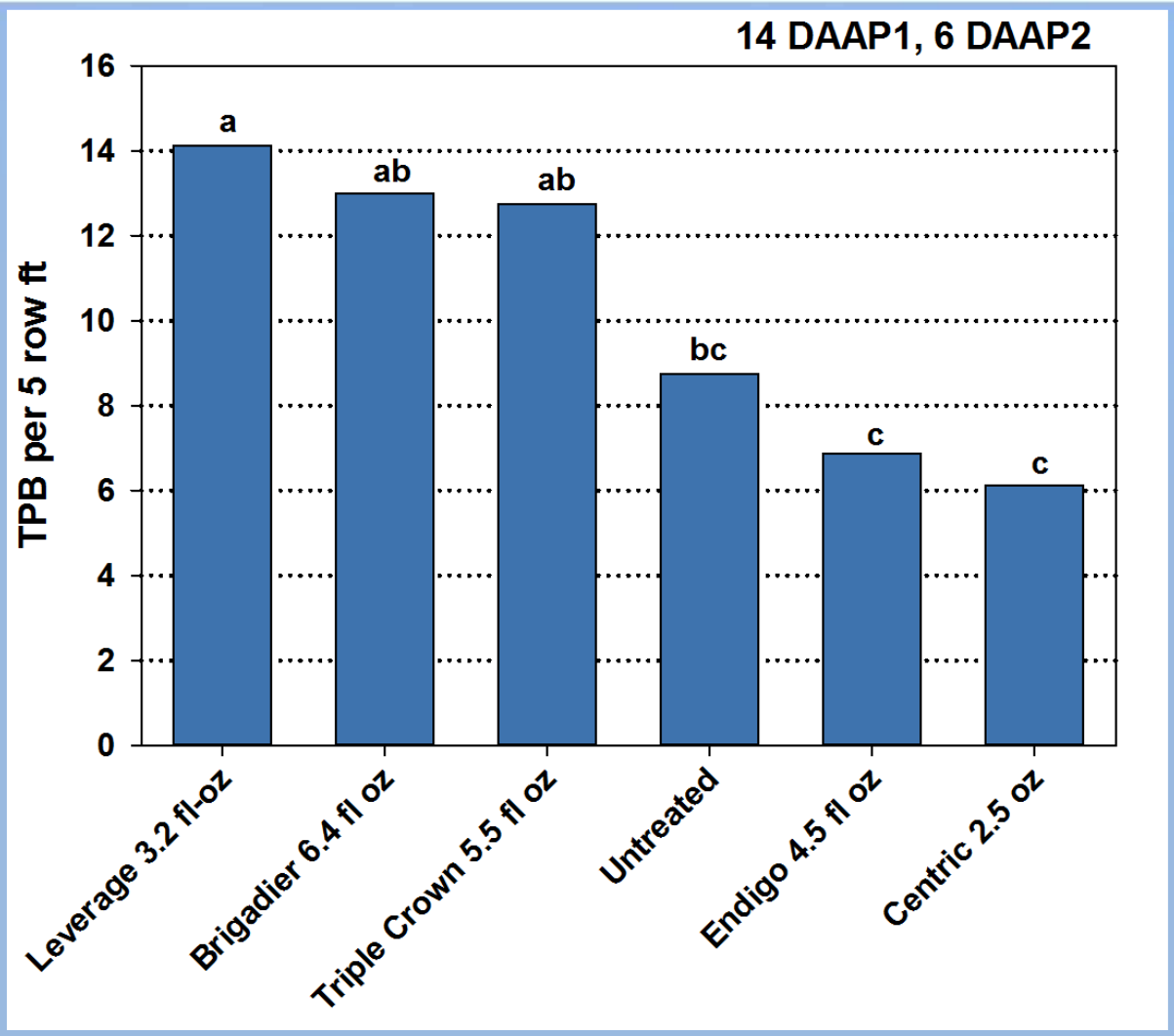
Acephate is a different story.

Acephate is a know esterase inhibitor and will synergize the efficacy of pesticides subjected to esterase degradation such as pyrethroids.

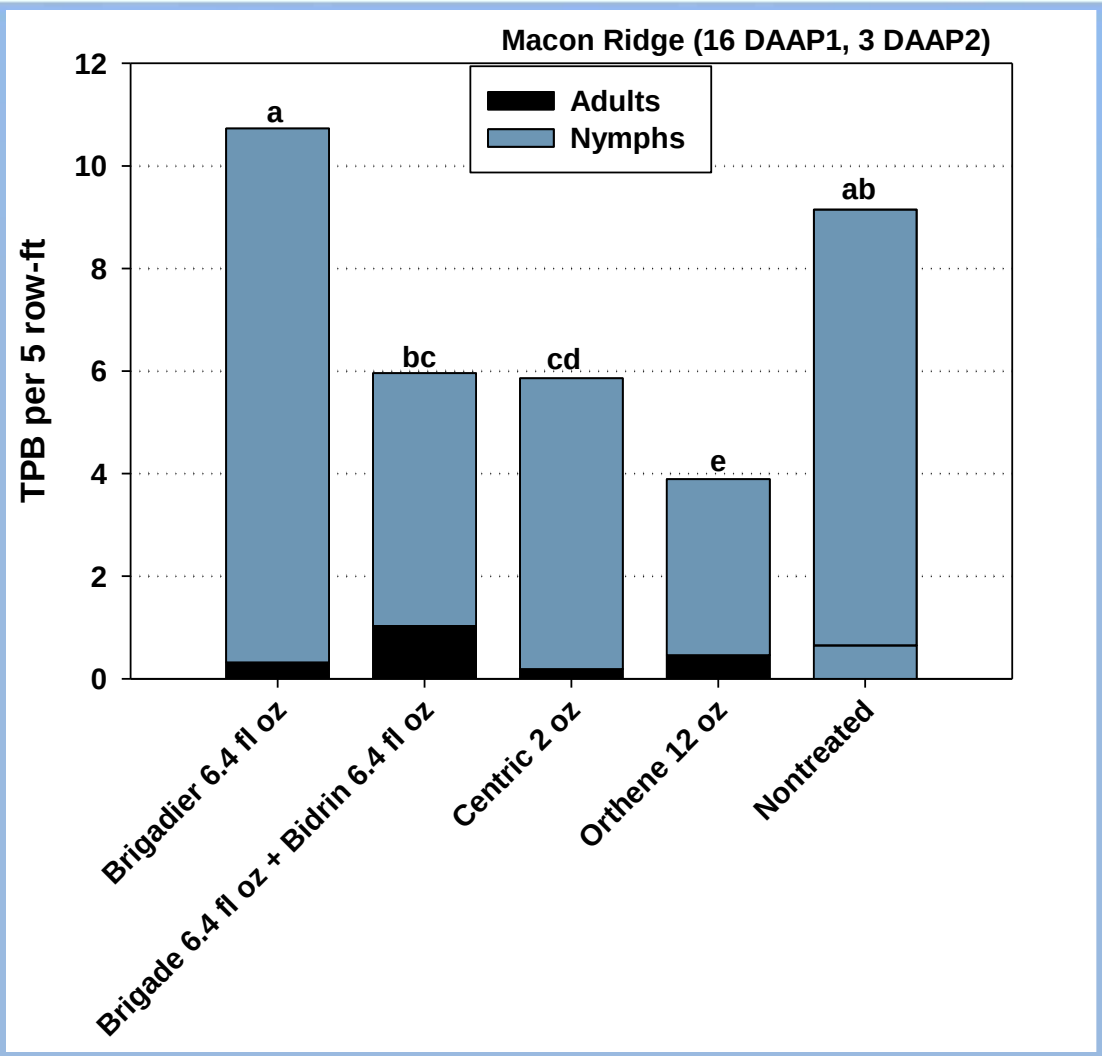
Tank mixes 2013



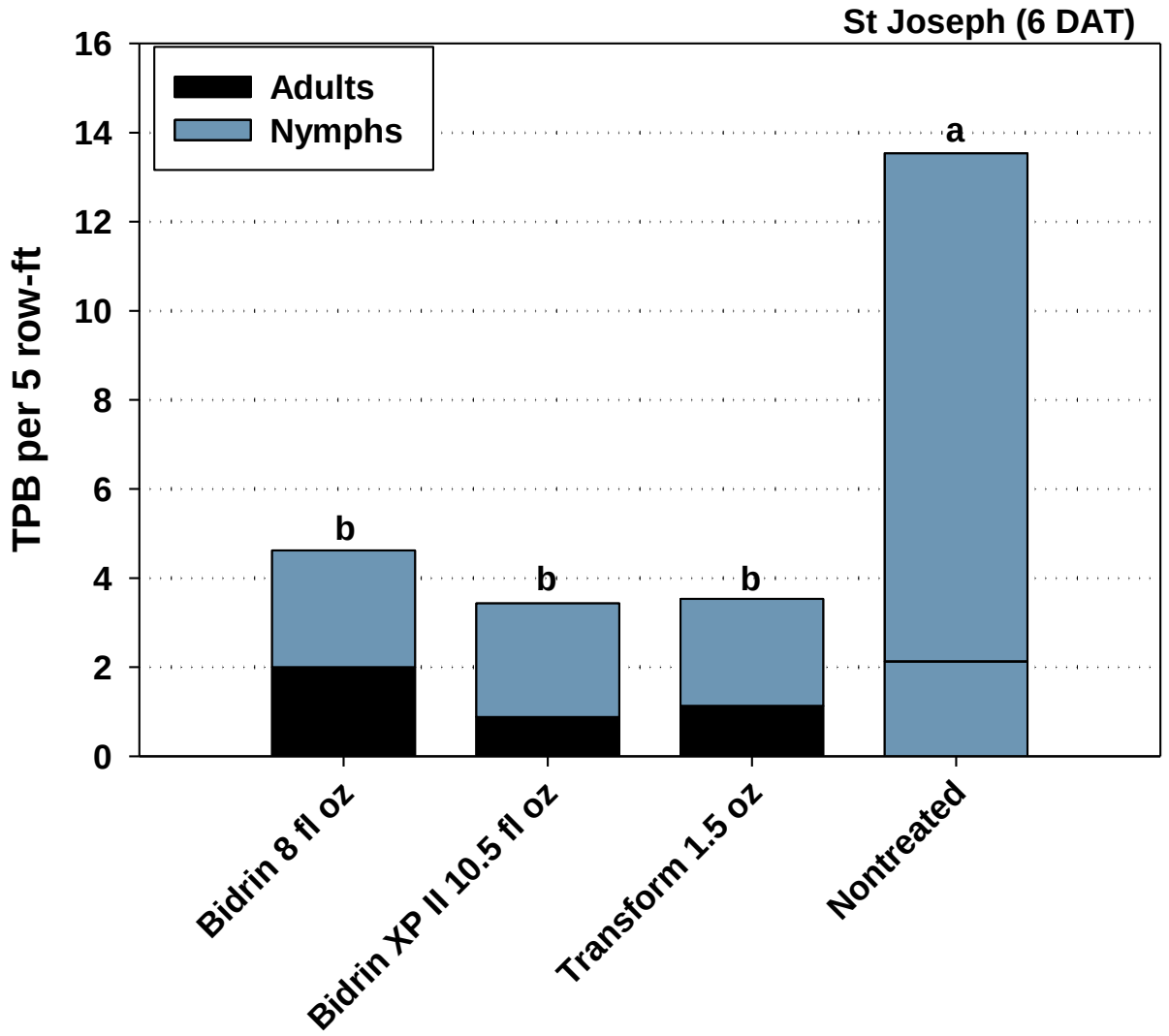
Neonicotinoid/Pyrethoids Mixtures



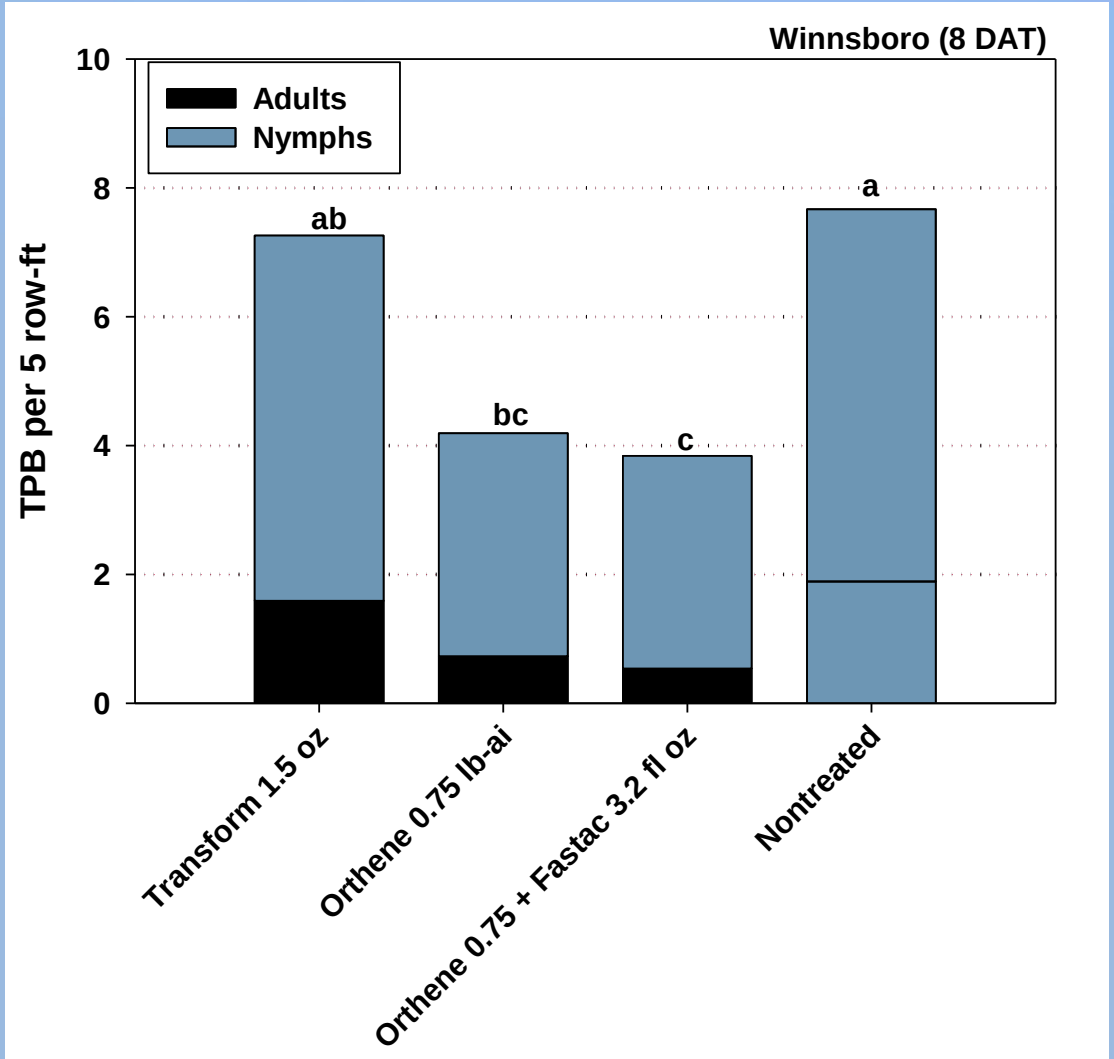
Neonicotinoid/Pyrethoids Mixtures



Bidrin/Pyrethoids Mixtures

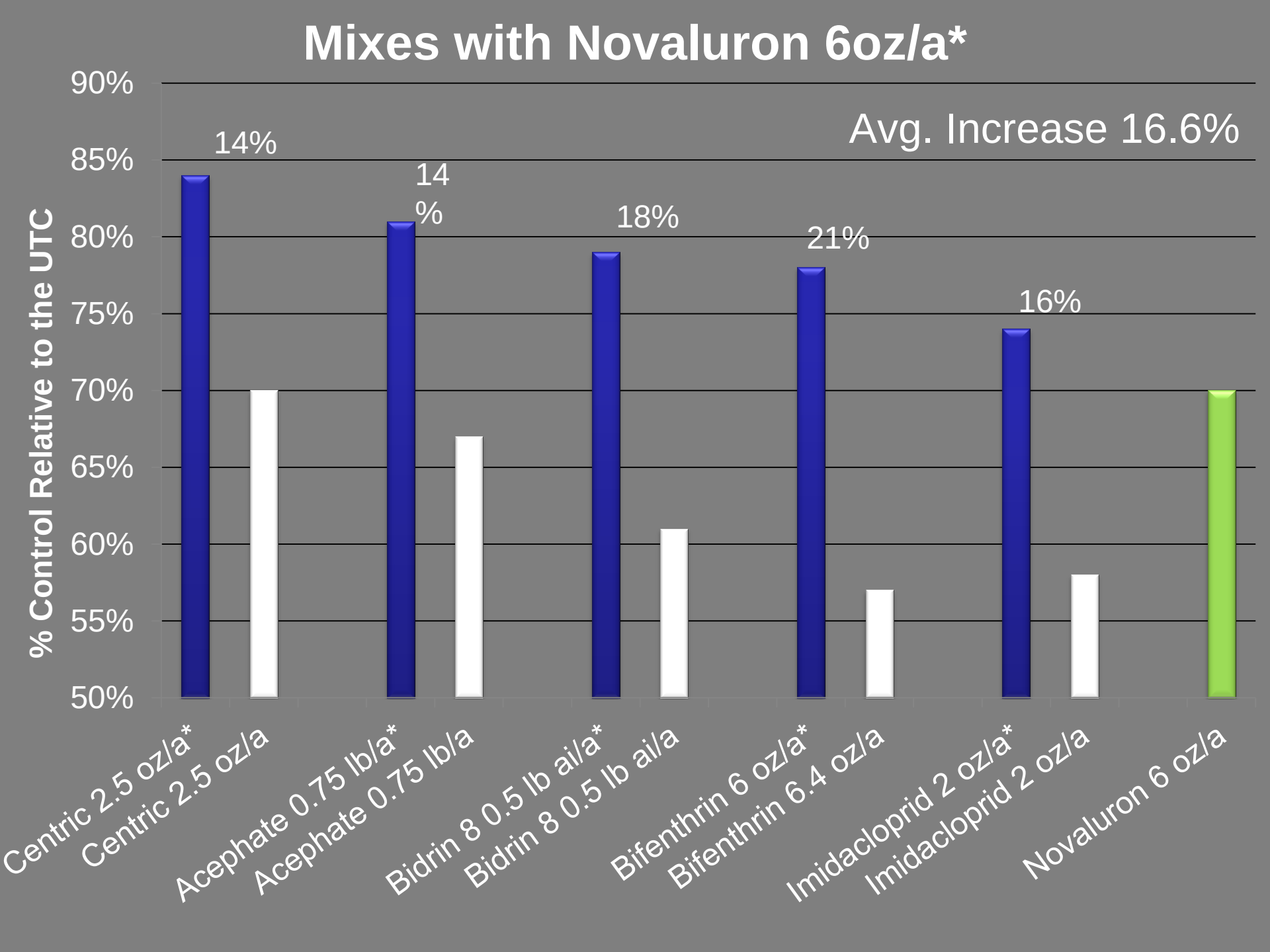


Acephate/Pyrethoids Mixtures



Mixes that Make Sense

- Multiple pests targeted
- An out of control plant bug population
- Mixes with Diamond


Mixes with Novaluron 6oz/a*
Avg. Increase 16.6%
% Control Relative to the UTC
90%
85%
80%
75%
70%
65%
60%
55%
50%
14%
14 %
18%
21%
16%
Centric 2.5 oz/a*
Centric 2.5 oz/a
Acephate 0.75 lb/a*
Acephate 0.75 lb/a
Bidrin 8 0.5 lb ai/a*
Bidrin 8 0.5 lb ai/a
Bifenthrin 6 oz/a*
Bifenthrin 6.4 oz/a
Imidacloprid 2 oz/a*
Imidacloprid 2 oz/a
Novaluron 6 oz/a

Insecticide Application Timings for Tarnished Plant Bug

- **Diamond every other application**
- **Delay as long as possible: Acephate, Bidrin, pyrethroids**
- **Avoid consecutive shots of same AI**
- **Shorten spray interval to ~5 days**

- Centric
- Transform
- Belay
- Carbine
- ± Diamond

- Centric
- Transform
- Belay
- Bidrin
- Acephate
- ± Diamond
- ± Pyrethroid

- Transform
- Bidrin
- Acephate ± Pyrethroid
- Malathion + Pyrethroid ULV

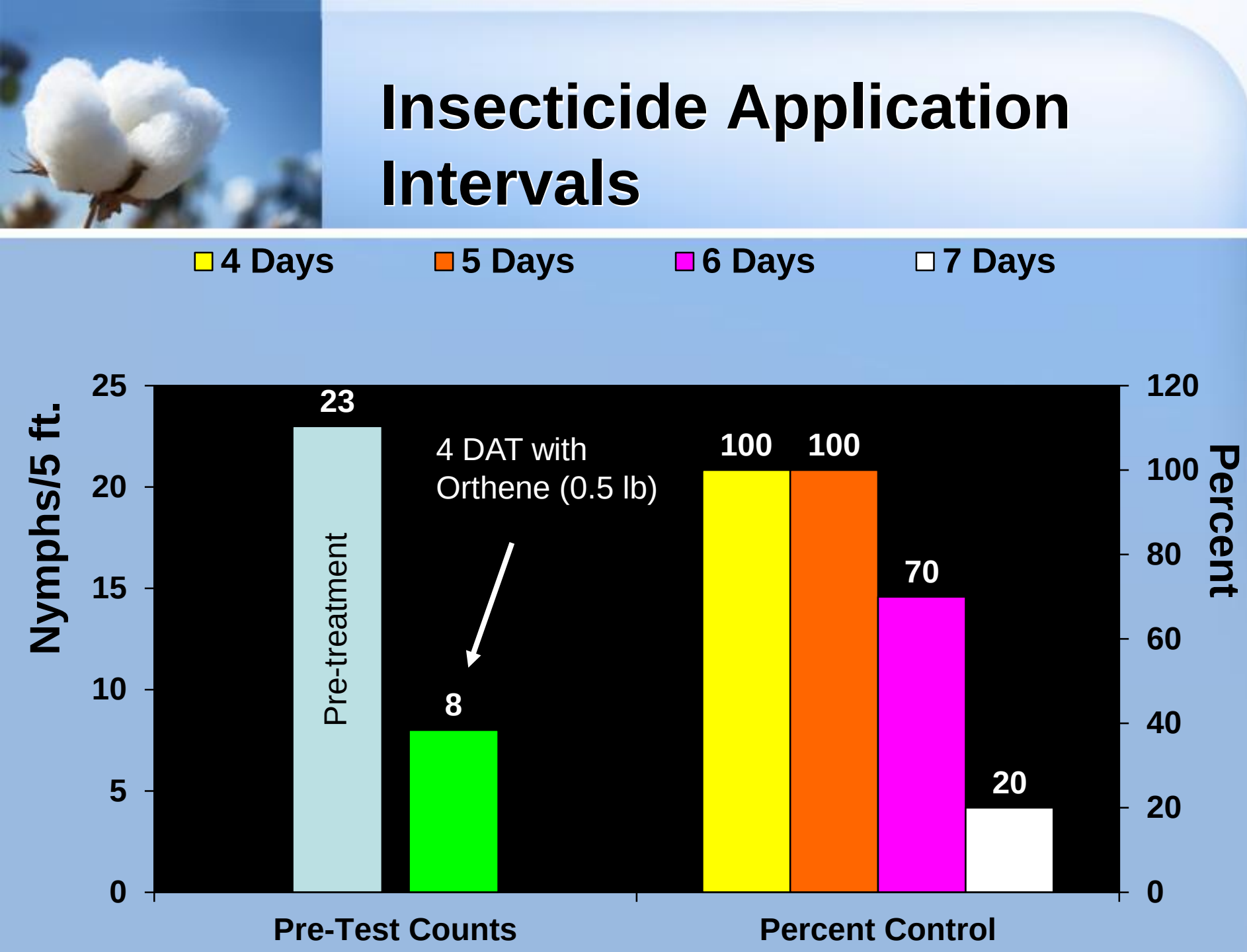
Apl
Not a huge concern

Aphids in this window
Greater injury potential

Planting | 1st Square | 1st Flower | Peak Flower | Cutout

~May 1 | ~June 1 | ~July 1 | ~July 21 | ~Aug 15

Insecticide Application Intervals



Questions?

Research Supported by:

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