

What We Have Learned From an Entomological Perspective



2019 Row Crop Short Course
Mississippi State University

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Aphids Colonizing Cotton in the U.S.

Cotton aphid



Cowpea aphid



Green peach aphid



Corn root aphid



Rice Root Aphid



Potato aphid



Black bean aphid



Bean root aphid



Aphid Vectors of CLRDV

- **Preliminary results from 2019**
 - What aphid species are present in cotton agroecosystems?
 - When is virus spread occurring?
 - Are young crops more susceptible to disease caused by CLRDV?
- **Virus spread by aphids**
- **What we have learned in 2019**

Objectives

1. Determine whether or not aphid management practices reduce final incidence of CLRDV.
2. Monitor aphid dispersal into cotton plots to identify timing of flights, and the species of aphids present in cotton agroecosystems.
3. Identify timing of primary spread of CLRDV into research plots.

Weekly monitoring of aphids and virus spread

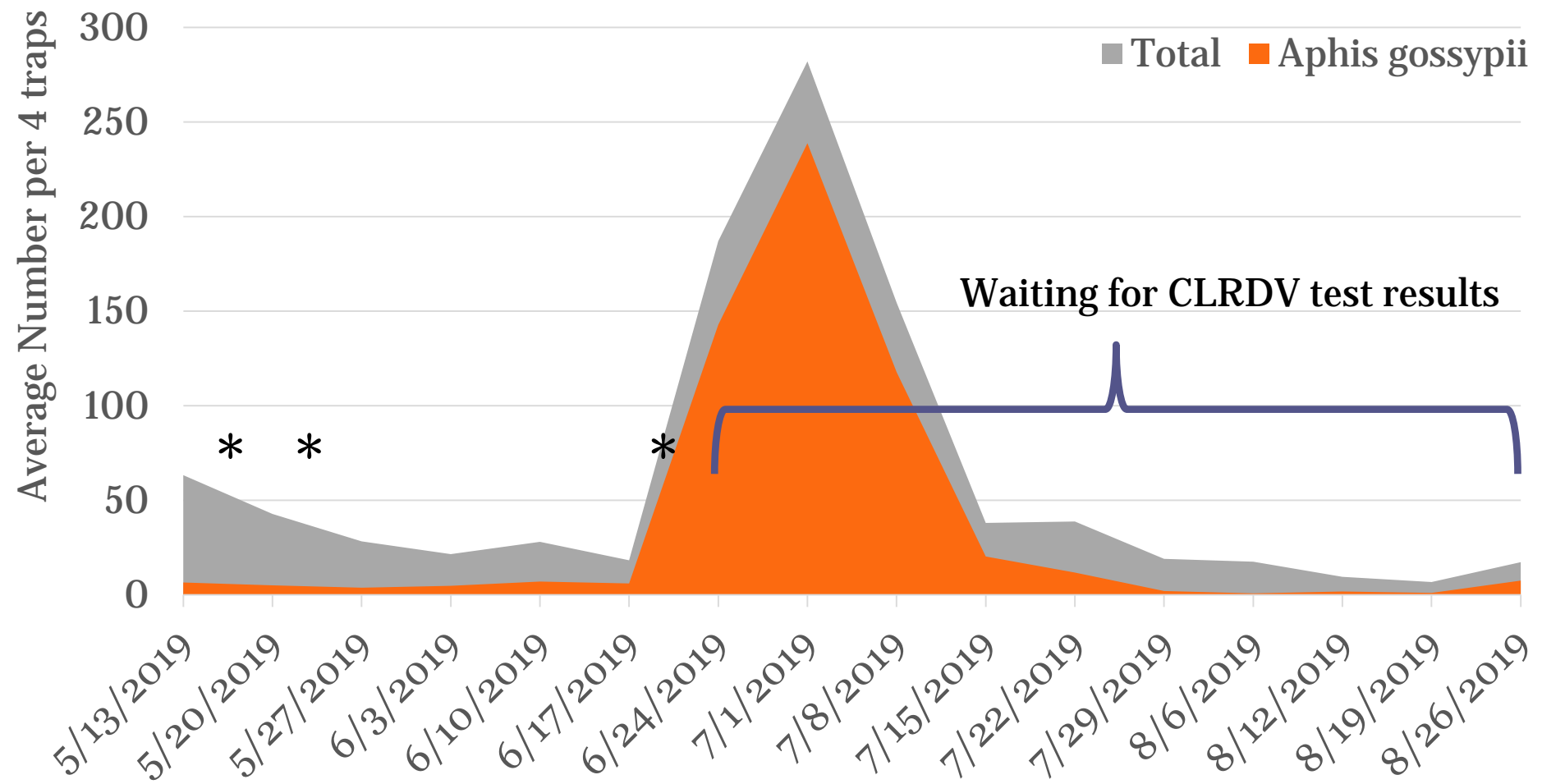
Sentinel Plants

2-3 true-leaf cotton



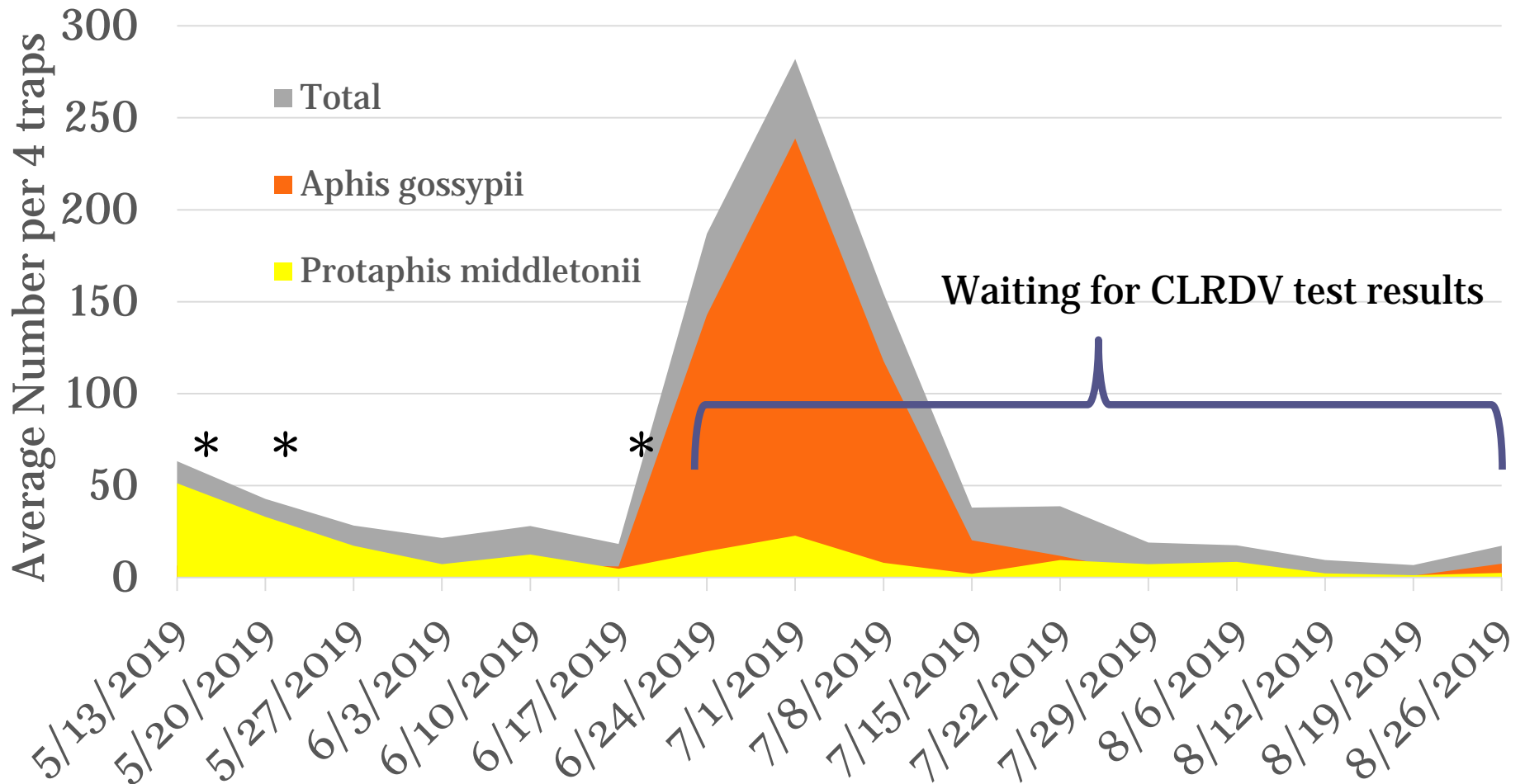
- Placed in field borders
- Plants collected and replaced weekly
- Conducted 1 week after plant until end of August

2019 Aphid Trapping and Sentinel Plants Brewton, AL



**Sentinel plants tested positive for CLRDV*

2019 Aphid Trapping and Sentinel Plants Brewton, AL



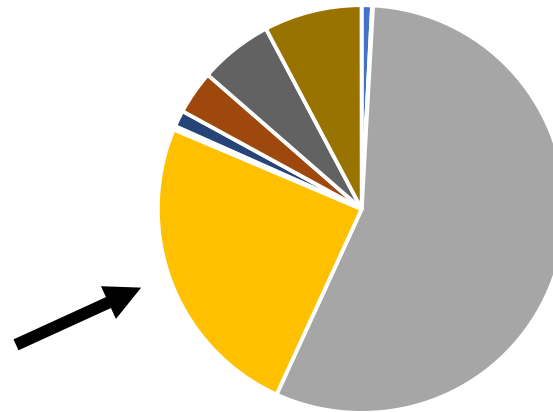
**Sentinel plants tested positive for CLRDV*

Weekly monitoring of aphids and virus spread



Corn root aphid

Brewton, Alabama
4,194 aphids



Results

- Methods to monitor virus spread were successful.
- All 8 species of aphids reported from cotton were detected.
- Cotton aphid was the predominant species.
- Low numbers of cowpea aphid and green peach aphid.
- Virus spread was detected during the first week of monitoring May 13-20.
 - Suggests other vector species may be present

Cage Study

Plant Date x Timing of Infection



Planted May 30, 2019

Shorter, AL

Cage Study

Plant Date x Timing of Infection

- **Experimental Treatments:**

1. No Aphids
2. Non-Viruliferous Aphids
3. Week 1 release of viruliferous aphids
4. Week 2 release of viruliferous aphids
5. Week 3 release of viruliferous aphids

Cage Study

Plant Date x Timing of Infection



Week 1 – 6/19/19

- 3 weeks after plant
- 3-4 true-leaf stage

Week 2 – 6/24/2019

- 4 weeks after plant
- 5-7 true-leaf stage

Week 3 – 7/3/2019

- 5 weeks after plant
- 1st pinhead square

*80-100% of plants infested 1 week after infestation
25-363 aphids per plant*

Cage Study

Plant Date x Timing of Infection



- Insecticide sprayed 2 weeks after infestation
- Cages removed 8 weeks after plant
- Plant mapping and symptom monitoring began

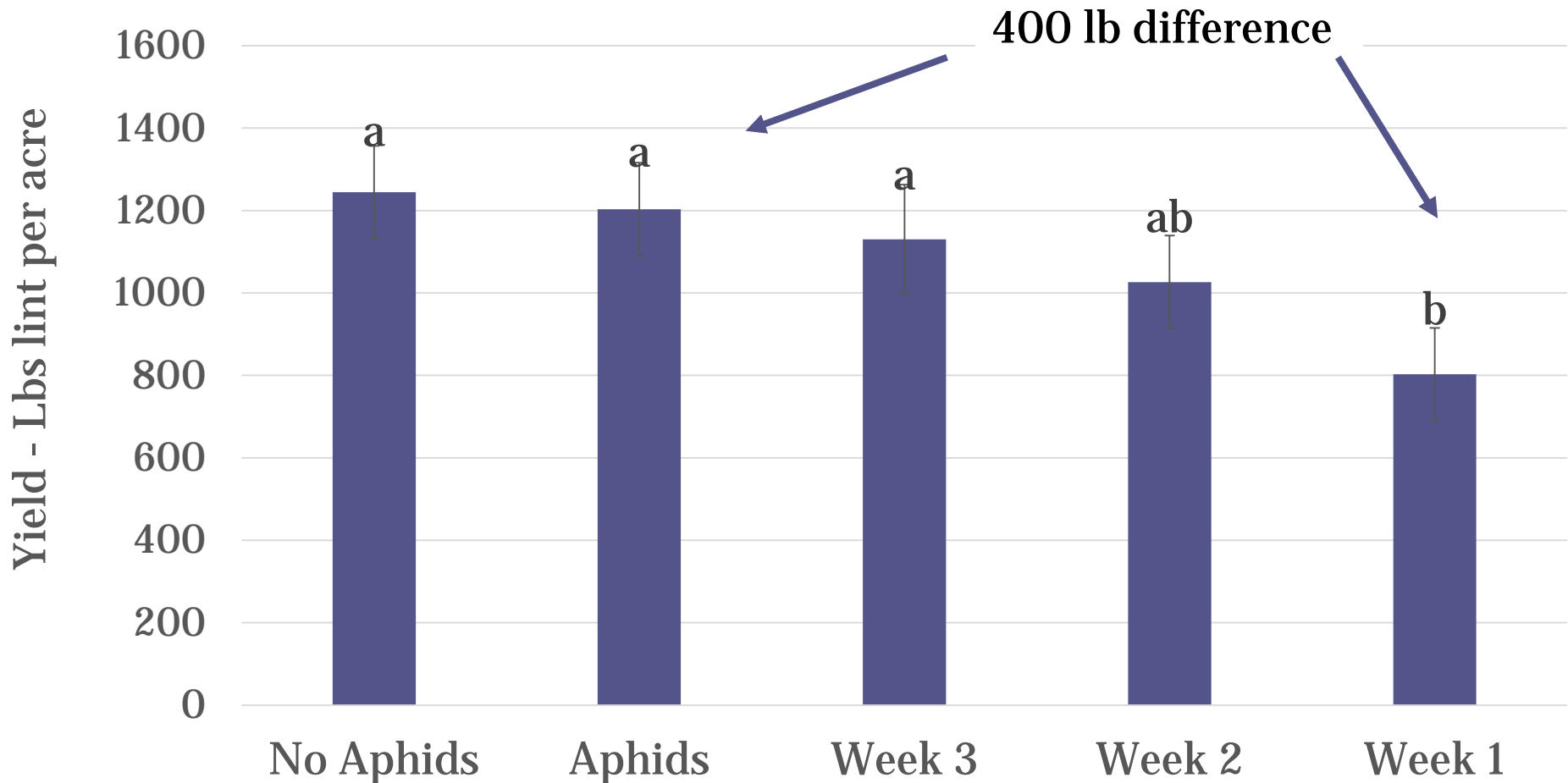
Cage Study

Marked plants for repeated measures assessments:

- **Plant Mapping**
 - Weekly after cages removed
 - 1st and 2nd position
 - Symptoms
- **Virus confirmation for marked plants**
 - Infection of 20-100% of plants by lab aphids
 - Up to 10% infection in control plots = virus spread after cages removed.
 - 70-100% infection naturally at this location
- **Yield evaluated for each plot**



Yield Impact Caused by Timing of Virus Infection

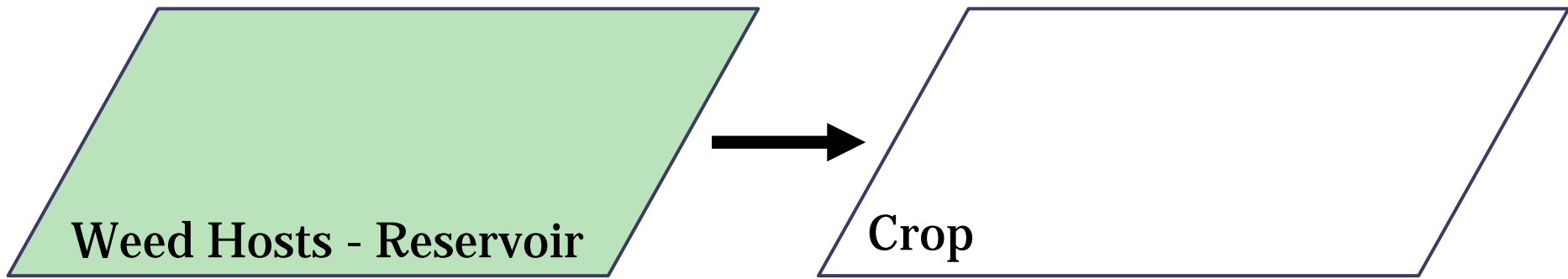


Results

- Yield loss increased as the age of cotton at the time of infection decreased.
- Yield loss was not due to a reduction in the number of bolls.
- Repeat in 2020



What we know about Key determinants of virus spread



- Number of vector species
- Transmission efficiency & mode of transmission
- Population size of vector species
- Amount of virus inoculum in landscape
- Seasonal population dynamics, timing of insect vector flights
- Distance of inoculum from crop

Mode of transmission for CLRDV

Brazil

Blue Disease - CLRDV

Acquisition:

- ?

Transmission:

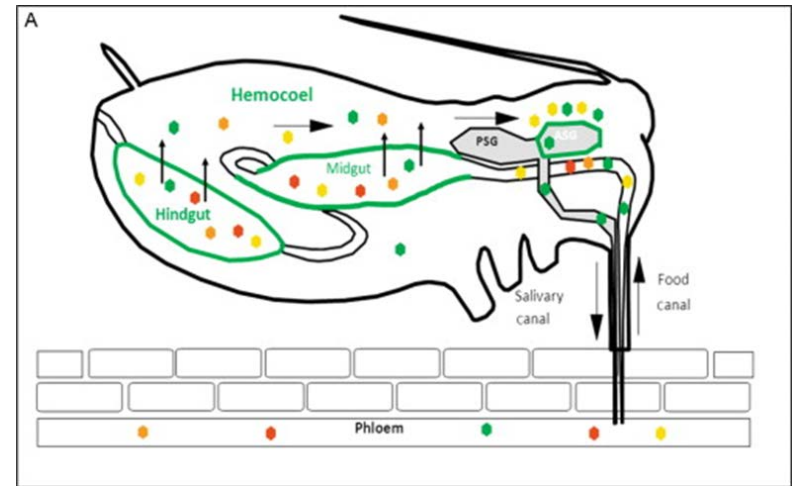
- Apterous – 1.5 hours
- **Alate – 40 seconds**

Increased with longer feeding

Duration:

- 12 days
- *Persistent*

Persistent & Circulative



****Experiments underway at
AU to confirm mode of
transmission***

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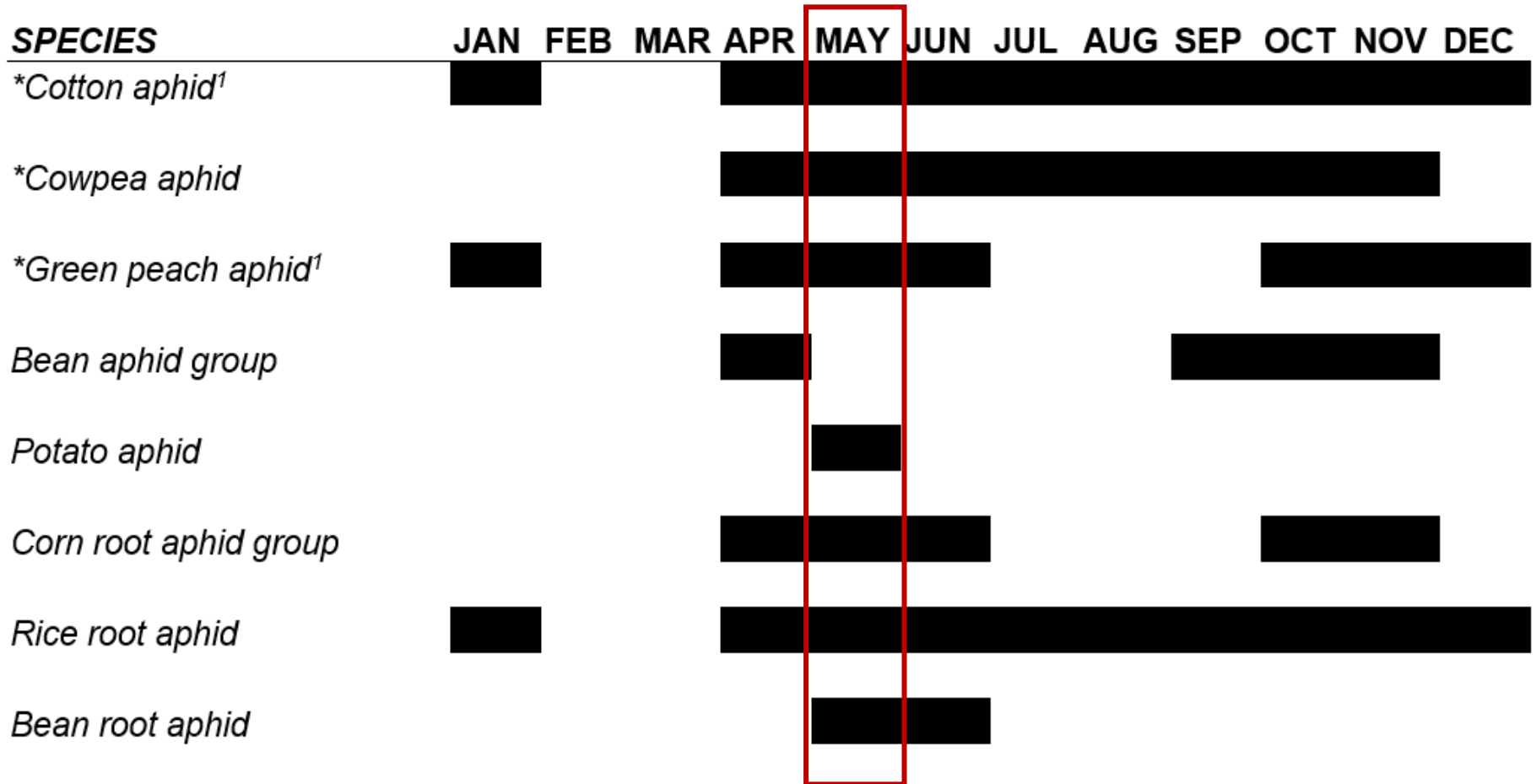


Bean root aphid



Aphids Colonizing Cotton in the U.S.

*Virus spread
began in May*

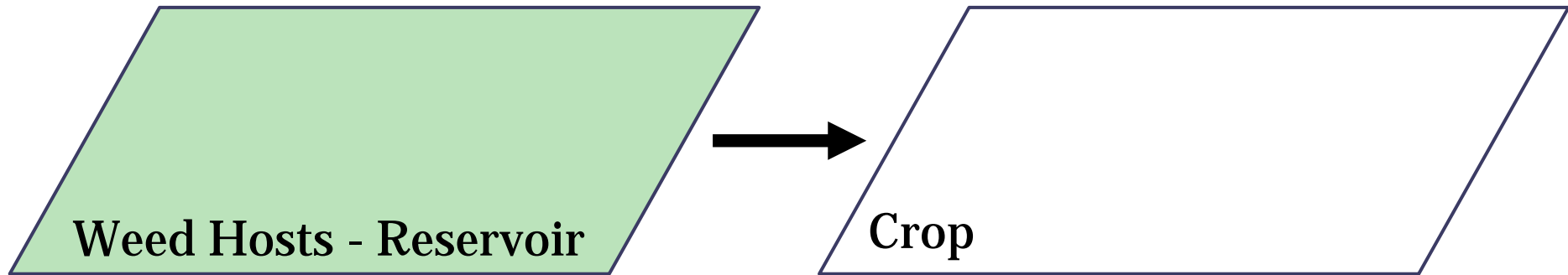


¹Males found, indicating aphid has a holocyclic life cycle.

*Reported vector of CLRDV

*Monitoring Conducted 1996-99
In Guntersville, AL by Kathy Flanders*

Key determinants of virus spread



- Number of vector species
- Transmission efficiency & mode of transmission
- Population size of vector species
- Amount of virus inoculum in landscape
- Seasonal population dynamics, timing of insect vector flights
- Distance of inoculum from crop

CLRDV - *Full host range not understood*



Henbit deadnettle



Evening primrose



White Clover



Carpetweed



Lespedeza spp.



Perennial Peanut

November 2, 2019 - Every plant had regrowth with aphids

$$\begin{aligned} &= 30,000 \text{ plants/A} \times 5 \text{ aphids/plant} \times 150 \text{ A} \\ &= 22,500,000 \text{ aphids} \end{aligned}$$



***Increase of overwintering
vector populations***

***Increases number infected
plants in reservoir***

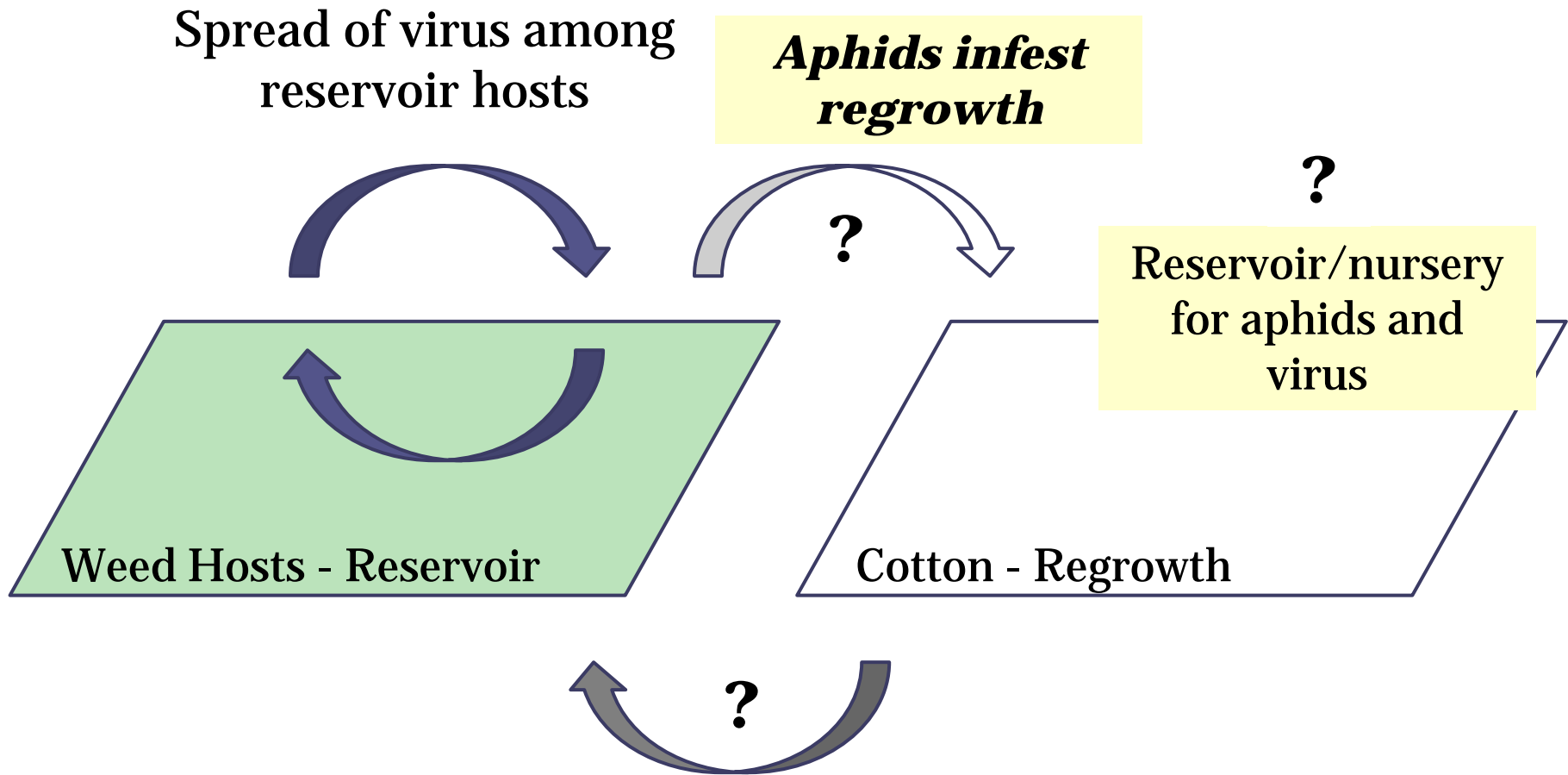
Virus Reservoirs - Host Ranges

Aphids infesting cotton have broad host ranges:

- **Cotton Aphid, 135 plant families**
- *Cowpea Aphid, 80 plant families
- *Green peach Aphid, 130 plant families
- *Corn Root Aphid, 11 plant families
- *Black Bean Aphid, 120 plant families
- *Potato Aphid, 90 plant families
- *Rice Root Aphid, 22 plant families
- *Bean Root Aphid, 35 plant families

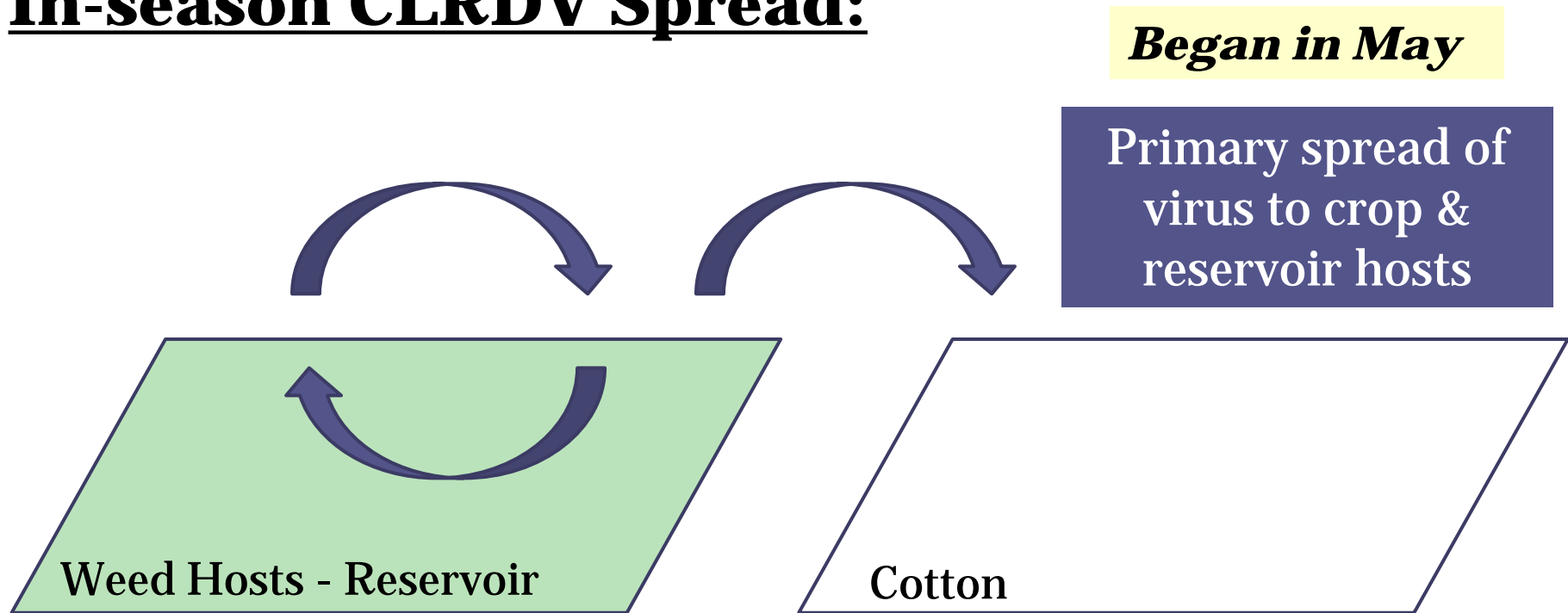
**Vector status of these species in the US is unknown*

Pre-season CLRDV Spread:



Spread of virus from cotton re-growth to reservoir

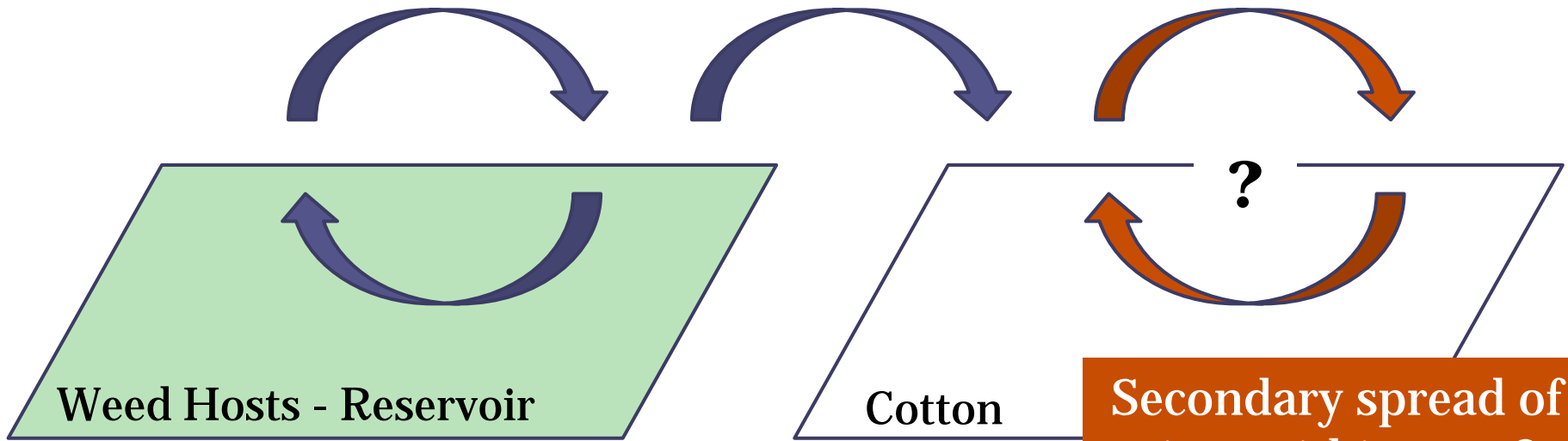
In-season CLRDV Spread:



- Distance of reservoir from crop – spread decreases as distance from source increases.
 - Aphids known to disperse long distances
 - CLRDV persists in vector for 12 days, which increases the potential for long-distance spread.

In-season:

Primary spread of virus to crop & reservoir hosts

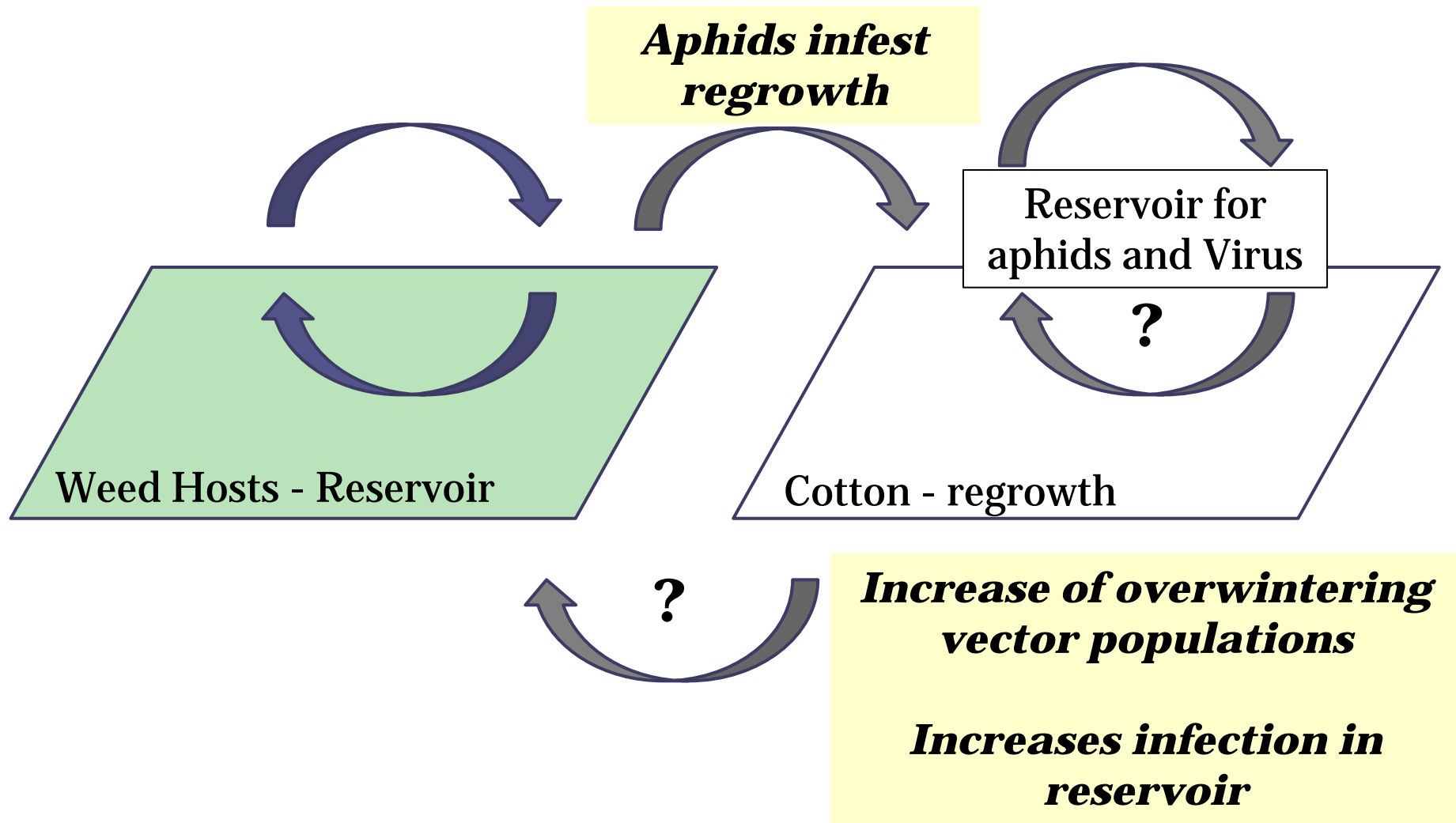


Secondary spread of virus within crop?

Spread of virus to reservoir hosts

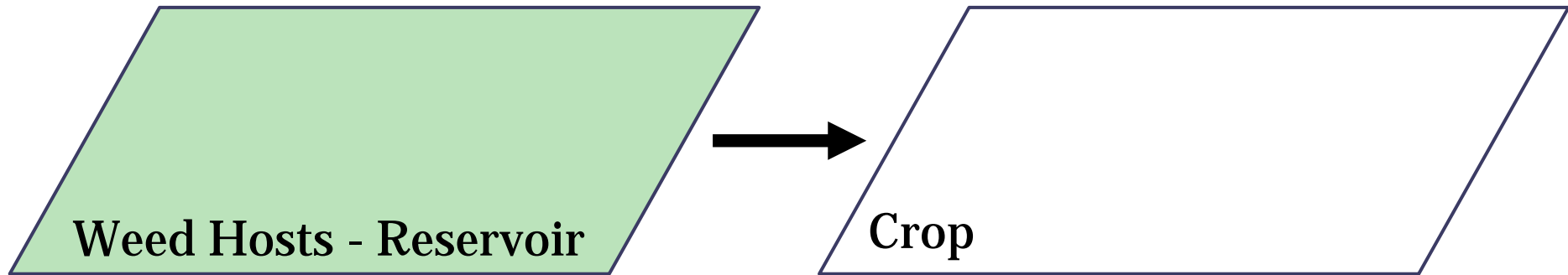
Never zeroed out aphids with repeated insecticide applications

Post-harvest CLRDV Spread:



Spread of virus from cotton re-growth to reservoir

Characterizing risk of CLRDV & CLRDD



- Knowledge of epidemiology is key for understanding risk of CLRDV **spread** to cotton and potential interventions.
- Knowledge of virus – vector – plant – environment interactions key for understanding risk of **disease** caused by CLRDV.

2019 Results & Future Directions

- **Aphids**

- Higher infestations in south AL, fewer managed fields north AL
- Aphid management does not reduce virus incidence
- Cotton aphid transmits CLRDV in US.
- *Other vectors may be present*

- **Virus**

- Ubiquitous in landscape
- Spread detected mid-May
- Detected in common weed hosts & in low production areas
- Higher incidence in south AL than north AL – how much of this influenced by vector distribution & abundance vs reservoir hosts?
- Need to determine whether agronomic practices can reduce inoculum

2019 Results & Future Directions

- **Disease**
 - Symptoms highly variable
 - Higher risk when young plants are infected
 - Yield impact – reduction in bolls
 - Yield impacts - reduction in lint
- **Need to identify interactions that increase disease risk:**
 - Virus spread and crop age
 - Variety & virus infection
 - Crop stress and disease
 - Abiotic factors

Acknowledgements

- Jacobson Lab: Counted 172,169 cotton aphids



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COTTON INCORPORATED

