Cotton Integrated Pest Management Research in Texas: Generating Ecologically-Based Information

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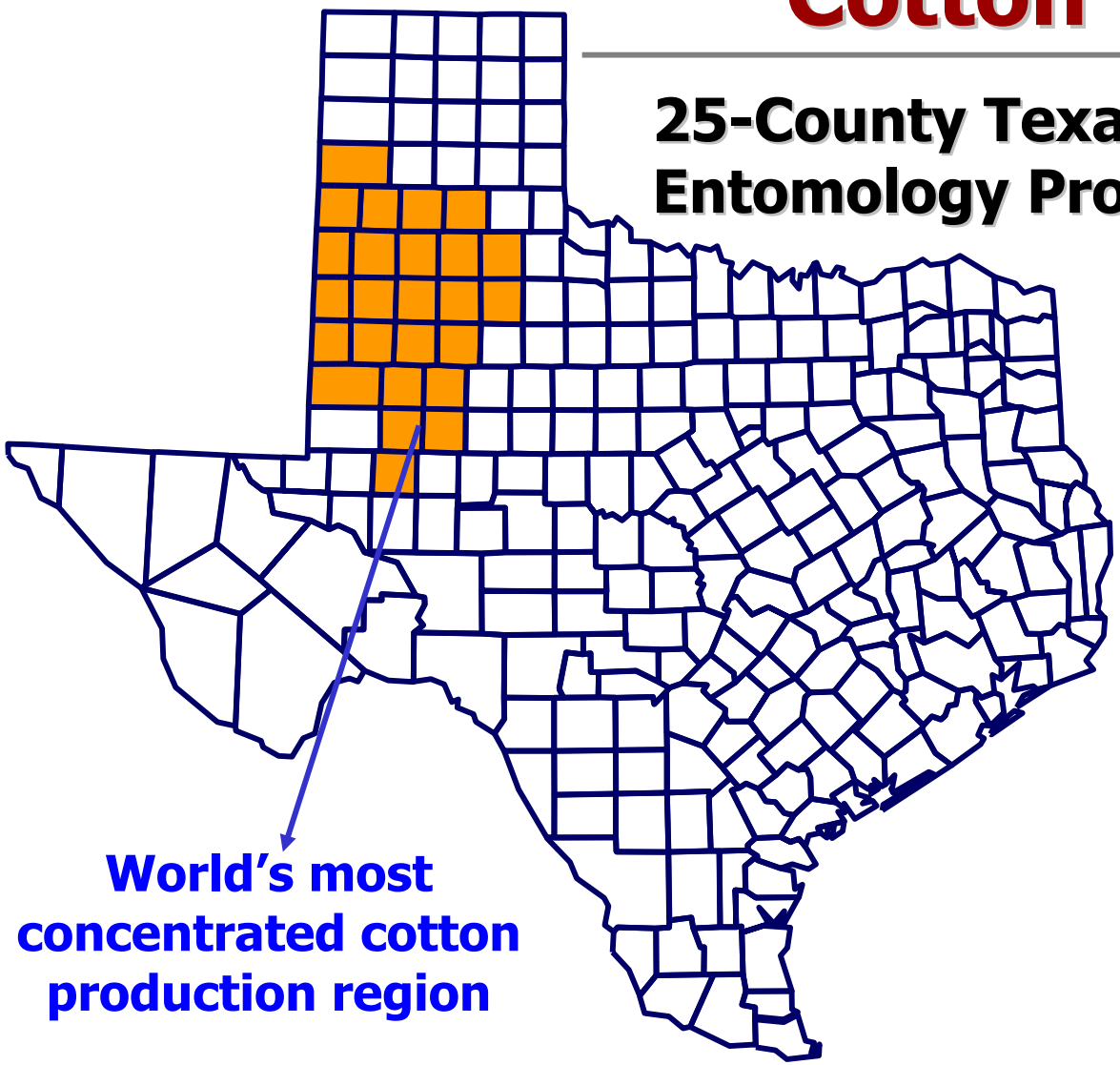
St. Louis, MO

Scope of Research in TX as a Cotton Entomologist

25-County Texas High Plains; PCG/Cotton Entomology Program Service Area



Base acres: 3.0 million

Lint harvest: 4.0 million bales

Farm level value: >$1 Billion

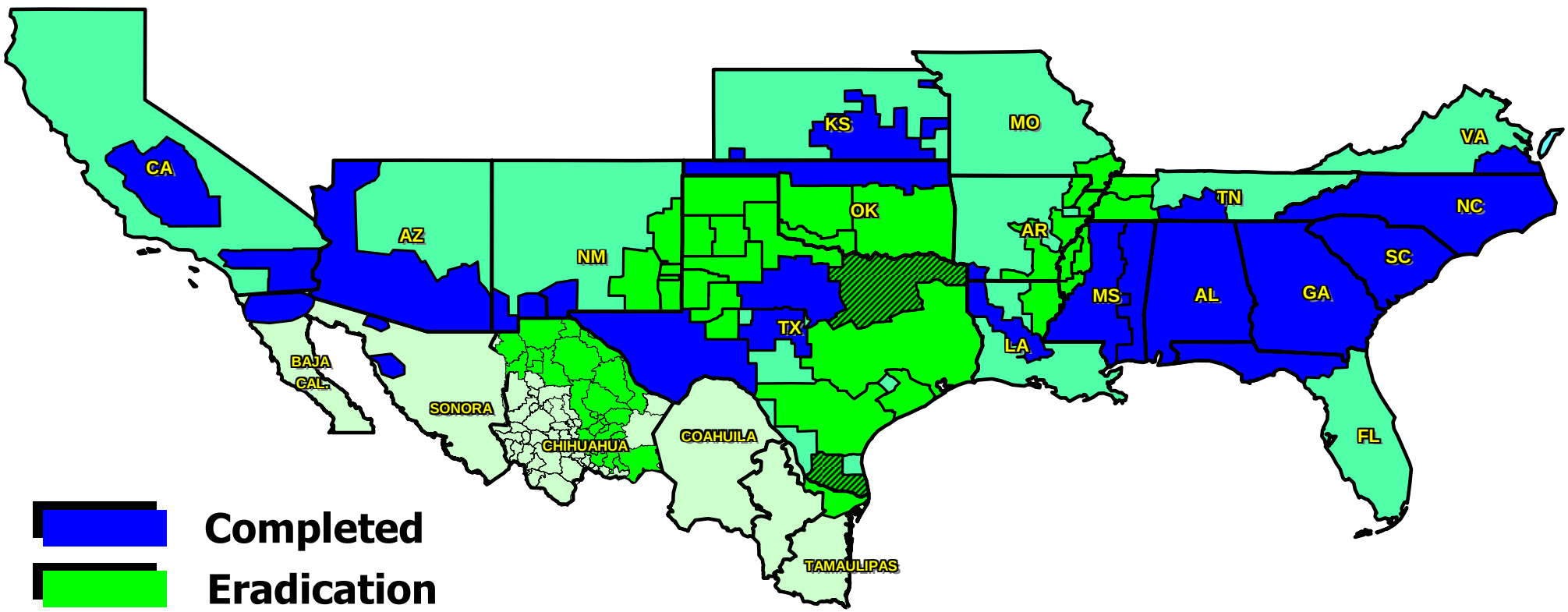
High Plains Cotton Production

60% of Texas

25% of the U.S.

5% of the world!

Boll Weevil Eradication in the U.S.
2005 Update



El-Lissy, USDA-APHIS, 2005

Transition to Post Boll Weevil Era

- Still heavily relying on insecticides to manage cotton arthropods, augmented by use of IPM.
- *Lygus* bugs are perceived as emerging pest problem.
- Adoption of transgenic Bollgard technology in the Texas High Plains is in the rise (15%).
- Natural enemy complex; alternate habitats.
- General shift in production technology (cultivar, herbicide, tillage, irrigation).

Opportunities to use cultural and biological approaches to pest management.

Progress (last 4-5 years)

1. Cotton aphid population dynamics modeling.
2. Developing a natural enemy decision-rule system.
3. Economic evaluation of Bollgard cotton.
4. Site-specific management of cotton arthropods.
5. Areawide monitoring of bollworms, tobacco budworms, and beet armyworms.
6. Conservation tillage and cotton insects.
7. Ecology and behavior of *Lygus* bugs.

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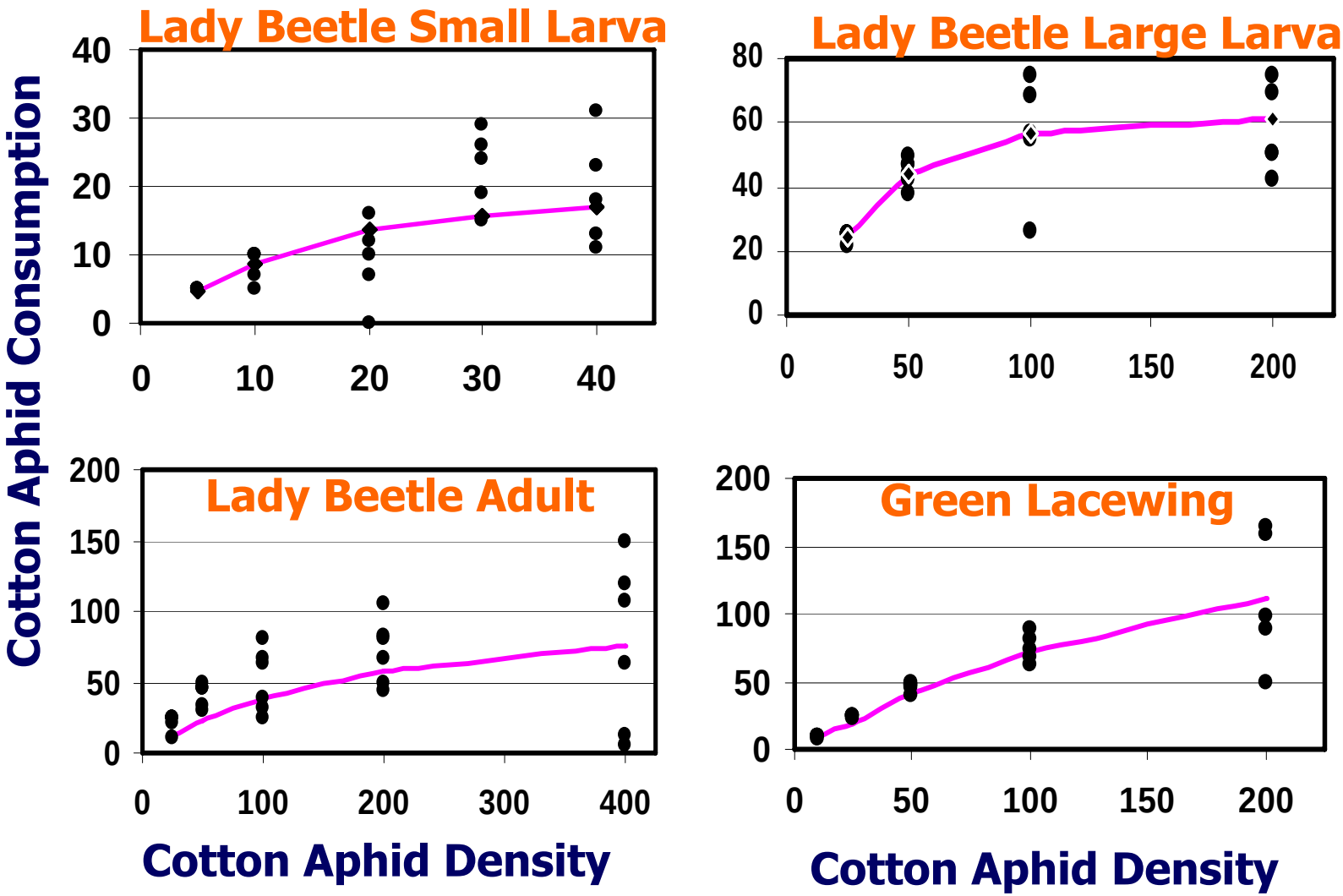
7. **Ecology and behavior of *Lygus* bugs.**

1. Cotton Aphid Population Dynamics Modeling

- Fecundity
- Survivorship
- Temperature
- Photoperiod
- Nutrition
- Predation
- Crowding

2. Developing a Natural Enemy Decision-Rule System



Cotton Aphid Suppression

Field Cage Study

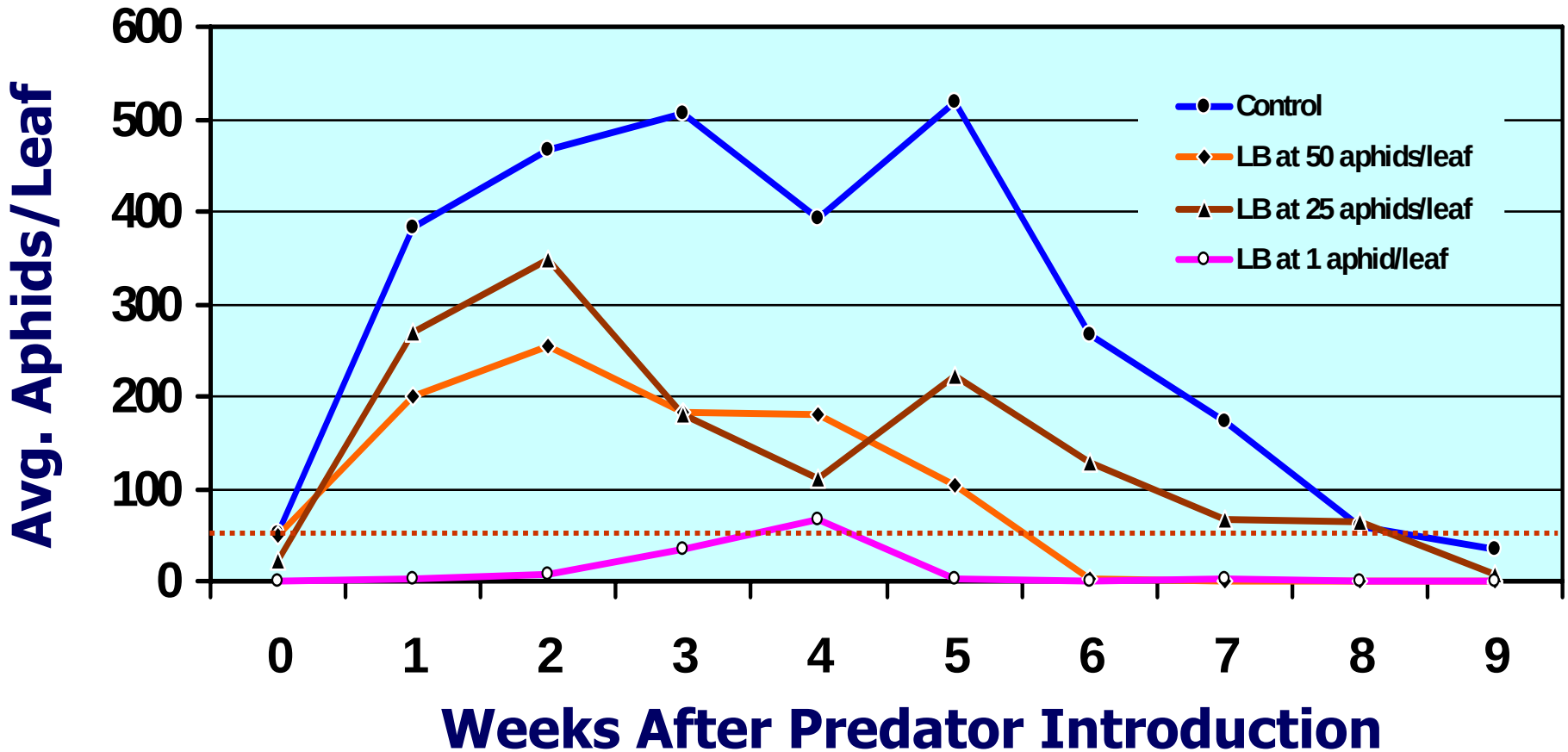
Effectiveness at:

1 aphid/leaf (1 LB/Plant)

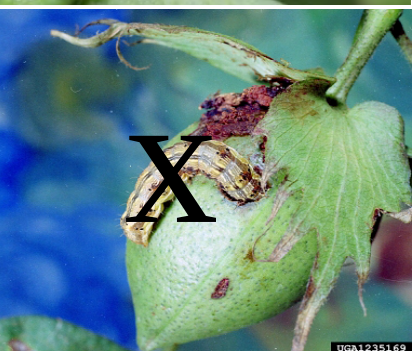
25 aphids/leaf (3 LB/Plant)

50 aphids/leaf (6 LB/Plant)

Aphid Population Suppression by Convergent Lady Beetle Larva in Cages, Lubbock, July-August, 2003



Economic Threshold: 50 aphids/leaf for two weeks



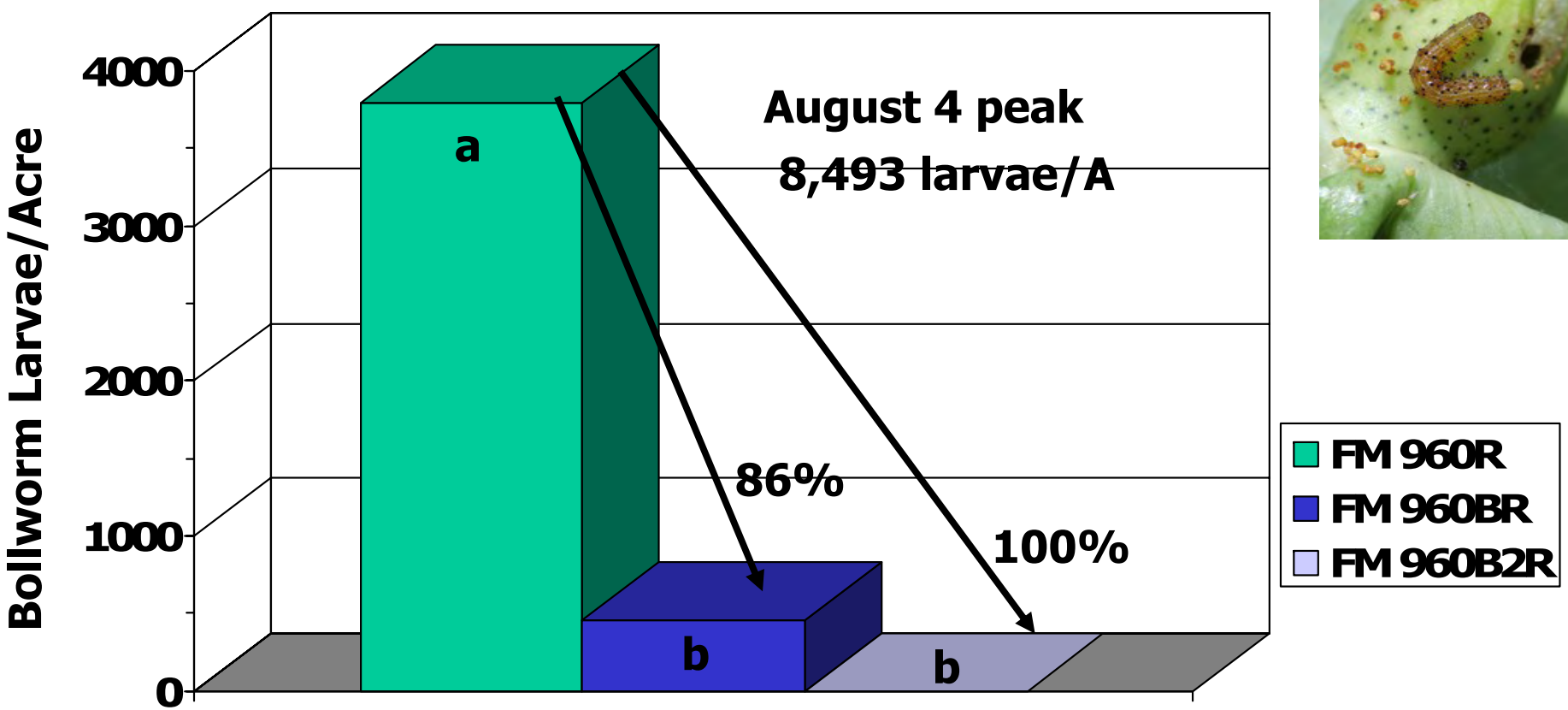
3. Economic Evaluation of Bollgard Cotton for the Texas High Plains

- Two locations
  - Idalou
  - Halfway
- Three cultivars
  - Roundup Ready
  - Bollgard
  - Bollgard II

Bollgard Technology Evaluation, Untreated Cotton, Idalou, TX 2004

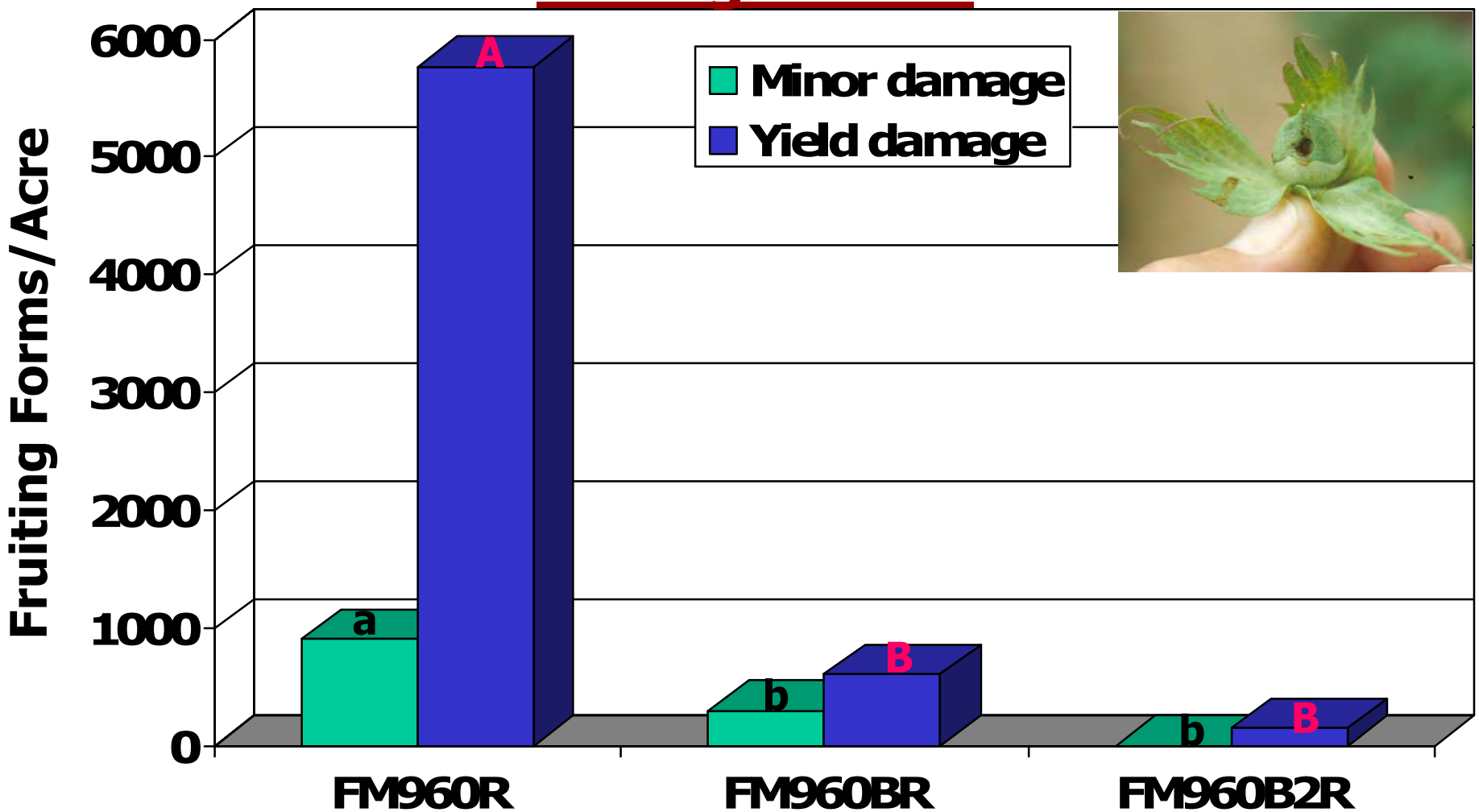
Bollworm larvae >3 days old

Season average



Bollgard Technology Evaluation, Untreated Cotton, Idalou, TX 2004

Damaged bolls

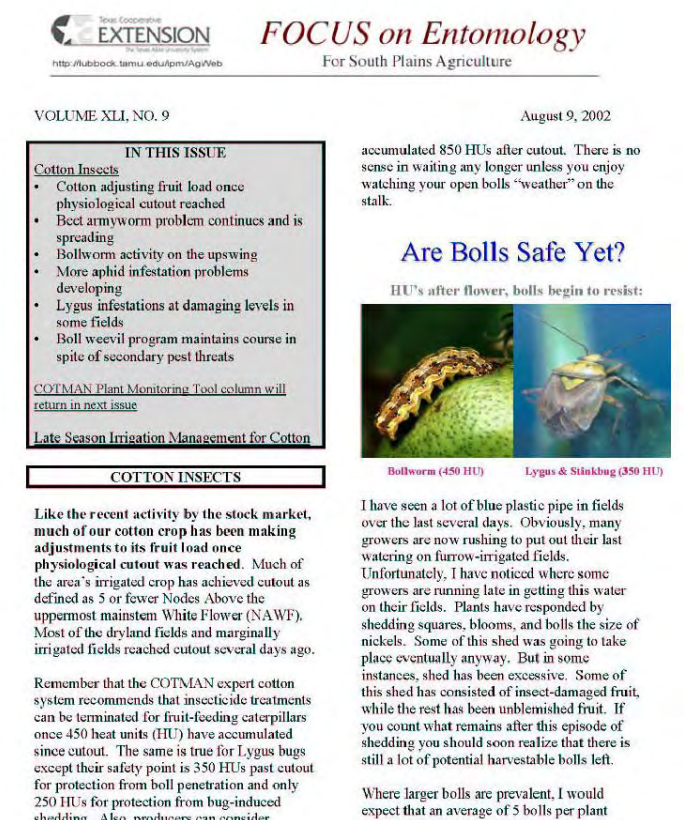


Is Bollgard Technology Fit for the Texas High Plains?

- **Both Bollgard and Bollgard II control bollworms around our threshold of 10,000 small larvae per acre.**
- **Bollgard II is also effective against beet armyworms, fall armyworms, and pink bollworms.**
- **Bollgard technology is certainly a good pest management insurance policy (≈15% adoption).**

4. Site-Specific Management of Cotton Arthropods

5. Areawide Monitoring of Bollworm, Budworm, and Beet Armyworm Moths



Texas Cooperative EXTENSION
http://lubbock.tamu.edu/ipm/AgriWeb

FOCUS on Entomology
For South Plains Agriculture

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IN THIS ISSUE

Cotton Insects
- Cotton adjusting fruit load once physiological cutout reached
- Beet armyworm problem continues and is spreading
- Bollworm activity on the upswing
- More aphid infestation problems developing
- Lygus infestations at damaging levels in some fields
- Boll weevil program maintains course in spite of secondary pest threats

COTMAN Plant Monitoring Tool column will return in next issue

Late Season Irrigation Management for Cotton

COTTON INSECTS

Like the recent activity by the stock market, much of our cotton crop has been making adjustments to its fruit load once physiological cutout was reached. Much of the area's irrigated crop has achieved cutout as defined as 5 or fewer Nodes Above the uppermost mainstem White Flower (NAWF). Most of the dryland fields and marginally irrigated fields reached cutout several days ago.

Remember that the COTMAN expert cotton system recommends that insecticide treatments can be terminated for fruit-feeding caterpillars once 450 heat units (HU) have accumulated since cutout. The same is true for Lygus bugs except their safety point is 350 HUs past cutout for protection from boll penetration and only 250 HUs for protection from bug-induced shedding. Also, producers can consider accumulated 850 HUs after cutout. There is no sense in waiting any longer unless you enjoy watching your open bolls "weather" on the stalk.

Are Bolls Safe Yet?

HU's after flower, bolls begin to resist:

Bollworm (450 HU) Lygus & Stinkbug (350 HU)

I have seen a lot of blue plastic pipe in fields over the last several days. Obviously, many growers are now rushing to put out their last watering on furrow-irrigated fields. Unfortunately, I have noticed where some growers are running late in getting this water on their fields. Plants have responded by shedding squares, blooms, and bolls the size of nickels. Some of this shed was going to take place eventually anyway. But in some instances, shed has been excessive. Some of this shed has consisted of insect-damaged fruit, while the rest has been unblemished fruit. If you count what remains after this episode of shedding you should soon realize that there is still a lot of potential harvestable bolls left.

Where larger bolls are prevalent, I would expect that an average of 5 bolls per plant

- **Weekly survey of three counties throughout the year.**
- **Summary information provided to target clientele through the electronic newsletter *FOCUS* on Entomology.**

6. Conservation Tillage and Arthropod Management

7. Ecology and Behavior of *Lygus* Bugs

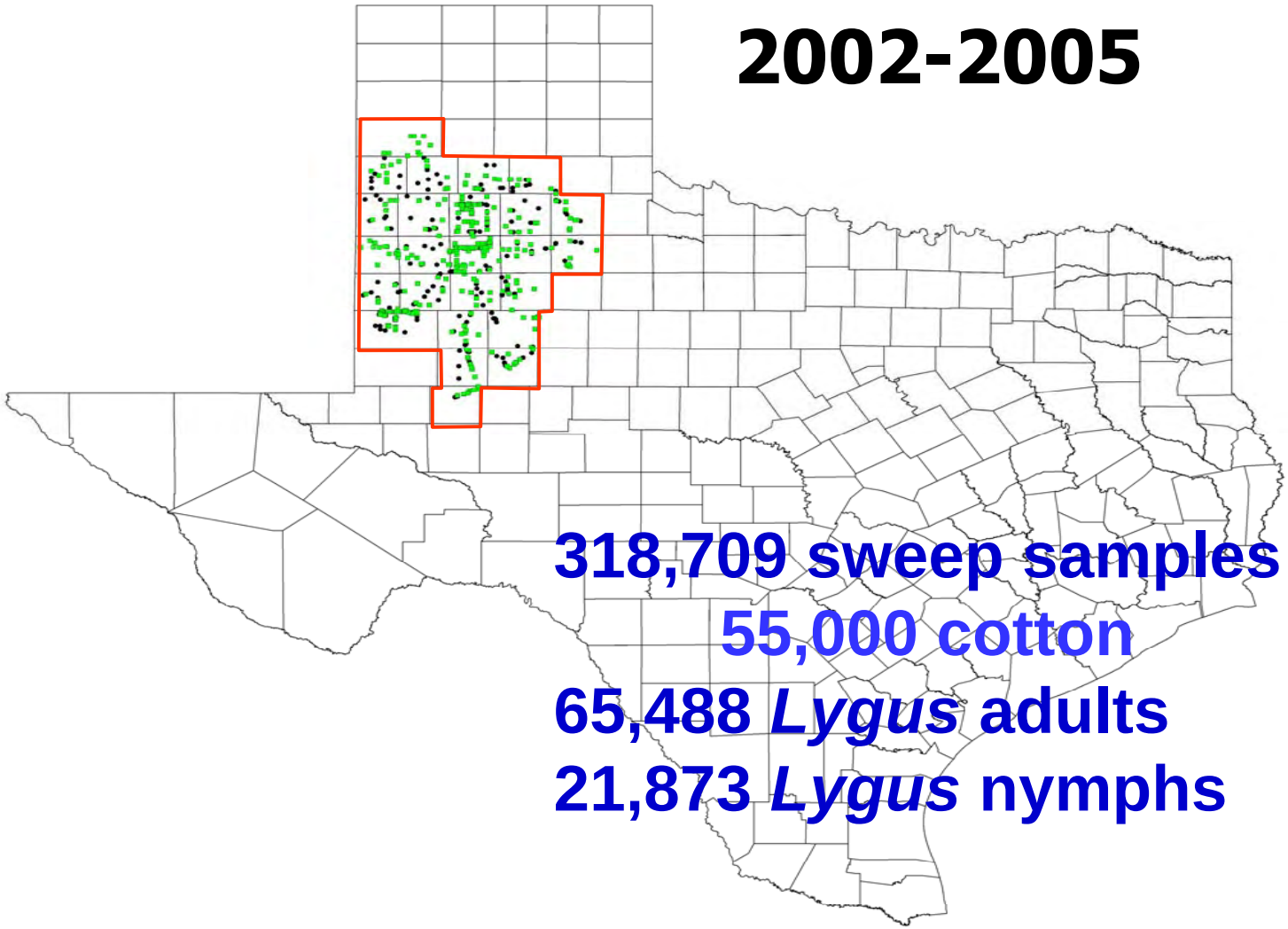
A Model for Cultural Management of Arthropods in Cotton

7. Ecology and Behavior of *Lygus* Bugs

- Identification of problems: extensive survey work.
- Host plant preference and suitability.
- Scope of damage; plant compensation.
- Plant susceptibility window-when is fruit safe?
- Insect behavior: intra-host movement.
- Insecticide efficacy, resistance issues.
- Understanding behavior and ecology at molecular level.

Areawide Survey: Host Plant Sequencing

2002-2005



318,709 sweep samples

55,000 cotton

65,488 *Lygus* adults

21,873 *Lygus* nymphs

Lygus Host Plants

Common Name	Scientific Name
Alfalfa	*Medicago sativa*
Black mustard	*Brassica nigra*
Blue mustard	*Chorispora tenella*
Curly dock	*Rumex crispus*
Field bindweed	*Convolvulus arvensis*
Flixweed	*Descurainia sophia*
Horseweed	*Conyza canadensis*
Kochia	*Kochia scoparia*
Lambsquarters	*Chenopodium* spp.
London rocket	*Sisymbrium irio*
Pigweed	*Amaranthus* spp.
Ragweed	*Ambrosia* spp.

Lygus Host Plants

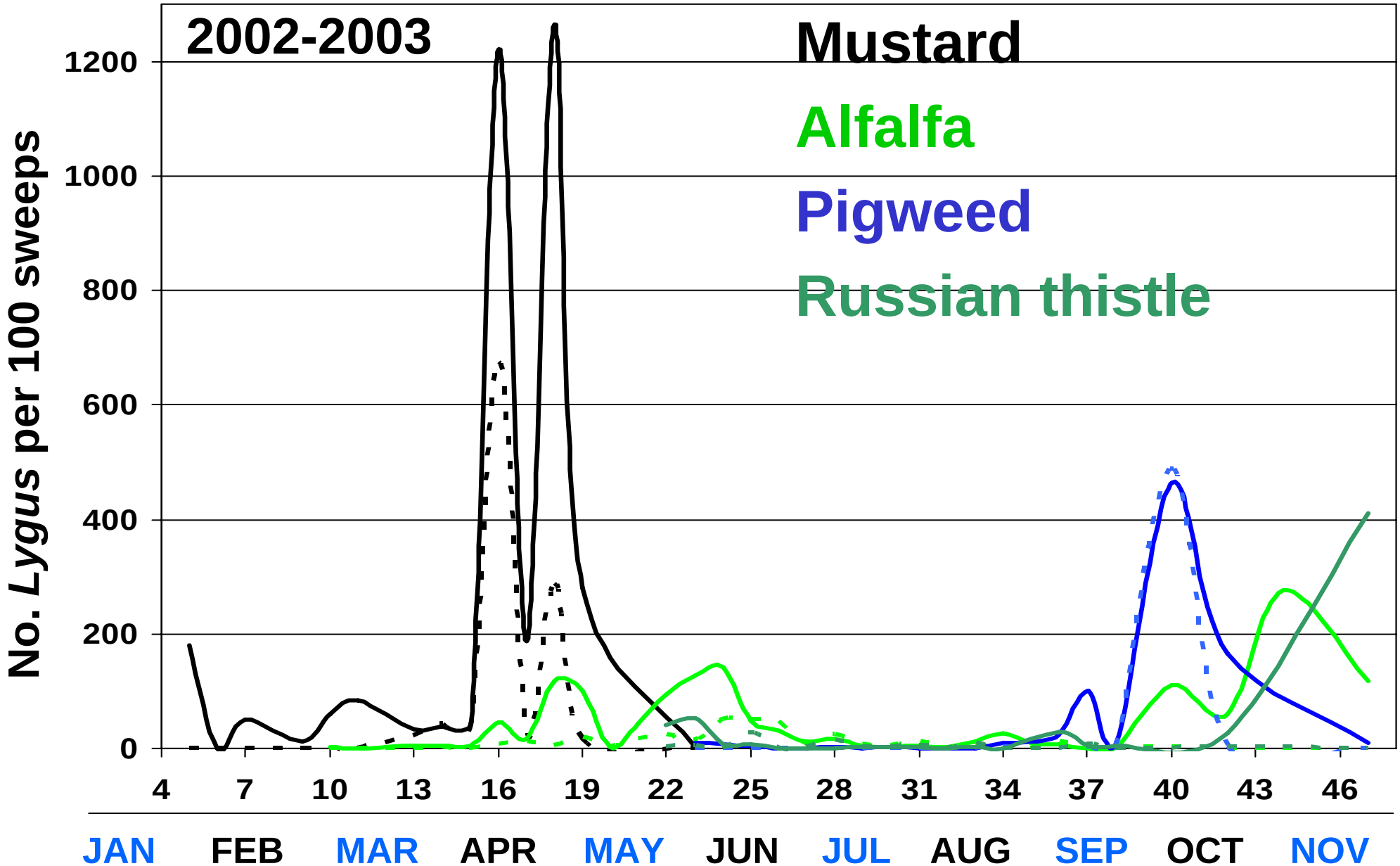
Common Name	Scientific Name
Redstem filaree	*Erodium cicutarium*
Russian thistle	*Salsola iberica*
Silverleaf nightshade	*Solanum elaeagnifolium*
Smartweed	*Polygonum* spp.
Texas blueweed	*Helianthus ciliaris*
Tumble mustard	*Sisymbrium altissimum*
Wild sunflower	*Helianthus annuus*
Woolyleaf bursage	*Ambrosia grayi*
Yellow sweetclover	*Melilotus officinalis*
Cotton	*Gossypium hirsutum*

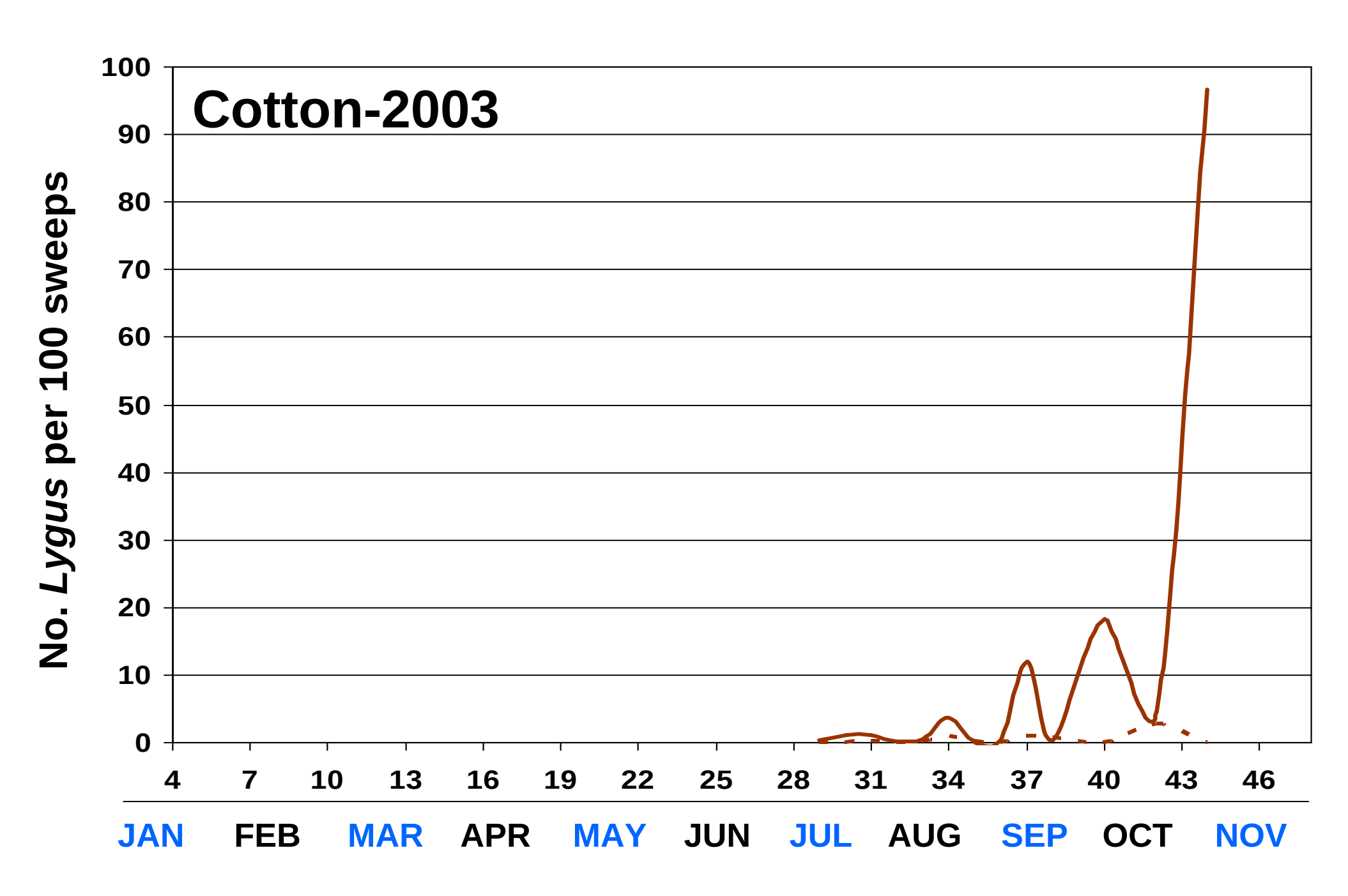
Flixweed

Lygus/100 sweeps

	2002	2003
0		
1-50		
51-100		
101-500		
>500		

Host Plant Sequence


2002-2003
Mustard
Alfalfa
Pigweed
Russian thistle
No. Lygus per 100 sweeps
0
200
400
600
800
1000
1200
4
7
10
13
16
19
22
25
28
31
34
37
40
43
46
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV


Cotton-2003
No. Lygus per 100 sweeps
100
90
80
70
60
50
40
30
20
10
0
4
7
10
13
16
19
22
25
28
31
34
37
40
43
46
JAN
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NOV

Lygus Host Preference

Dominant Non-cotton Hosts and Cotton

Alfalfa

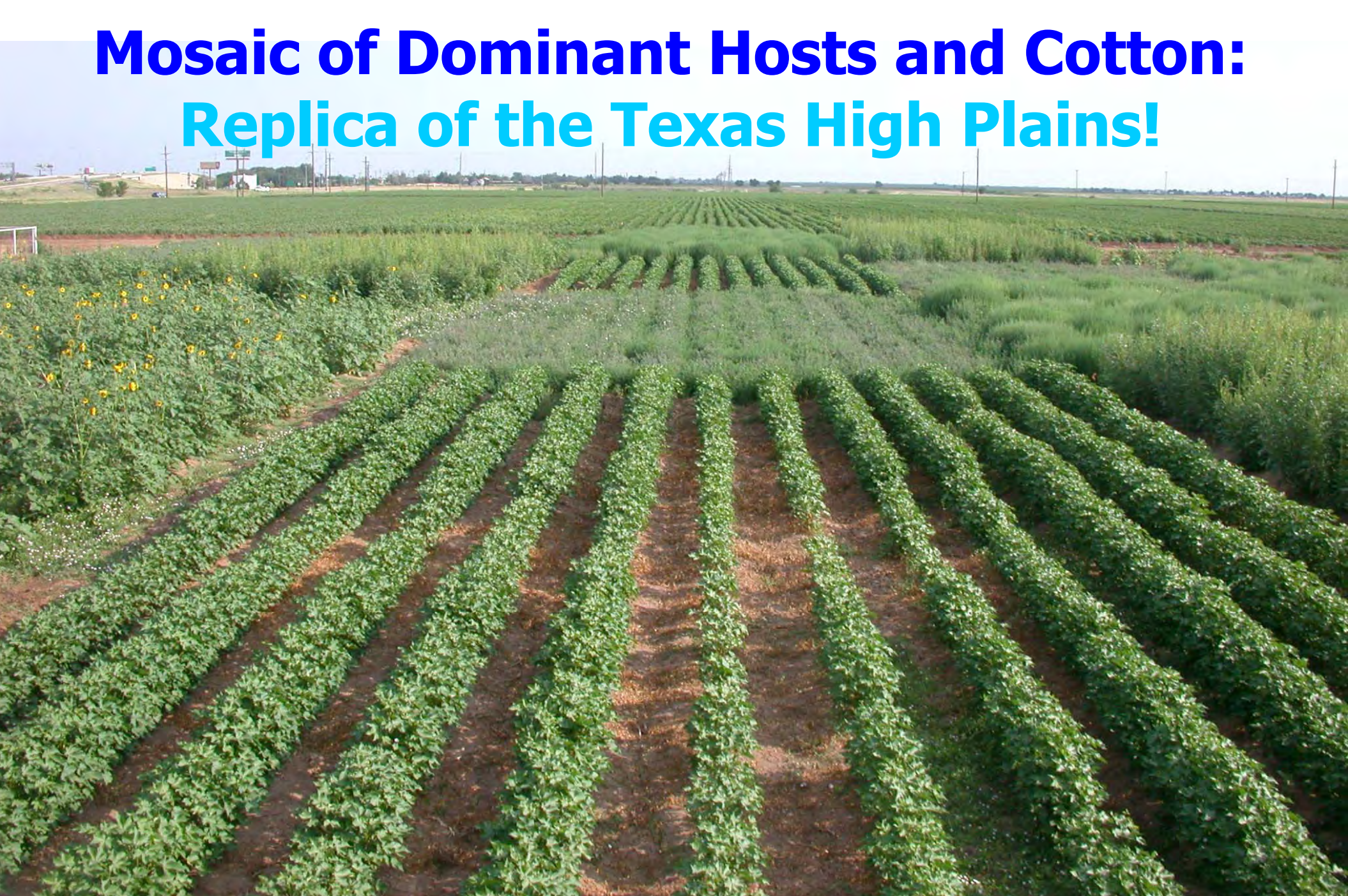
Sunflower

Cotton

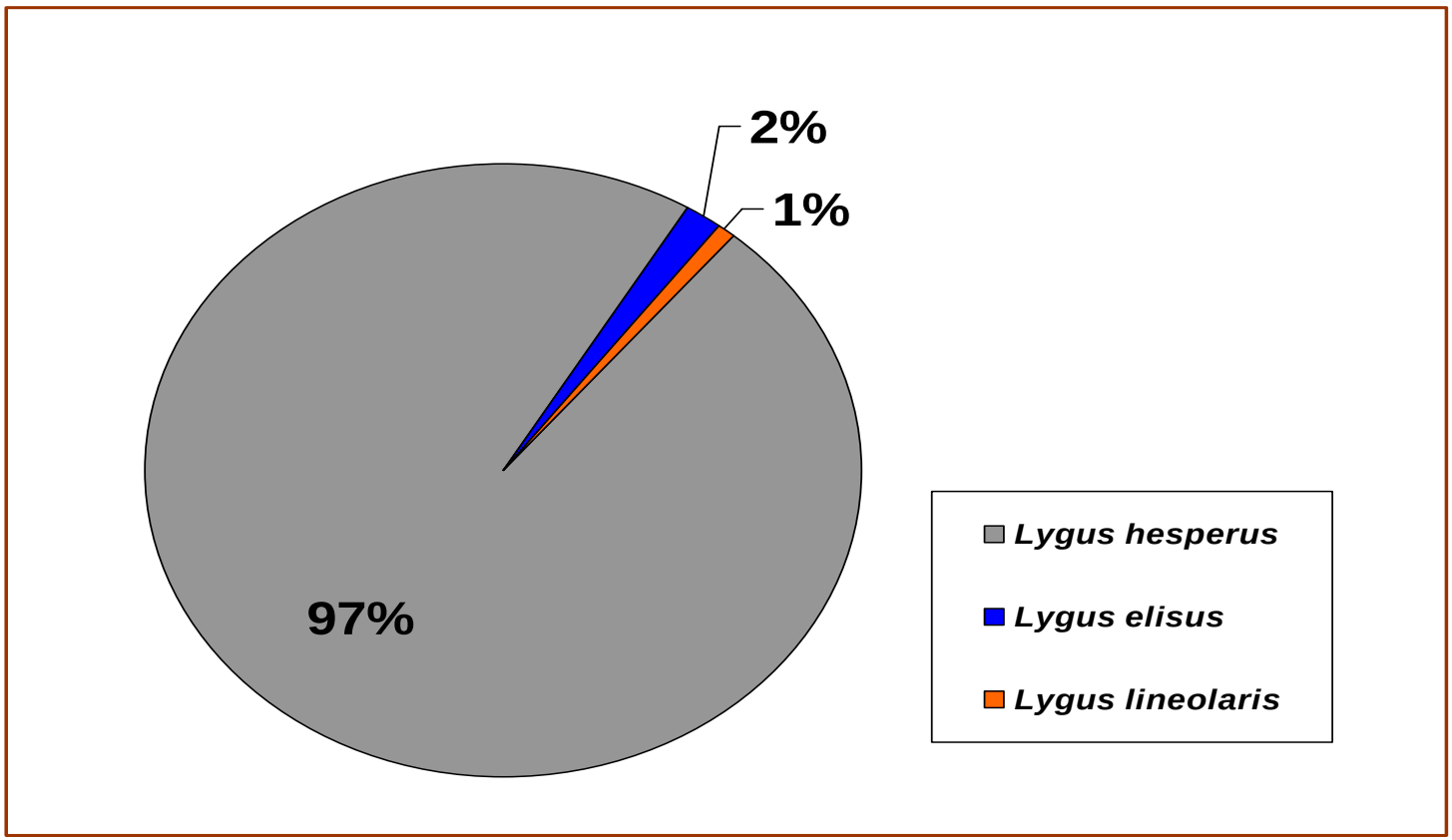
Pigweed

Russian thistle

Mosaic of Dominant Hosts and Cotton:
Replica of the Texas High Plains!

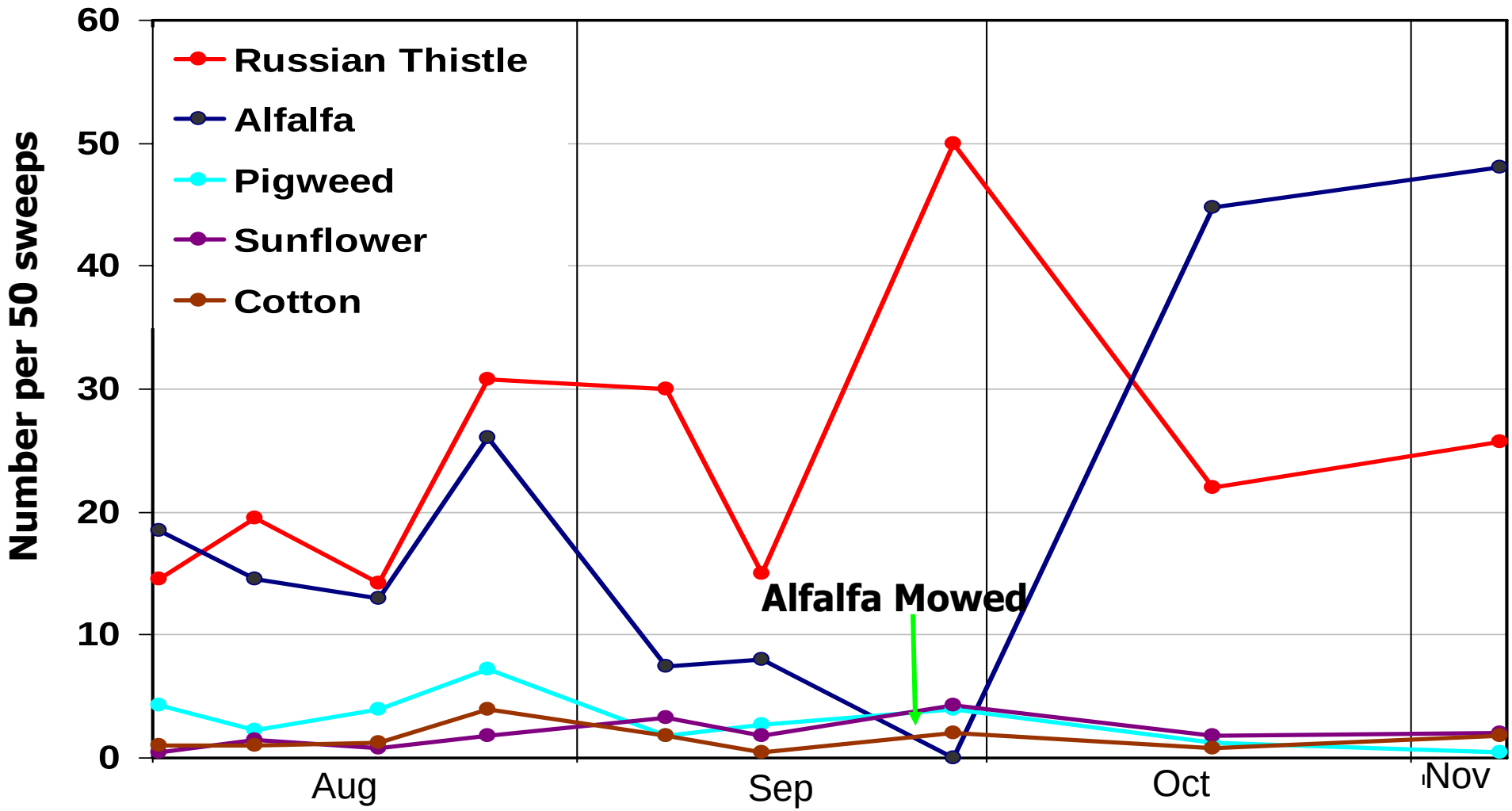


Species Composition in the Population

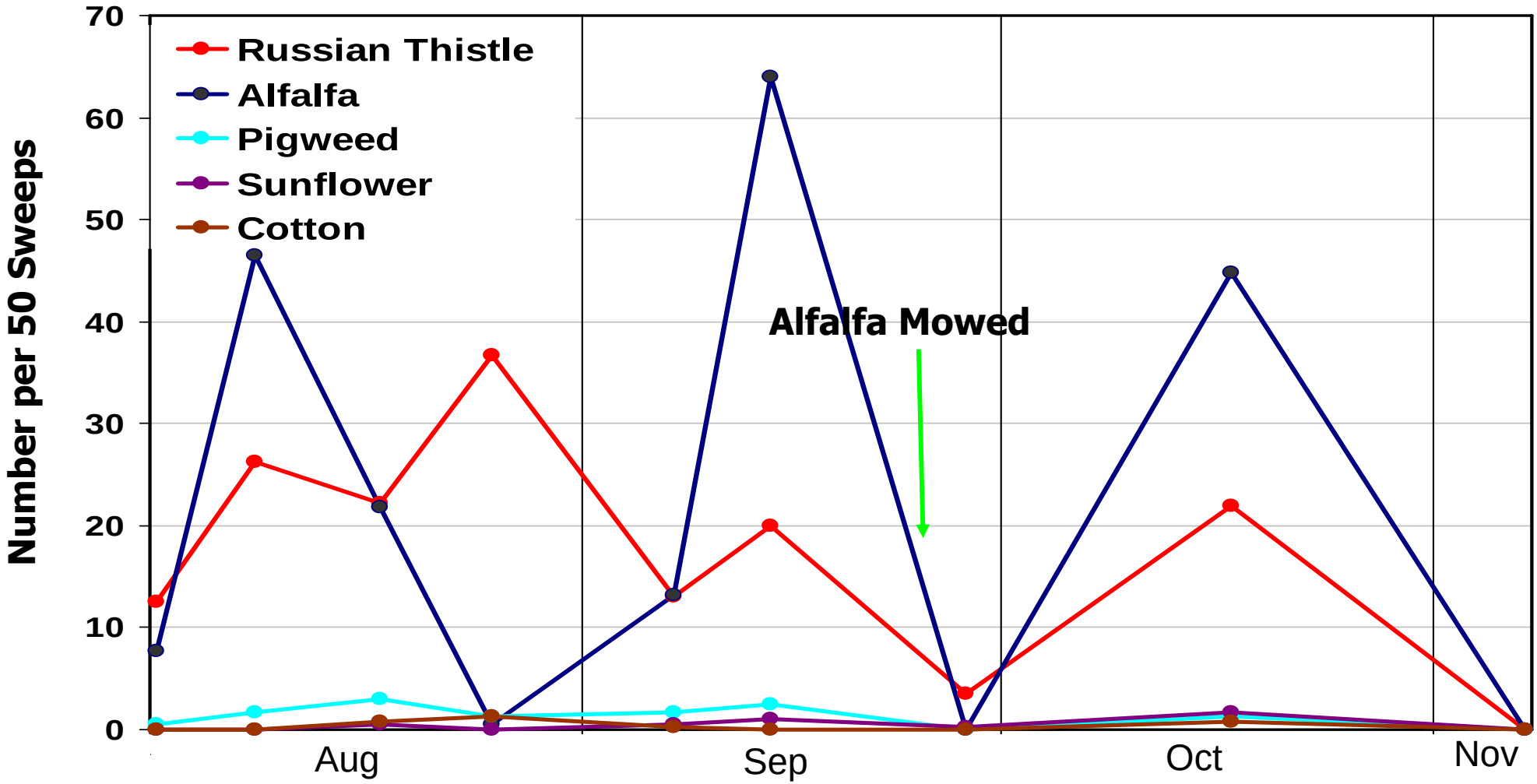


Species identification were based upon keys for adult males.

Colonization/Seasonal Abundance
L. hesperus adults



Reproduction/Seasonal Abundance
L. hesperus nymphs



Cotton Compensation of *Lygus* Induced Fruit Loss

Experimental Protocol

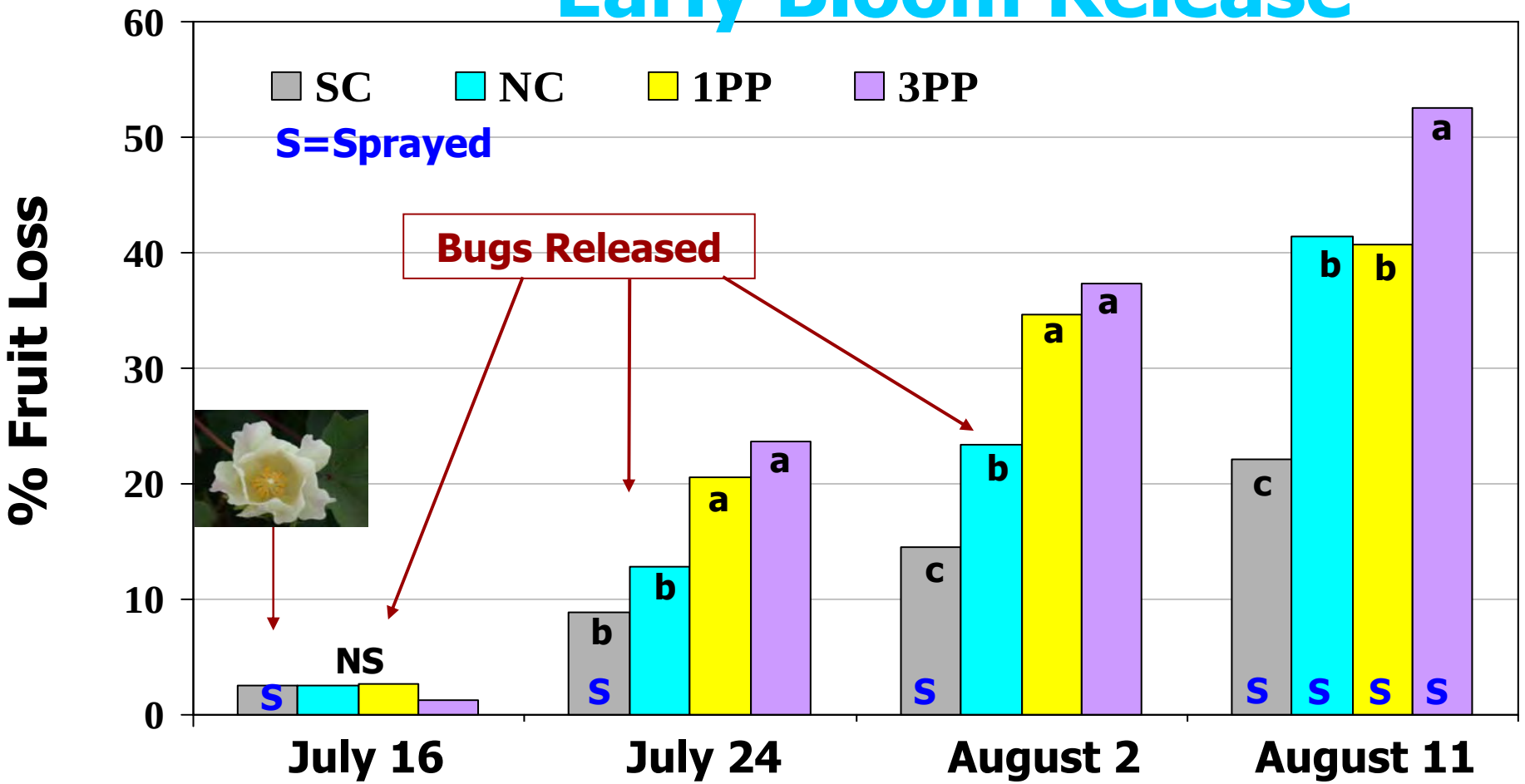
- ***Lygus*** **nymphs (2nd instar) released weekly for three consecutive weeks, 2005.**

Early bloom
(July 16-August 10)

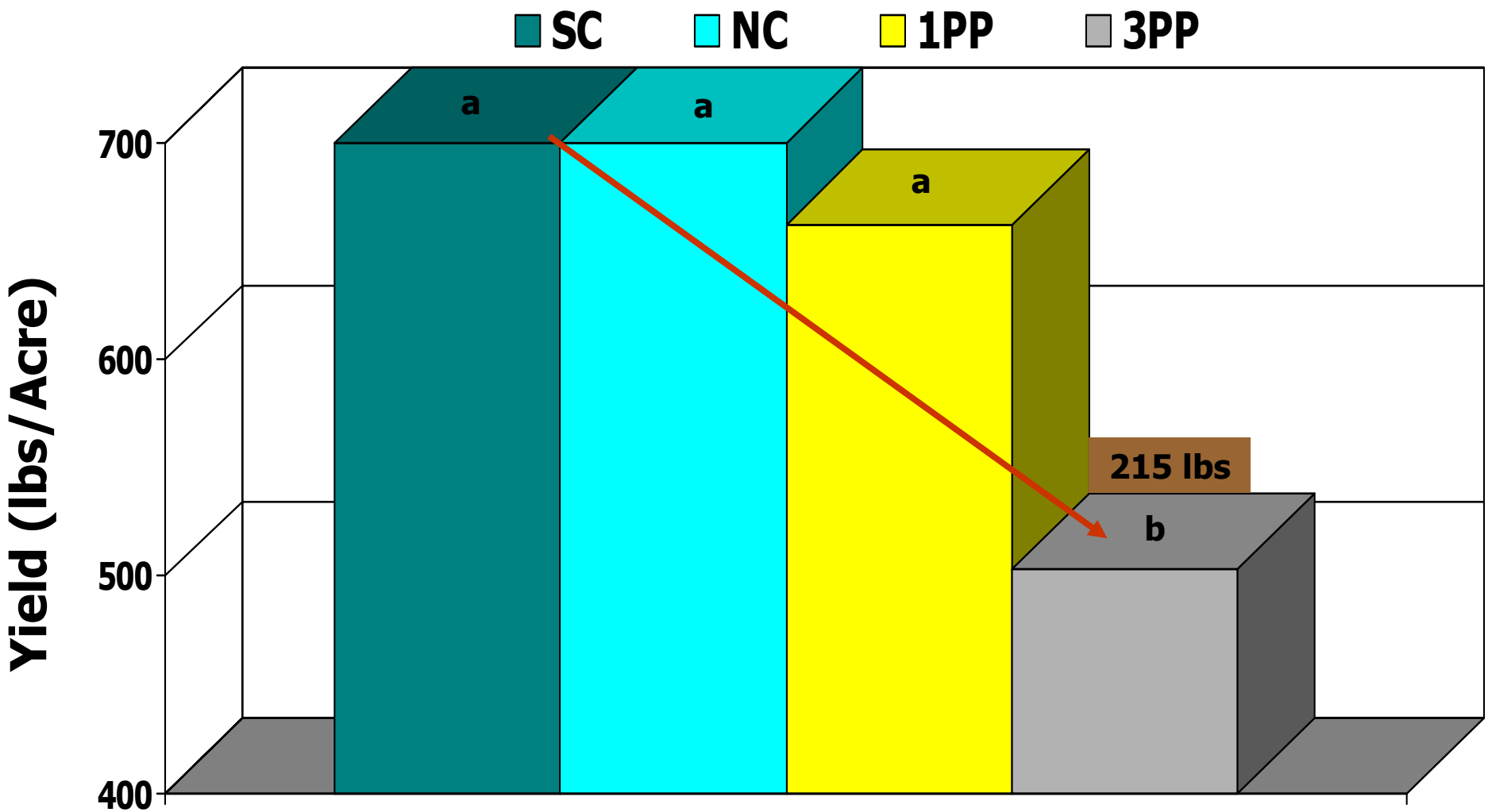
Lygus Bugs Released

- **Treatments:**
  - **0 *Lygus* achieved through insecticide control**
  - **0 *Lygus* released (natural control)**
  - **1 *Lygus* per plant**
  - **3 *Lygus* per plant**
- **COTMAN and plant mapping performed.**

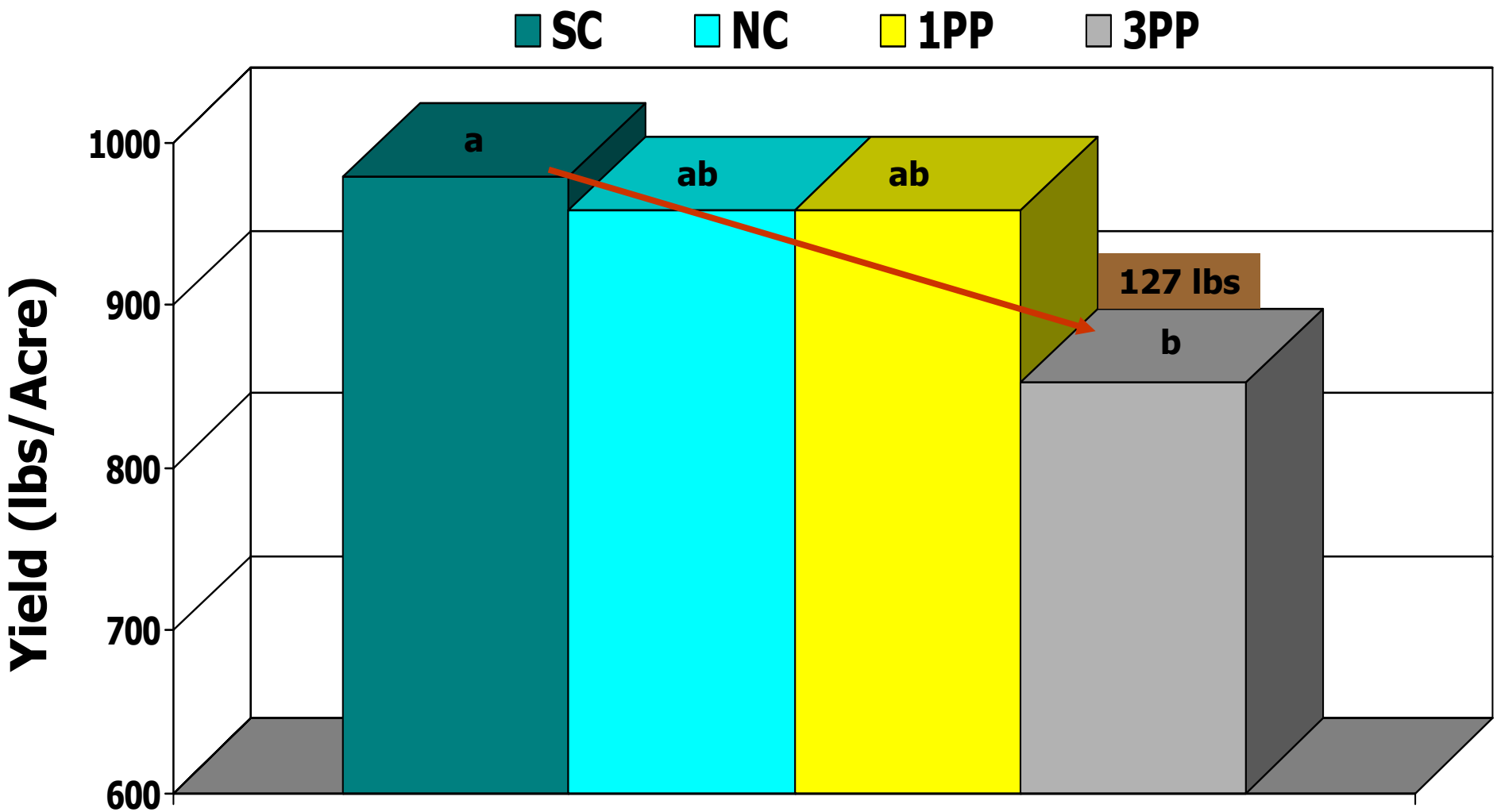
Percentage Fruit Loss
Lubbock, Texas, 2005
Early Bloom Release



Lint Yield from the First Fruiting Position
Lubbock, Texas, 2005



Total Lint Yield: Compensation Study
Lubbock, Texas, 2005



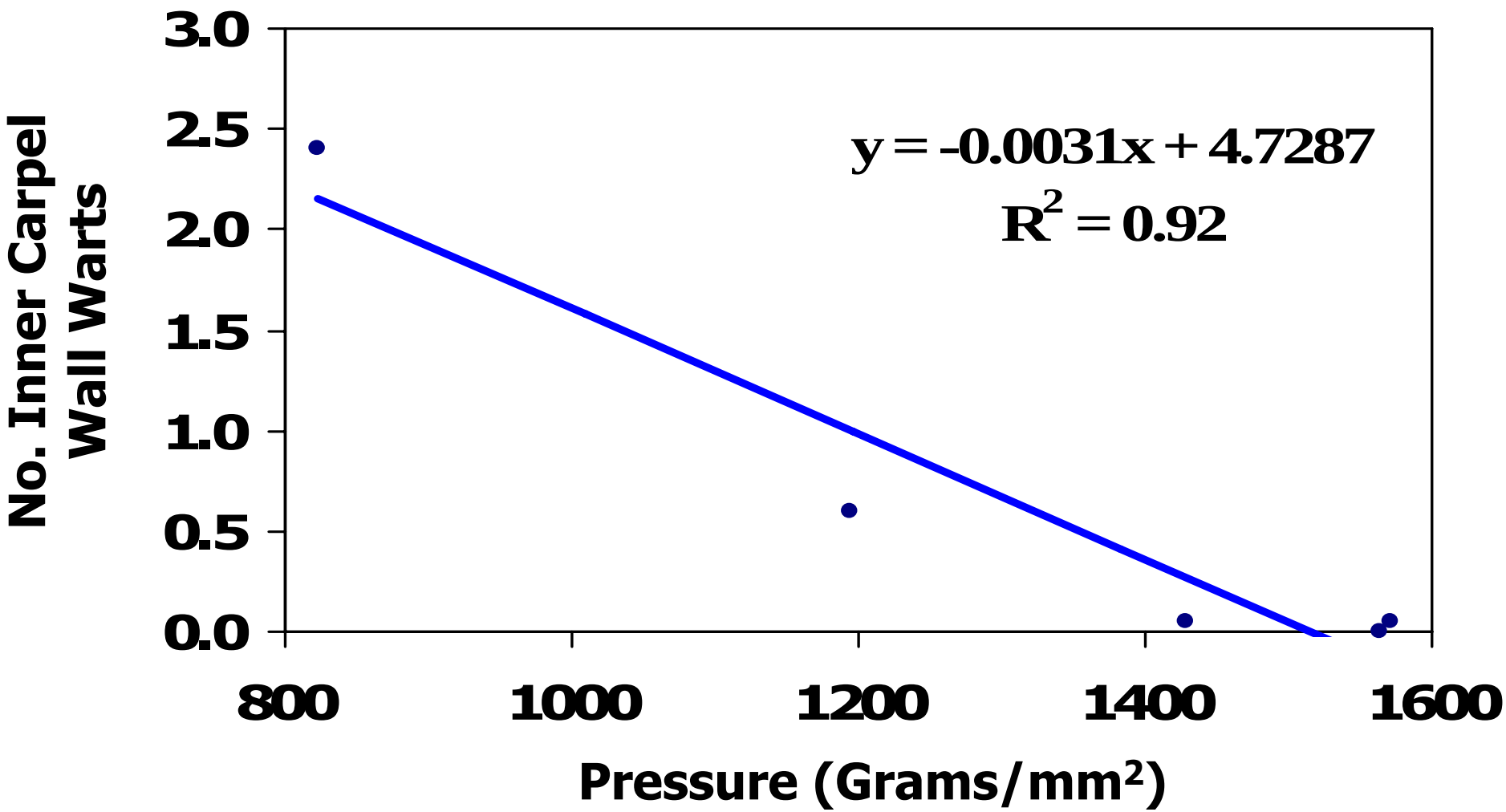
When is a cotton boll safe from *Lygus* damage?

Lygus external probing

Damage inside the boll

Measuring carpel wall toughness using a penetrometer

Regression Analysis Predicting Boll Susceptibility, PM 2326RR



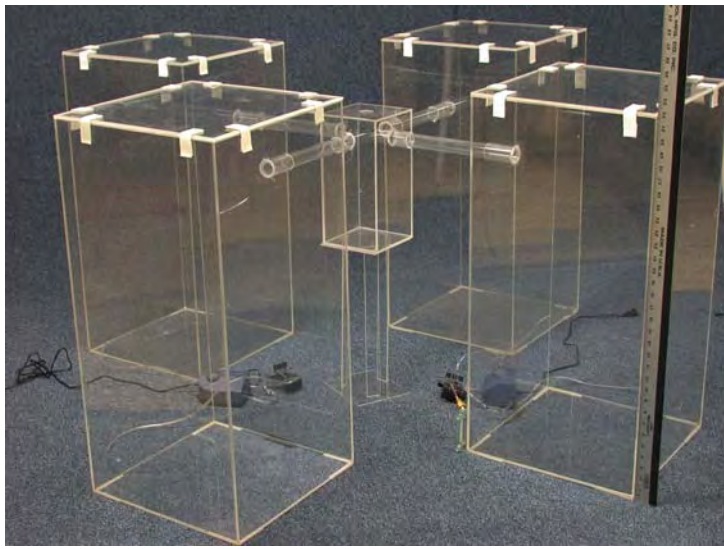
Current Projects

Boll Susceptibility Study
Use of Commercial Penetrometer

- Use of a more precise penetrometer to refine the boll suceptibility cut-off value.
- Evaluate boll susceptibility differences due to irrigation and cultivar.

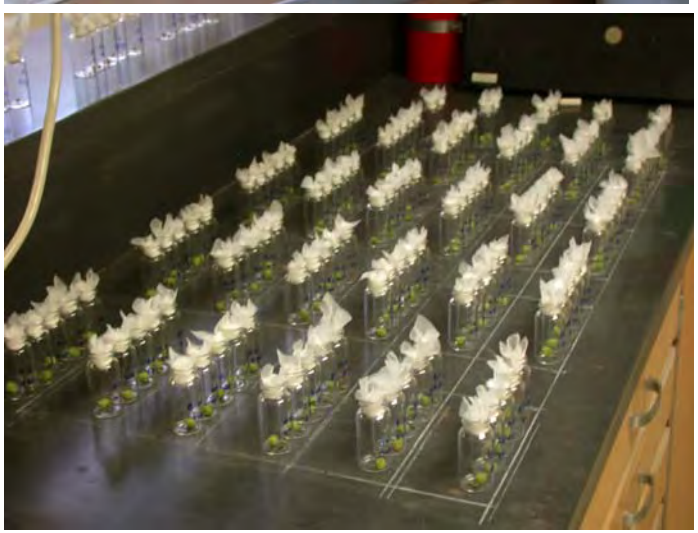
Behavioral Bioassay
Multi-Choice Olfactometer

- Behavioral bioassays using a multi-choice olfactometer.
- Potential chemistry work to determine kairomone or other plant constituents for host preference.



Insecticide Efficacy
Resistance Issues

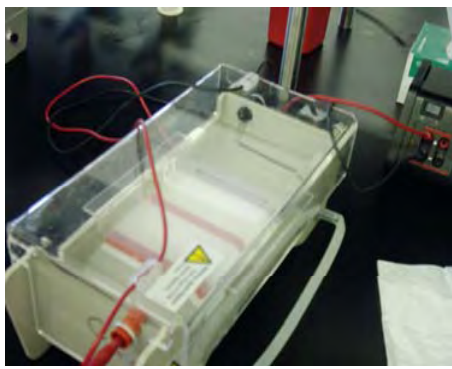
- **Bioassays to determine baseline susceptibility to potential insecticides.**
- **Temporal and spatial monitoring of potential resistance to commonly used insecticides.**



Behavioral Ecology of *Lygus* at Molecular Level

Molecular Systematics and Phylogeography

- **Restriction Fragment Length Polymorphism (RFLP).**
- **Amplified Fragment Length Polymorphism (AFLP).**
- **Microsatellite markers.**



Behavioral Ecology of *Lygus* at Molecular Level

Insect Movement between Cotton and Non-cotton Hosts

Protein markers

Spraying of markers

Data acquisition

Acknowledgments