GIFT Experience Summer 2009

Anna Perrin & Dr. Toews Lab Personnel

(From Left to right: Back Row-Blake Crabtree, Jessica Corbett, Dr. Mike Toews, John Herbert, Alton Hudgins; Front Row- J. David Griffin, Anna Perrin)

GIFT Program

- **GIFT**

  Georgia Intern-Fellowships for Teachers Program with the University of Georgia and the Georgia Institute of Technology

- **Placement:**

  University of Georgia at the Tifton Campus in Dr. Michael Toews Entomology Lab

Dr. Michael Toews

- **Assistant Professor of Entomology**
  UGA Tifton Campus
  Ph.D., Oklahoma State University, 2001
- **Adjunct Assistant Professor**
  Clemson University, Department of Entomology, Soils, and Plant Sciences
- His research program is based on developing ecologically based strategies for sustainable pest management of cotton insect pests, primarily southern green stink bugs.

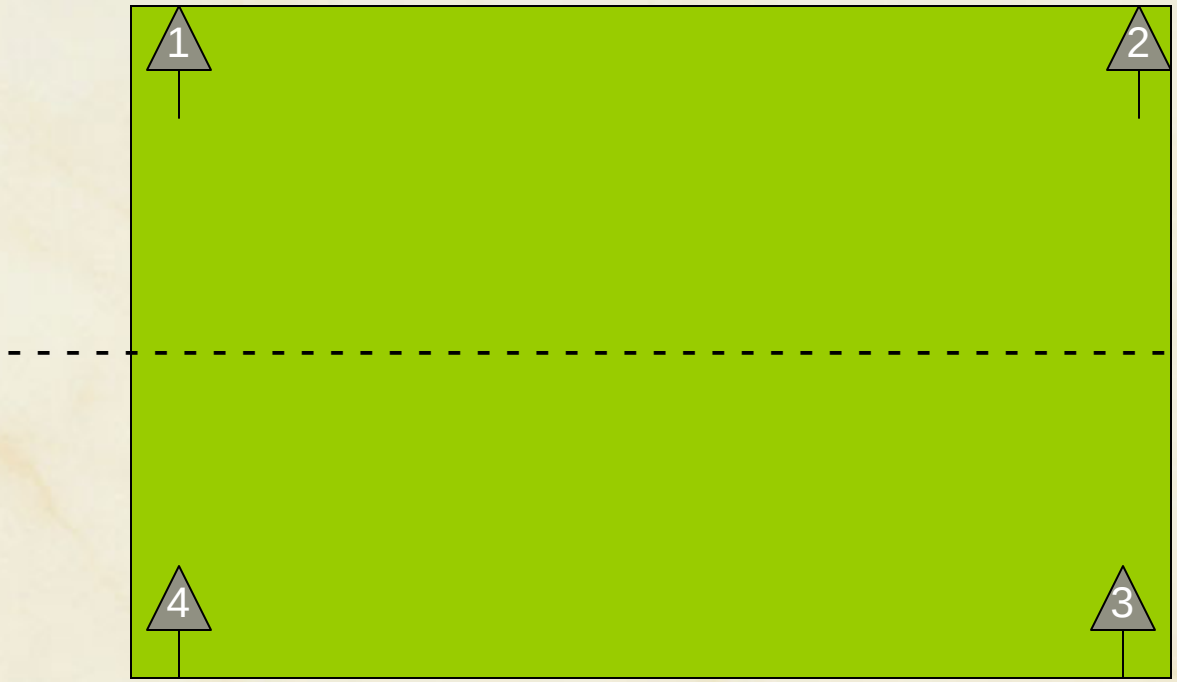
Experiments

- Monitoring Tobacco Budworms and Corn Earworms (Moths) over Time in *Bt* Cotton vs. Non-*Bt* Cotton
- Susceptibility of Stored Food to Insect Infestation
- Detection of Inexpensive Marking Proteins using ELISA
- Host Plant Resistance for Tobacco Budworm Control in *Bt* Cotton vs. Non-*Bt* Cotton
- Farmscape Sampling of Stink Bugs

Monitoring Tobacco Budworms and Corn Earworms (Moths) over Time in *Bt* Cotton vs. Non-*Bt* Cotton

- 1 moth trap was placed at each corner of a cotton field that had *Bt* cotton on one side & Non-*Bt* cotton on the other side
- A pheromone for Tobacco Budworms (TBW) was placed in 2 of the traps diagonal to each other & pheromones for Corn Earworms (CEW) were placed in the other 2 traps; pheromones were changed weekly
- Number of moths captured in each trap was recorded daily

Field Setup of Moth Traps



Non-*BT* Cotton

BT Cotton

Moth Trap	Type of Pheromone
1	TBW
2	CEW
3	TBW
4	CEW

Bt Cotton

Splicing Genes Together

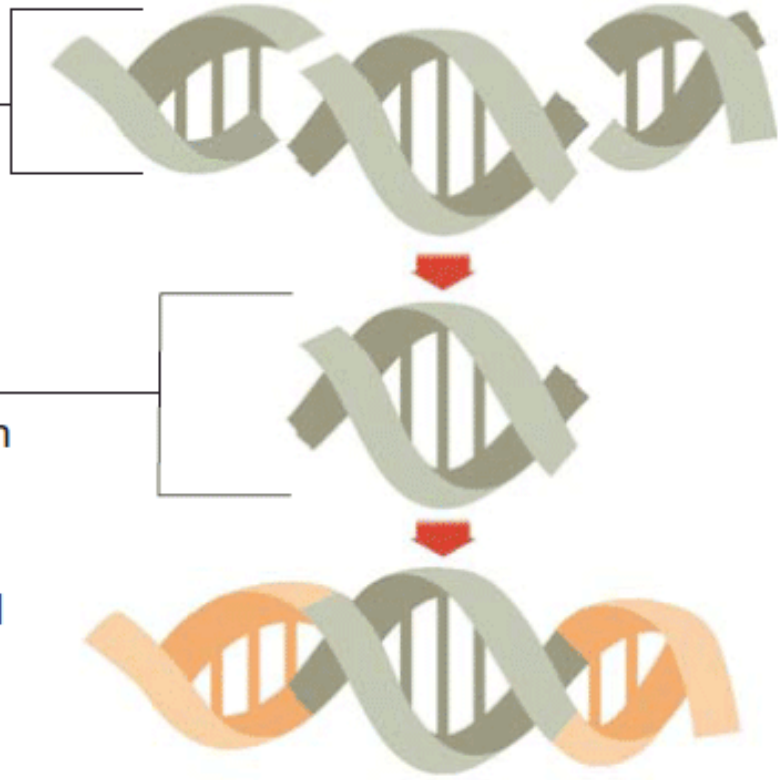
Employing genetic engineering, researchers can take certain genes from a source organism and put them into another plant or animal.

An Example of Genetic Engineering:

1 Scientists take *Bacillus thuringiensis*, a commonly occurring soil bacteria…

2 …and use enzymes to remove from it the Bt gene, which produces a protein that turns toxic in the digestive tract of caterpillars.

3 The Bt gene is then incorporated into the chromosomes of cotton and corn, killing caterpillars that feed upon these plants.



SOURCE: North Carolina State University, College of Agriculture and Life Sciences

Bt Cotton benefits - http://www.monsanto.co.uk/primer/cotton.html

Results of Moth Experiment

Susceptibility of Stored Food to Insect Infestation

- Humans desire a safe and nutritious food supply that is free of insect infestation, insect feces, excessive insect parts, and microbes that could be transmitted by insects. A wide variety of beetles have evolved to feed in raw food types and processed foods.

Types of Beetles Used

Sawtoothed Grain Beetle

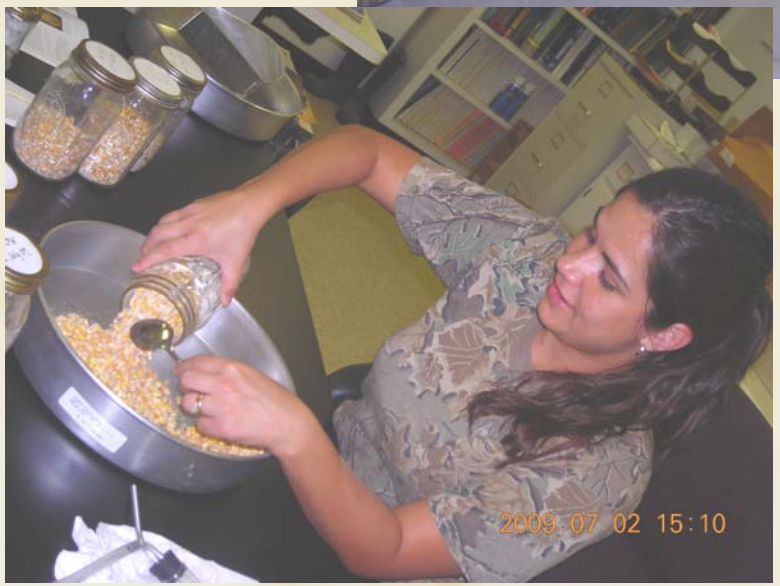
Lesser Grain Borer

Rice Weevil

Red Flour Beetle

Commodities (Food Products) Used

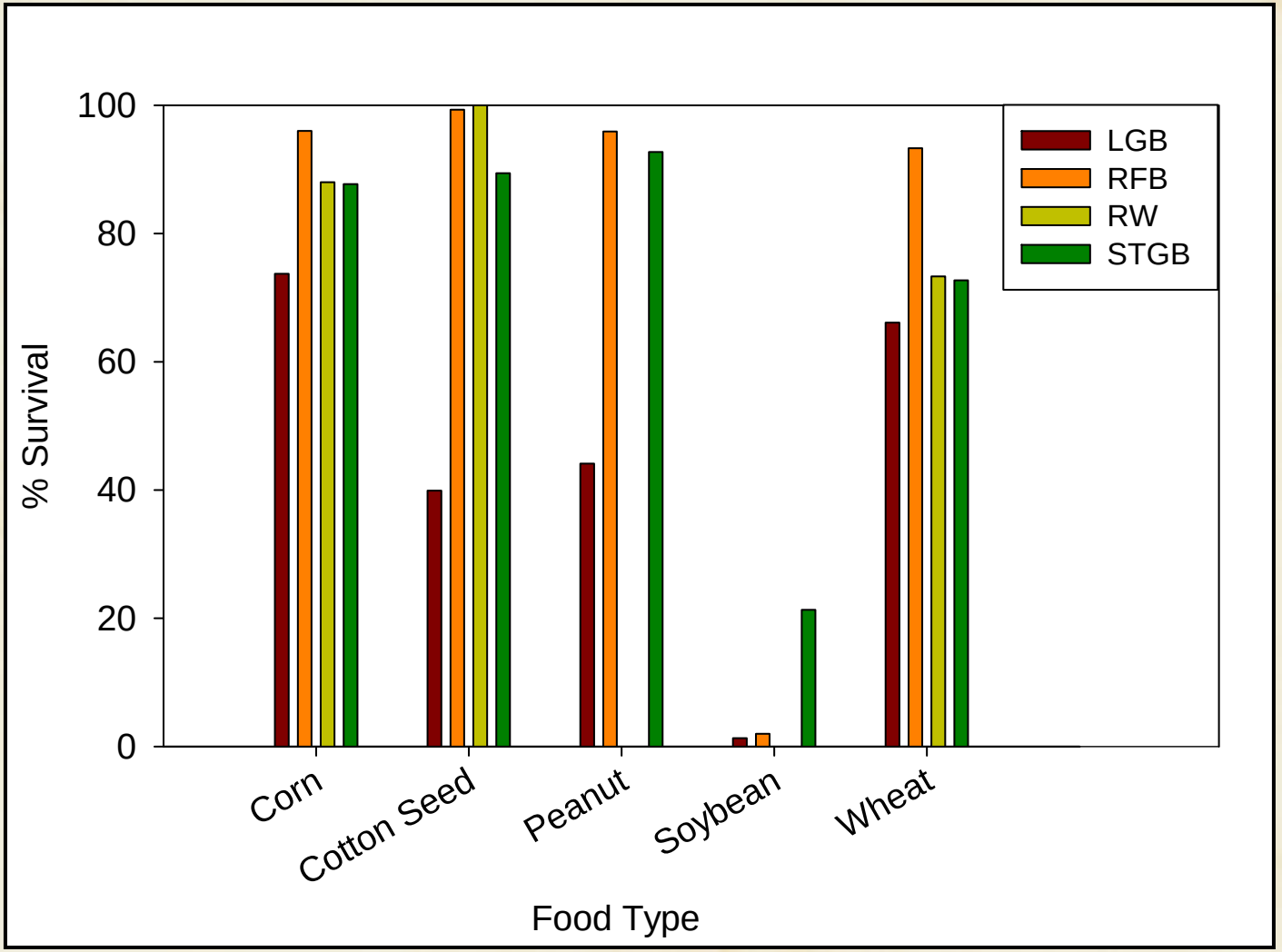
- Soybeans
- Cotton Seed
- Corn
- Wheat
- Peanuts



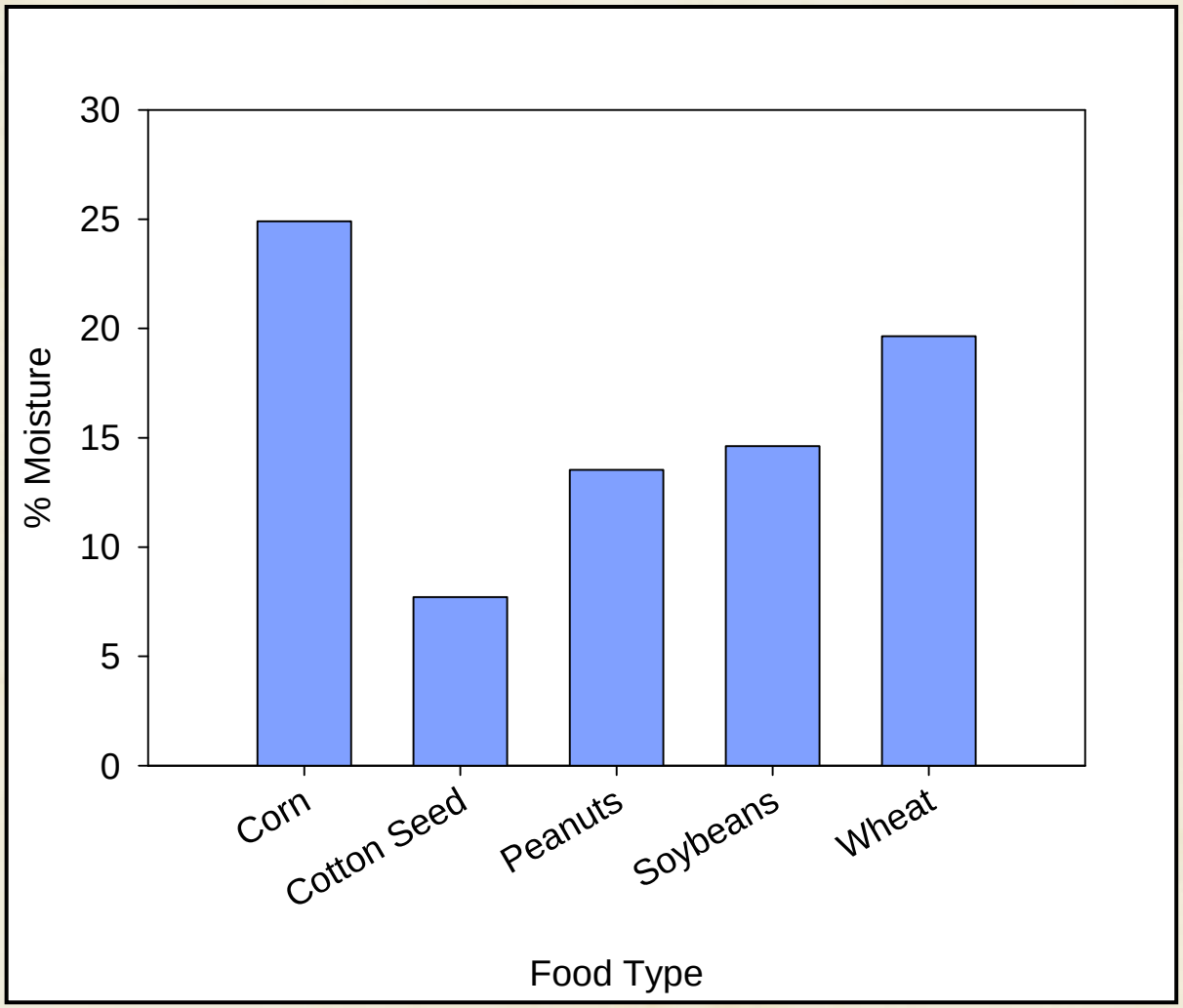
Experiment Procedure

- 13 regular quart sized mason jars were filled with of 200.0 ± 1.0g of each commodity, excluding cotton seed where only 100.0 ± 1.0g was used
- 50 adults of each type of insect (STGB, LGB, RW, & RFB) were aspirated and released into separate jars (3 replications each) for each food product
- Jars were labeled & placed in a growth chamber at 28°C for 2 weeks
- 1 jar of each commodity was used to test for moisture content

Results of Stored Food Products



Moisture Content



Real World Application

- If we have an idea what insect species to expect in specific stored commodities, we can develop a sampling and monitoring approach that targets that species. (Do they develop inside kernels, would they fly to a trap or walk into a trap, is there a commercial pheromone?).

Detection of Inexpensive Marking Proteins using ELISA

- An understanding of insect movement among different habitat types is critical for formulating pest management strategies. However, most insects are too small for tagging with a radio collar or bird band.

Stink Bug Protein Marking

- Live stink bugs were dipped one at a time in a solution containing the marking protein to be tested (75 in soymilk & 75 in egg whites).
- 75 live stink bugs were dipped in distilled water to be used as standards or controls.
- Each group of insects were placed in a separate aquarium & allowed time to dry.
- Insects were then placed in individual 2.0 ml microcentrifuge tubes and frozen at -20° C.

(ELISA)
(Enzyme Linked Immunosorbent Assay)

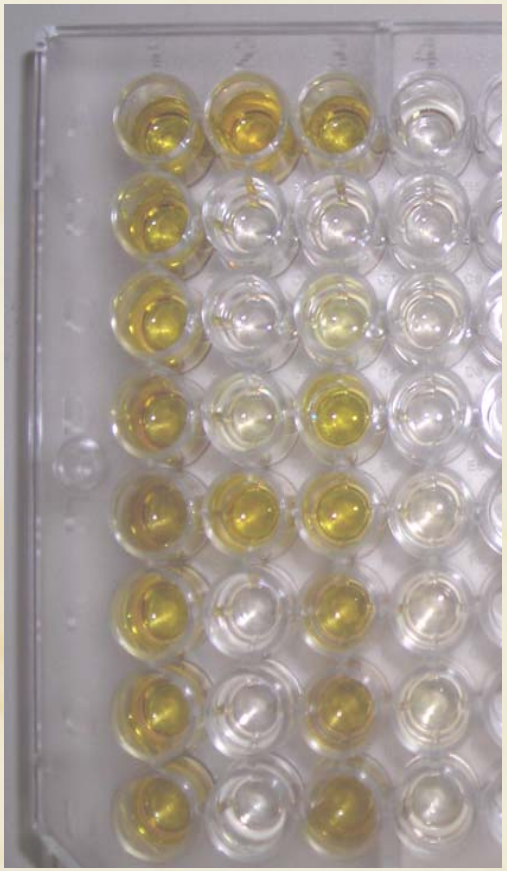
- The ELISA procedure was conducted based on a published method. At the end of the procedure, the microplates were read at 450nm on a plate reader to determine the optical density of each reaction.

Results of ELISA

- Wells that contained wash solution from protein marked insects exhibited a strong color change whereas wells that contained wash solution from nonmarked individual insects exhibited no color change.

Readings are the optical density of the reaction

3.843	3.788	3.804	0.088
3.829	0.093	0.092	0.088
2.421	0.083	0.271	0.12
3.696	0.201	3.942	0.076
3.741	3.809	3.94	0.15
3.11	0.083	3.914	0.128
3.163	0.073	3.727	0.141
3.156	0.068	3.773	0.111



Real World Application

- If we are able to detect the presence of the proteins on insects that were marked in the field, we should be able to spray the proteins over large areas and recover much larger numbers of insects than if we had to capture the insects first, release them, and then recapture the same insects at a later time.

Host Plant Resistance for Tobacco Budworm Control in Bt Cotton vs. Non-Bt Cotton

- >95% of the cotton grown in GA has been genetically engineered
  - A gene has been inserted into the cotton plant genome to produce toxins
  - The *Bacillus thuringiensis* or *Bt* gene was originally isolated from a soil dwelling bacterium
- This gene causes the cotton plants to produce a toxin that is toxic only to caterpillars due to their basic pH environments of their stomachs. Other animals (like humans) have an acidic stomach.

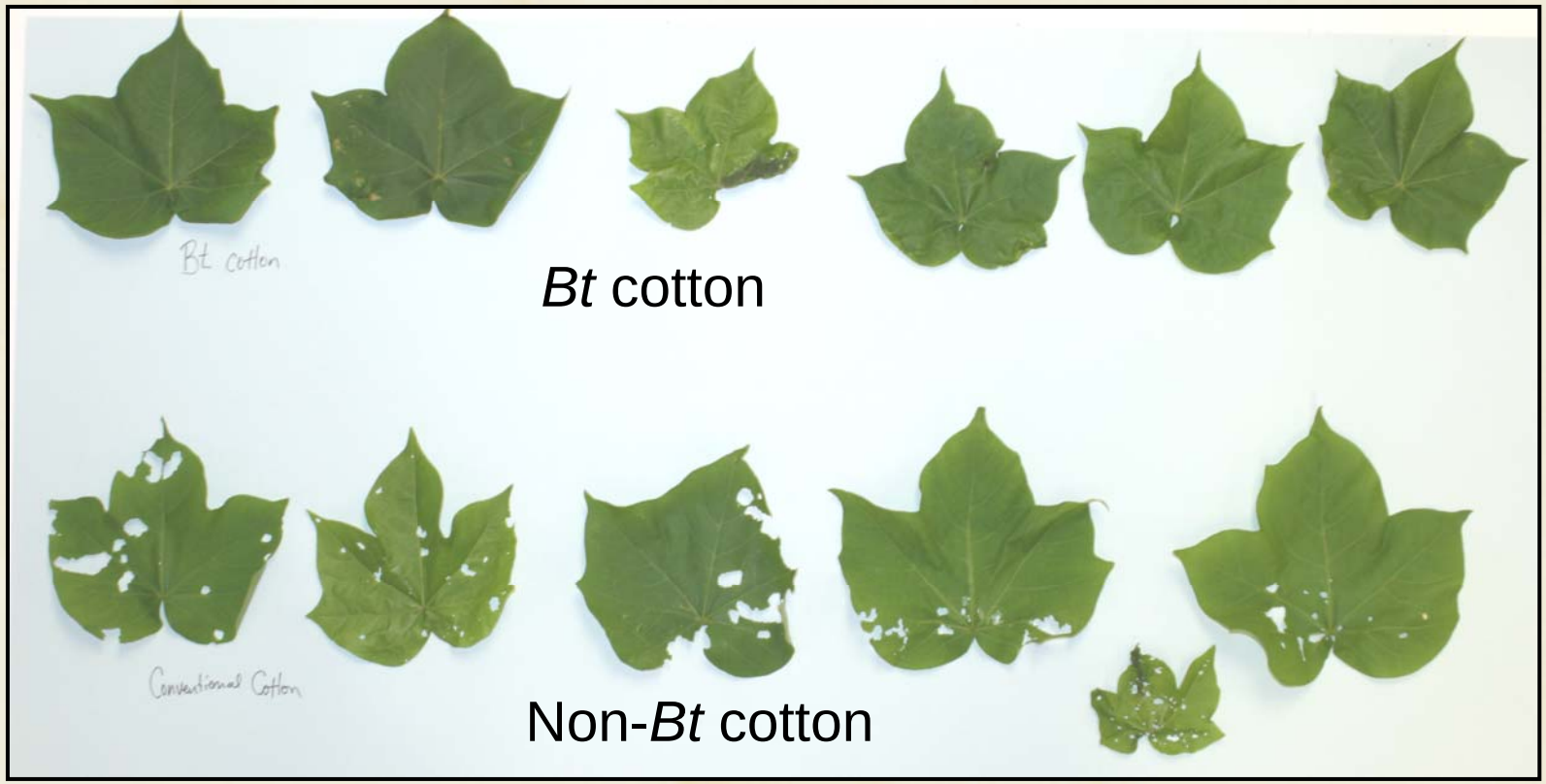


Measuring How Effective *Bt* Cotton is in Prohibiting TBW Damage Compared to Conventional (Non-genetically engineered) Cotton

- Two leaves on each of four plants per plant type (*Bt* vs non *Bt*) were infested with a single young tobacco budworm for a total of 8 replications per treatment level and contained to area for 48 hours.

Results of Cotton Damage

- There was noticeably less leaf damage on the *Bt* cotton compared to the conventional cotton.
- All but 1 of the caterpillars placed on the *Bt* cotton died



Real World Application

- Prevention of cotton leaf damage and subsequent death of the caterpillar as a result of biogenetically engineered plants prevents the need for foliar insecticide treatments which:
  - can be expensive
  - time consuming
  - likely kill non-target beneficial insects, such as predators and parasitoids
- The loss of this natural control could lead to secondary pest outbreaks like spider mites, aphids, or whiteflies.
  - Would require more insecticide applications.
  - Tobacco budworms are highly resistant to pyrethroid insecticides, which are preferred because they are inexpensive

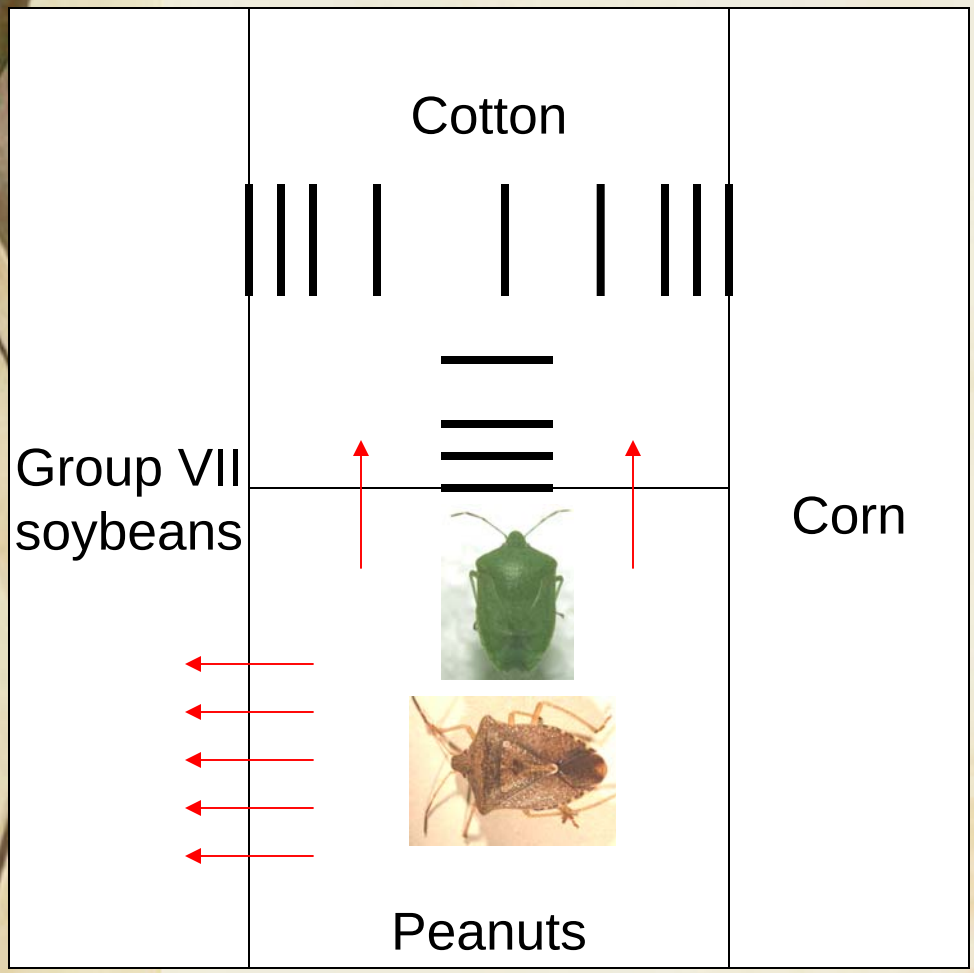
Farmscape Sampling of Stink Bugs

- A complex of phytophagous stink bugs (Hemiptera: Pentatomidae) have recently become serious insect pests in southeastern US cotton production.
- While these pest populations can be effectively mitigated with insecticide applications, there are no available chemistries for selectively removing stink bugs without disrupting natural enemies.
- An understanding of host plants utilized by these stink bugs during the summer growing season may help farmers target stink bug control efforts in time and space for the most effective control with the least cost and effort.

Procedure

- Cotton plants and plants in surrounding fields (i.e. peanuts, watermelons, planted pines, grain sorghum, soybeans, and weedy field borders) were scouted from seedling up through reproductive maturity.
- 25 double row sweeps with a 15-inch sweep net were used to scout for stink bugs in each of the crops grown in the farmscape.
- Scouting was done weekly.
- The number and species of stink bugs in 25 sweeps of habitat is recorded (Toews)

Real World Application



- A knowledge of when stink bugs are likely to occur in each crop may help farmers target treating stink bugs early in the season before they increase in numbers and devastate late maturing crops like cotton.

Summary of Experience

- My GIFT experience was an overall enjoyment!
- It enlightened me on new technologies used and leading research being performed in the field of agriculture.
- GIFT gave me ideas on how to use more inquiry based activities in my classroom, encouraging students to use reasoning and problem solving skills.
- The GIFT program gave me first hand experience in "real-world" application for some of the content that I teach in Biology.
- I highly recommend the GIFT program for any science teacher!