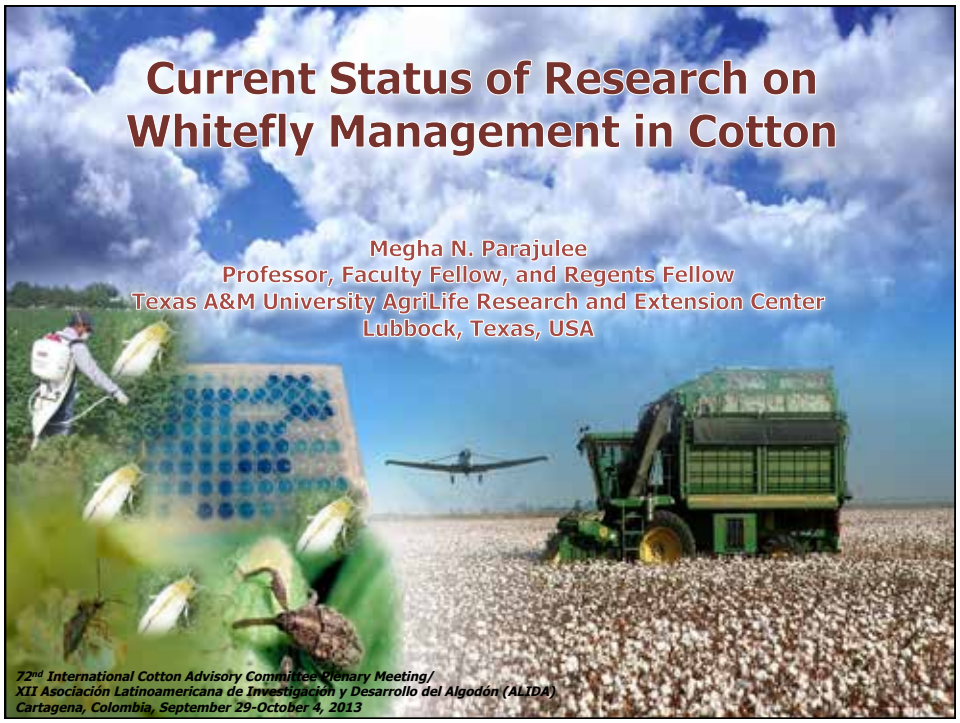


Whitefly

(Hemiptera: Homoptera)

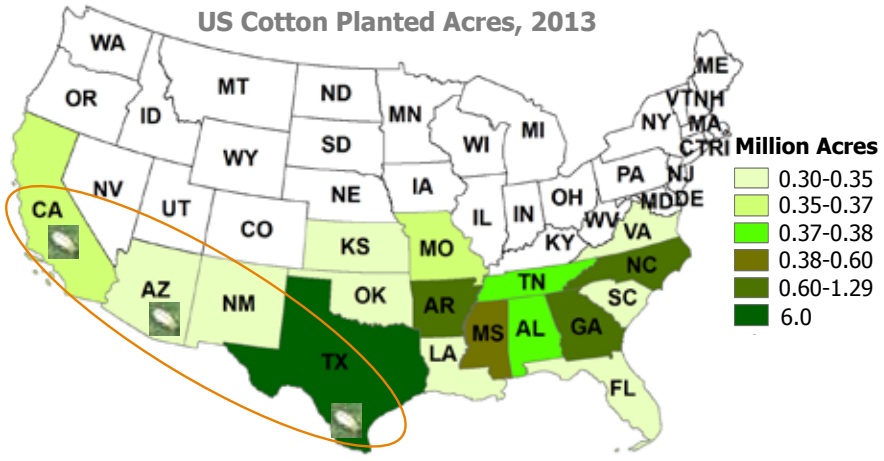
- **More than 1500 species of whitefly**
- ***Bemisia tabaci* complex**
- **Global prominence in 1980s (Biotype B)**
- **Biotype B*; Biotype Q* (Mediterranean)**
- ***B. tabaci* is a complex of 11 well-defined groups containing 24+ morphologically indistinguishable species**
- **Sweetpotato whitefly, Cotton whitefly; Silverleaf whitefly**
- ***Bemisia tabaci* / whitefly (wide host range; >600 hosts)**

Whitefly Damage to Cotton

- High populations deplete phloem sap to cause yield reductions.
- Sooty mold development on leaves, inhibits photosynthesis, and reduces yield and quality.
- Both adults and nymphs secrete concentrated honeydew, causing sticky lint.
- Vectors viruses causing cotton leaf curl and cotton leaf crumple diseases.




Whitefly Severity in Cotton in the United States

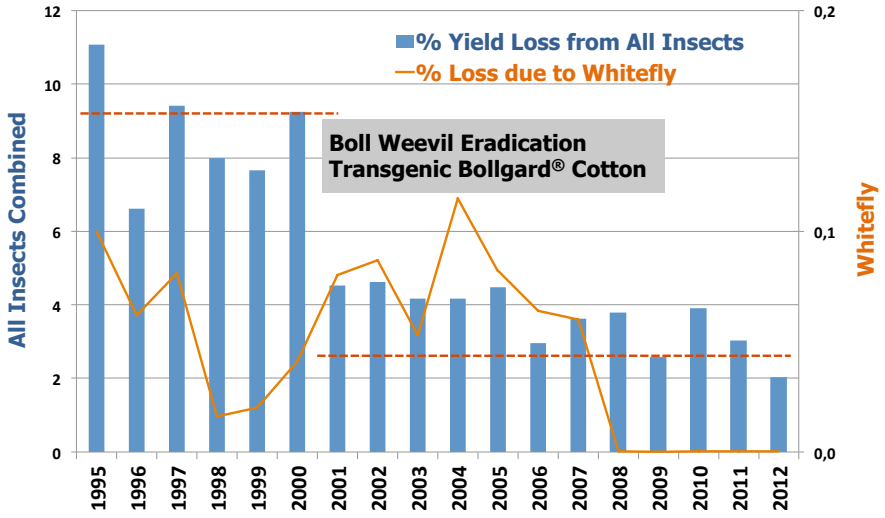


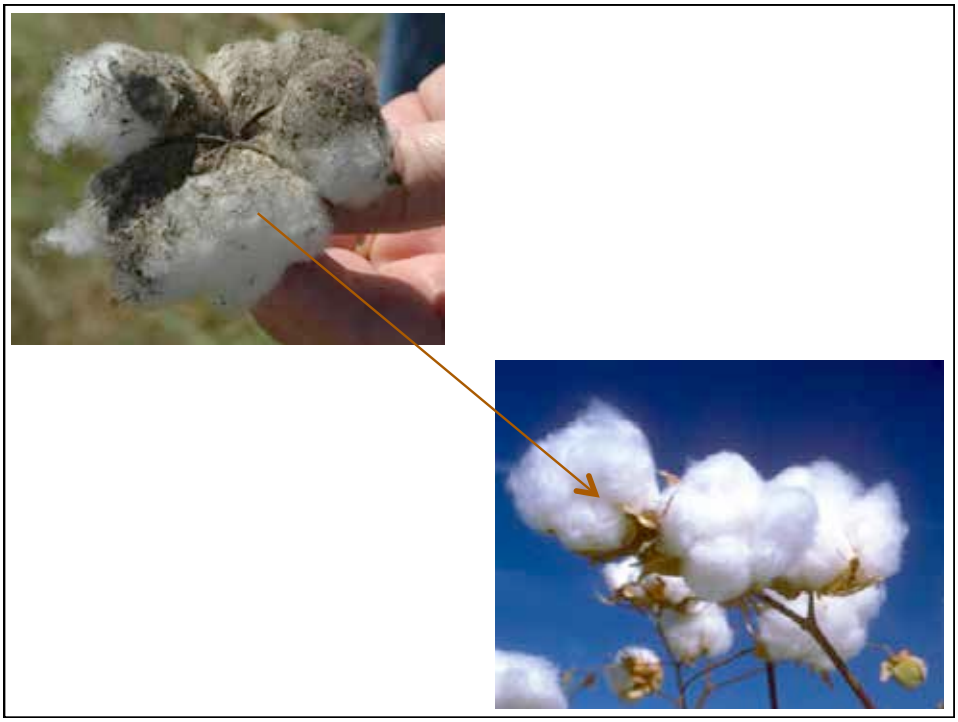
The Problem

Why the Whitefly is More Problematic than Other Insects?

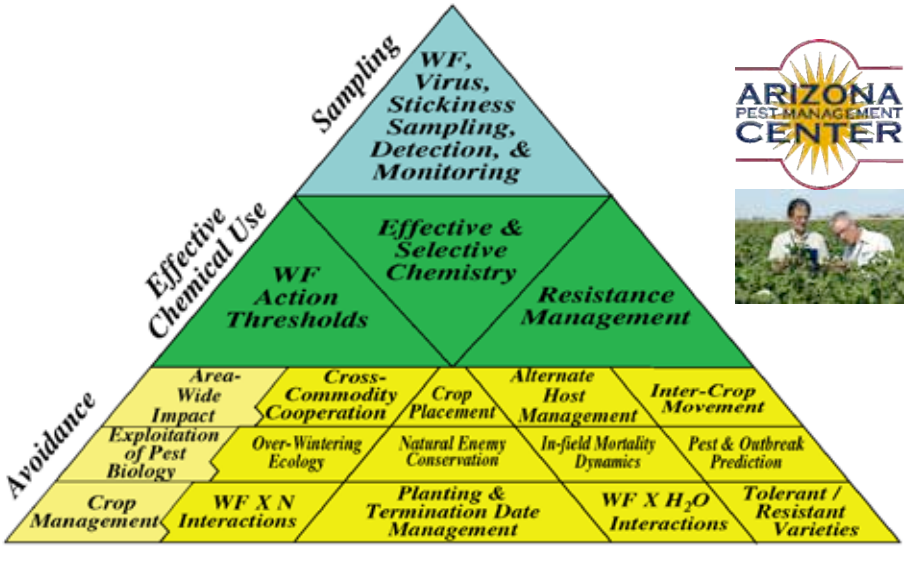
Deposition of Honeydew | Sticky Lint | Fiber Processing

U.S. Cotton Lint Loss: Whitefly vs. Other Insects





Comprehensive Integrated Approach
Whitefly IPM in the Western United States



Sampling

Whitefly, Virus, and Sticky Lint

- **Monitor the field margins**
- **Sample for whiteflies twice a week during the critical periods (leaf turning for adults and leaf discs for nymphs)**
- **Treatment threshold**
  - **40% leaves infested with >3 adults or large nymphs (early season)**
  - **10 adults per leaf or 3 nymphs per cm^2 disc**
  - **Thermodetector counts of 5 is the sticky lint threshold**

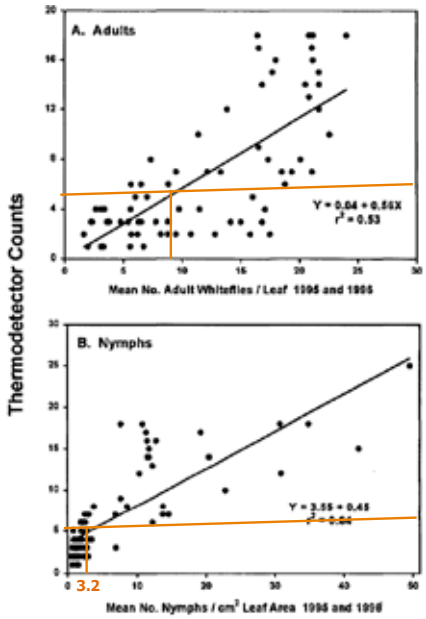


Fig 5. Mean numbers of (A) *B. argentifolii* adults per leaf turn, (B) all-stage nymphs per square centimeter of leaf disk and thermodetector counts in 1995 and 1996.

Henneberry et al. 1998

Threshold for Sticky Lint

9 adults/leaf

3.2 nymphs/cm^2 leaf disk

Effective Chemical Use

- **Early season for nymphs: IGRs (Insect growth Regulators) [Buprofezin (Courier), Pyriproxyfen (Knack), Spiromesifin (Oberon).**
- **Early season for adults: Non-pyrethroid insecticides [acetamiprid (Assail), Chlorpyrifos (Lorsban), Oxamyl (Vydate)].**
- **Avoid pyrethroids (broad-spectrum) until boll open**
  - **Increase spider mites and aphids**
  - **More toxic to natural enemies**
- **Late season populations: Pyrethroids [Bifenthrin (Brigade), Fenpropathrin (Danitol)], plus OP.**

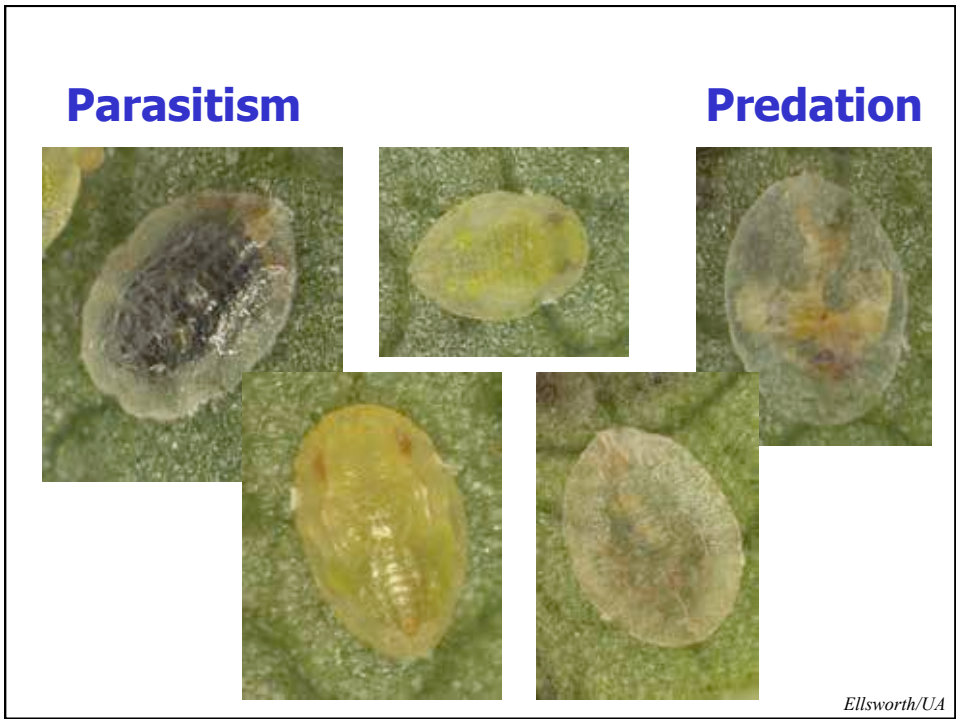
Resistance Management

- **Both Biotype B and Q resistant to most commonly used insecticides by 1990s**
- **International cooperation (IACR- Rothamsted and Bet Dagan, Israel)**
- **Cooperative research: California, Arizona, and Texas**
- **Conserve natural enemies, limit/selective insecticide use, diversify the insecticide chemistry**
- **Three-stage chemical use: IGR, other non-pyrethroid insecticides, and synergized pyrethroids**
- **Sampling, threshold, and agronomic/cultural methods**


Approach

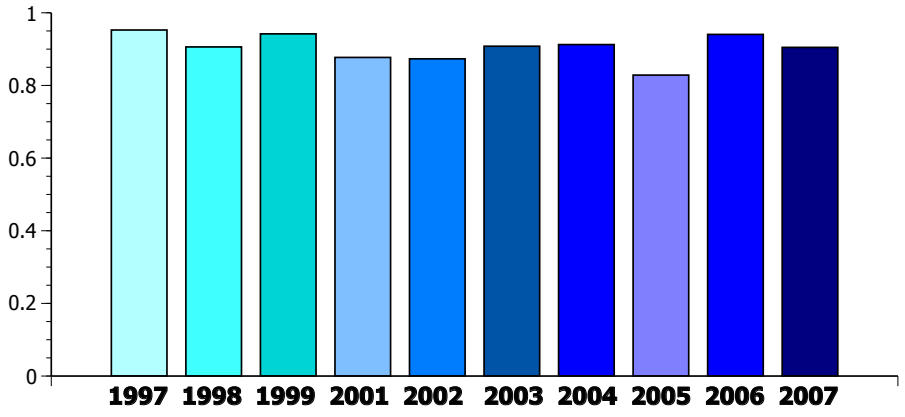

Whitefly adult stuck to leg
Biologically and Ecologically Driven Management System
20 predator species and 5 parasitoid species


Biological Control
Unsprayed
Natural Enemies Excluded
Broad-spectrum Lygus sprays release whiteflies
Naranjo & Ellsworth, Pest Management Science, 2009


Parasitism
Predation
Ellsworth/UA

Generational Mortality > 90%

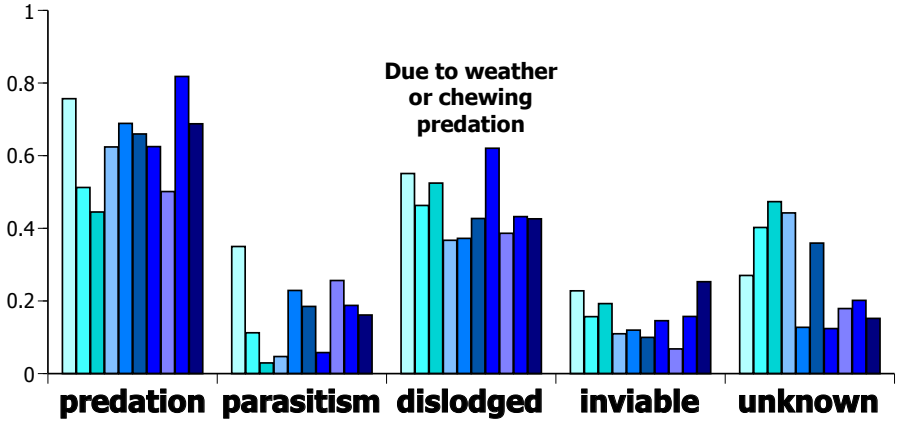
Natural Mortality!!!



10-yr untreated cotton
Apparent mortalities

Ellsworth/UA

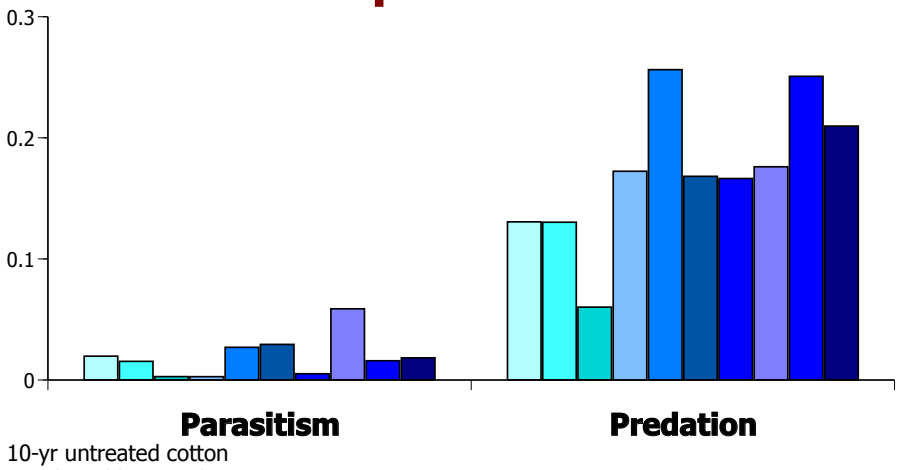
Predation consistent mortality factor



10-yr untreated cotton
Marginal mortalities

Ellsworth/UA

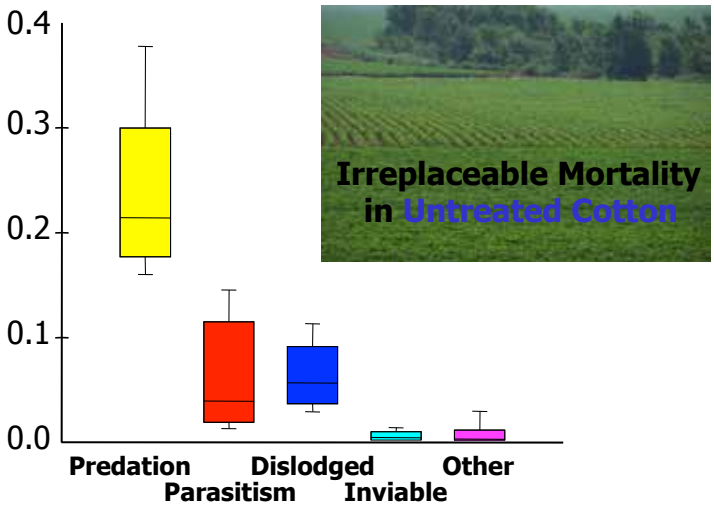
Predation provides much higher irreplaceable mortality than parasitoids



10-yr untreated cotton
Irreplaceable mortalities

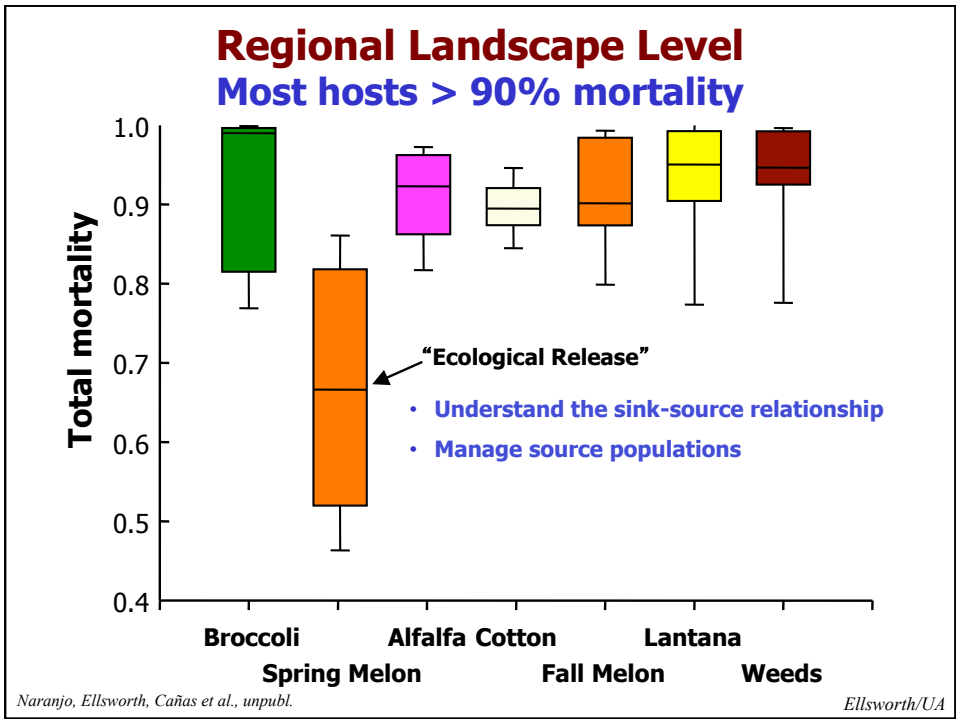
Ellsworth/UA

Predation is highest factor



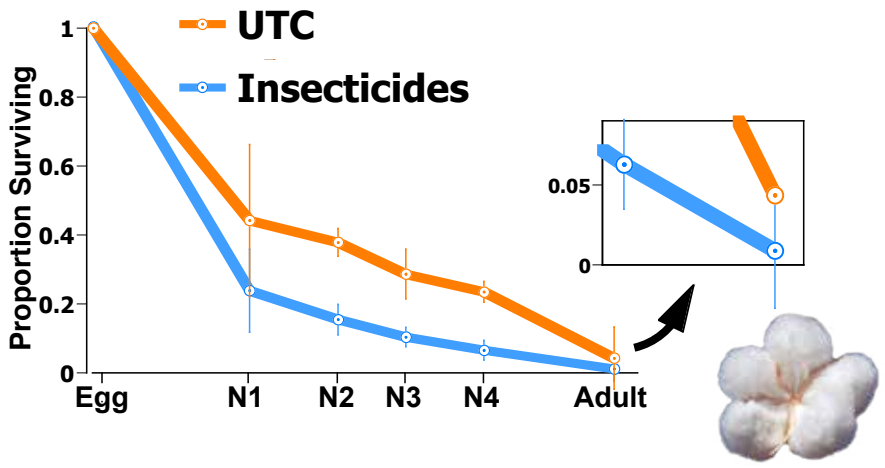
Naranjo & Ellsworth, Entomologia Exp. et Appl. 2005

Ellsworth/UA


Regional Landscape Level
Most hosts > 90% mortality
Total mortality
1.0
0.9
0.8
0.7
0.6
0.5
0.4
"Ecological Release"
• Understand the sink-source relationship
• Manage source populations
Broccoli
Spring Melon
Alfalfa
Cotton
Fall Melon
Lantana
Weeds
Naranjo, Ellsworth, Cañas et al., unpubl.
Ellsworth/UA

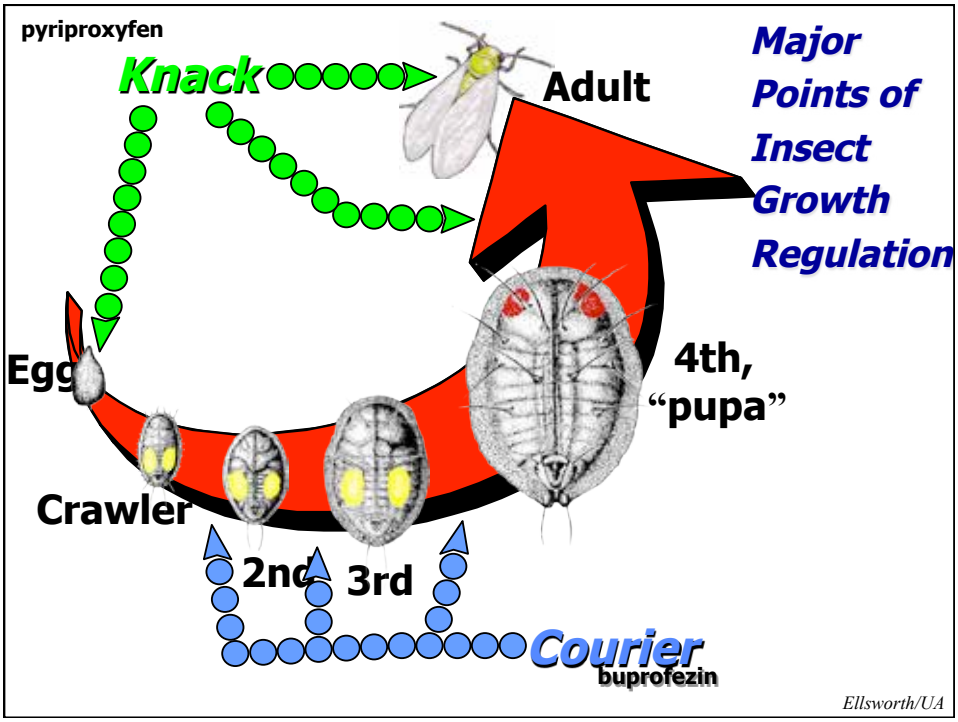

Selective and Effective Use of Chemicals
Selective
Insecticide

Selective insecticides drive survivorship to < 5%



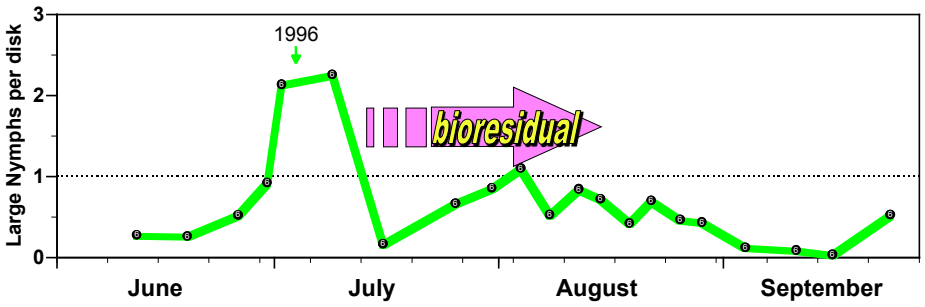
Naranjo & Ellsworth, Entomologia Exp. et Appl. 2005

Ellsworth/UA



Ellsworth/UA

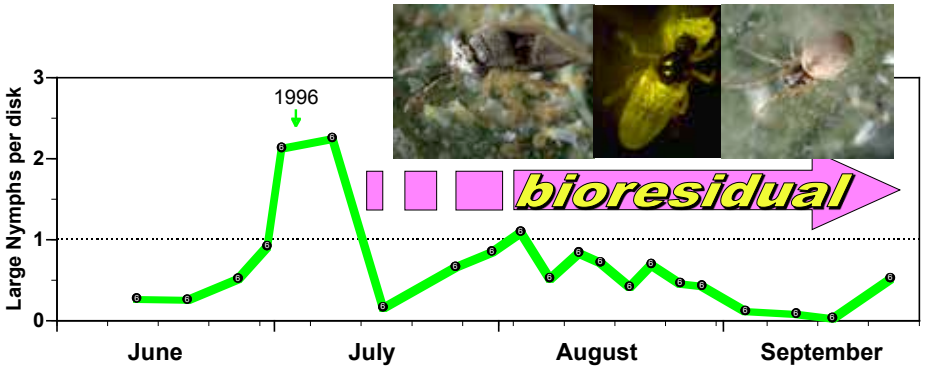
Historical Comparisons
IGR Pyriproxyfen, 1996



Naranjo & Ellsworth, Pest Management Science, 2009

Ellsworth/UA

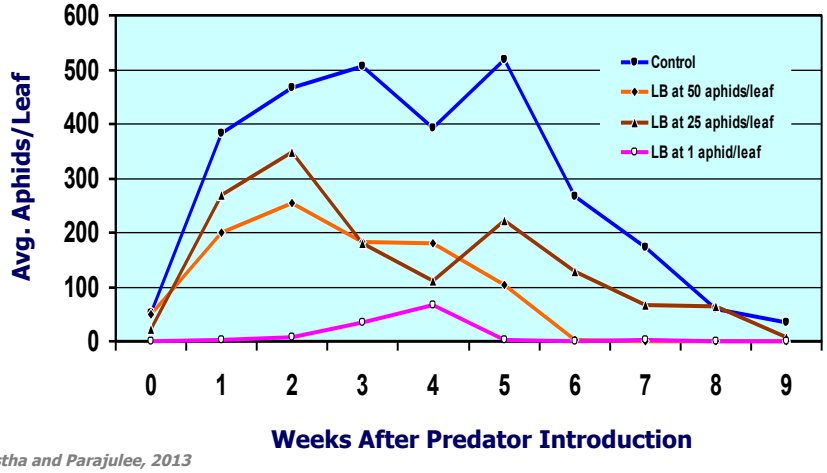
Historical Comparisons
IGR Pyriproxyfen, 1996



Naranjo & Ellsworth, Pest Management Science, 2009

Ellsworth/UA

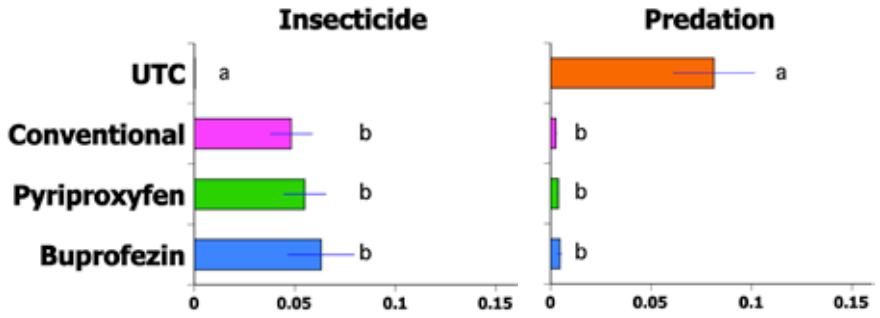
Cotton Aphid Population Suppression by Convergent Lady Beetle in Cotton, Lubbock, Texas



Shrestha and Parajulee, 2013

Integration of Insecticides and Predation
Insecticides Replace Predation

Irreplaceable Mortality in Selective vs. Conventional Sprays: 1st Generation Post

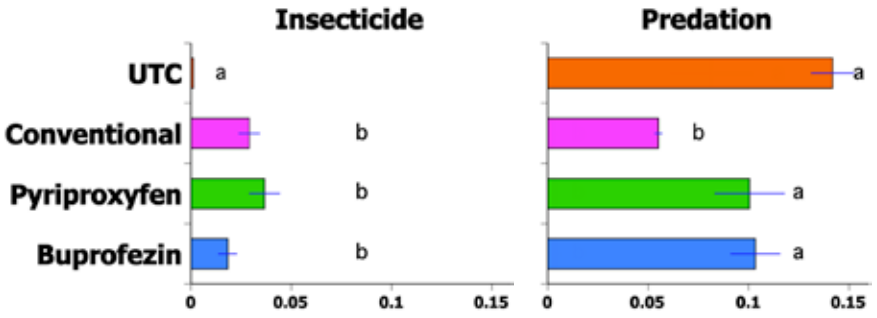


Naranjo & Ellsworth, Pest Management Science, 2009

Ellsworth/UA

Benefits of bioresidual

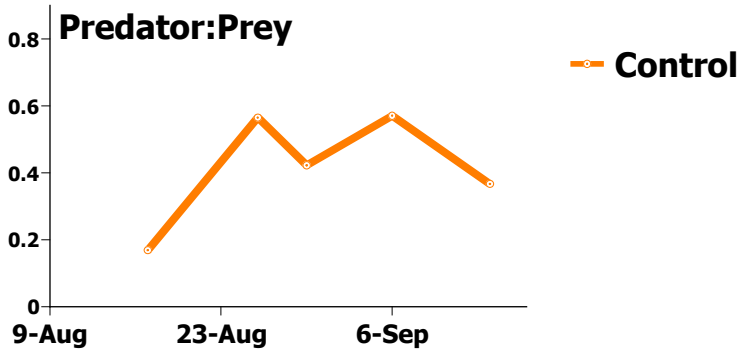
2nd Generation Post



Naranjo & Ellsworth, Pest Management Science, 2009

Ellsworth/UA

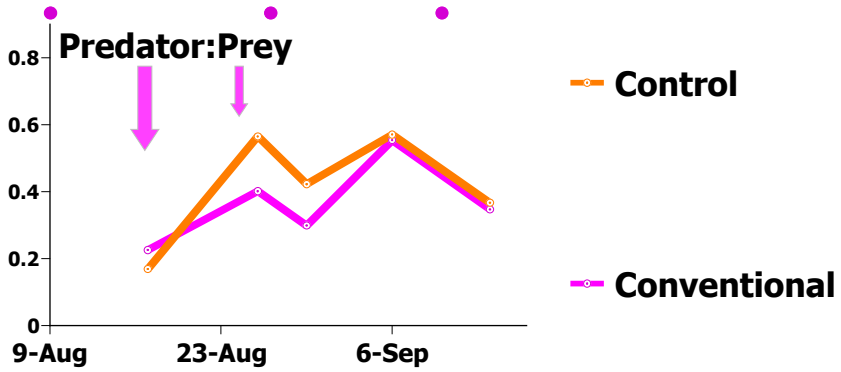
Predators increase & keep pace



Naranjo, Ellsworth, Hagler, Bio. Control 2004

Ellsworth/UA

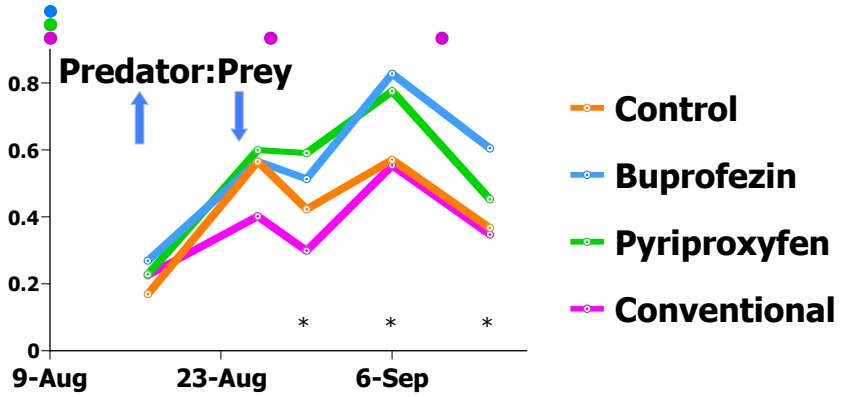
No improvement in balance



Naranjo, Ellsworth, Hagler, Bio. Control 2004

Ellsworth/UA

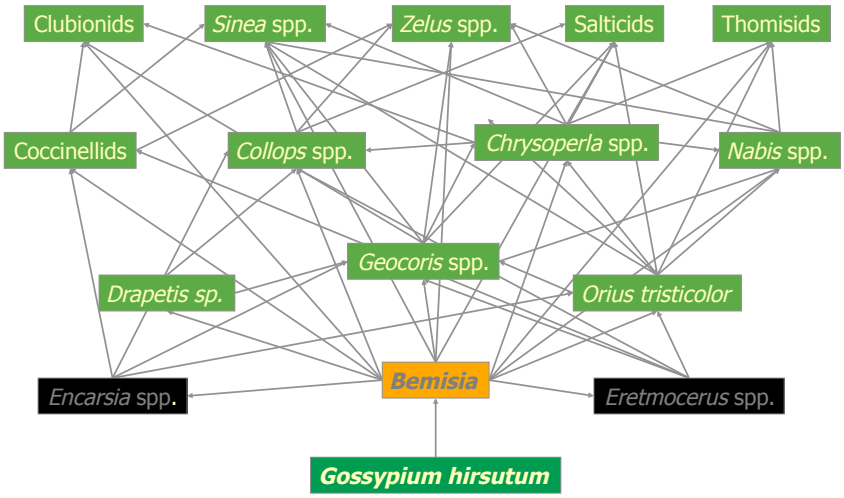
Selective insecticides improve balance significantly



Naranjo, Ellsworth, Hagler, Bio. Control 2004

Ellsworth/UA

Food Web in Cotton

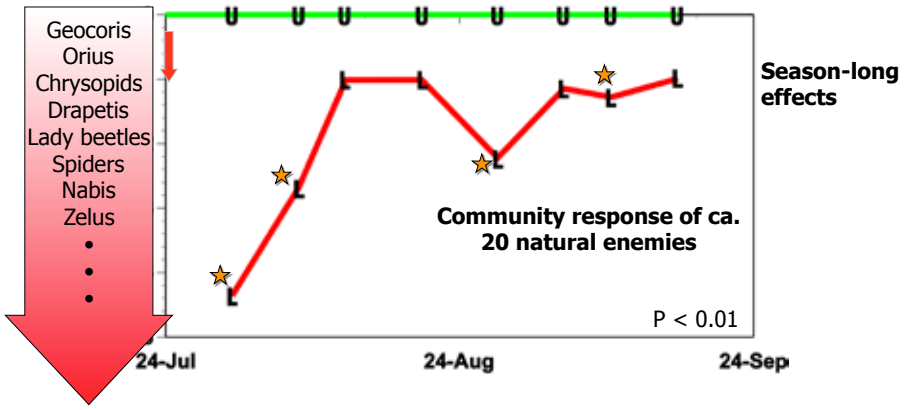


Ellsworth/UA

Principal Response Curve

Natural Enemies to Broad Spectrum Insecticide

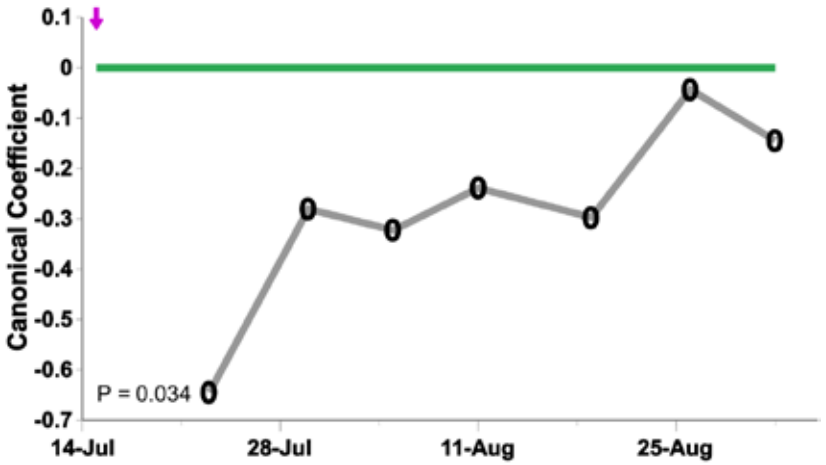
No Broad-Spectrum Insecticide Early



Naranjo, Ellsworth, Hagler, Biol. Control 2004

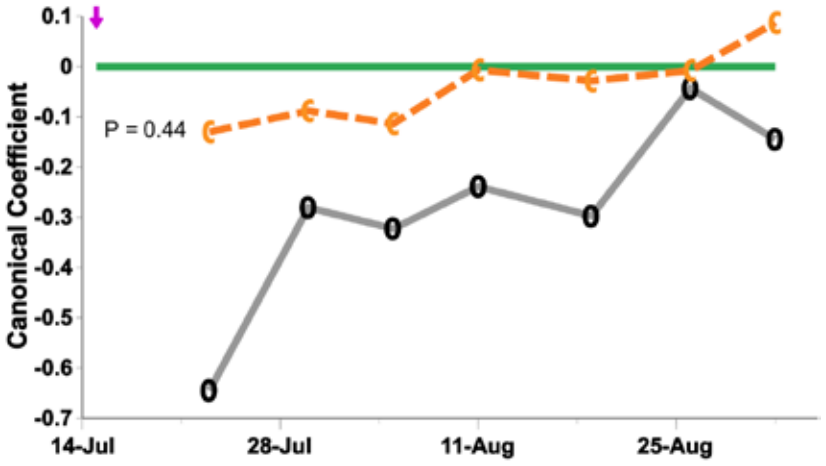
Ellsworth/UA

Orthene (acephate)



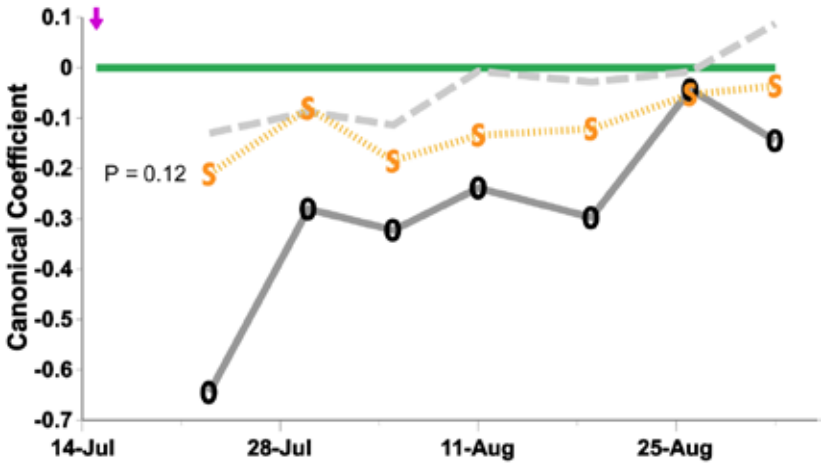
Ellsworth/UA

Cyazypyr



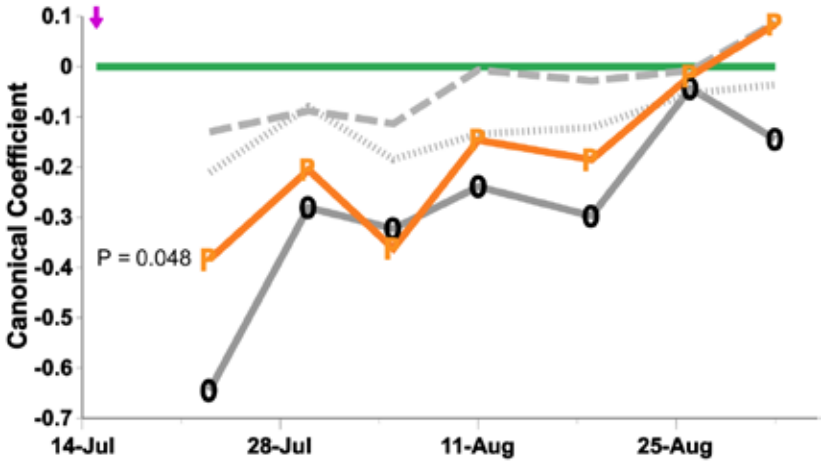
Ellsworth/UA

Spirotetramat

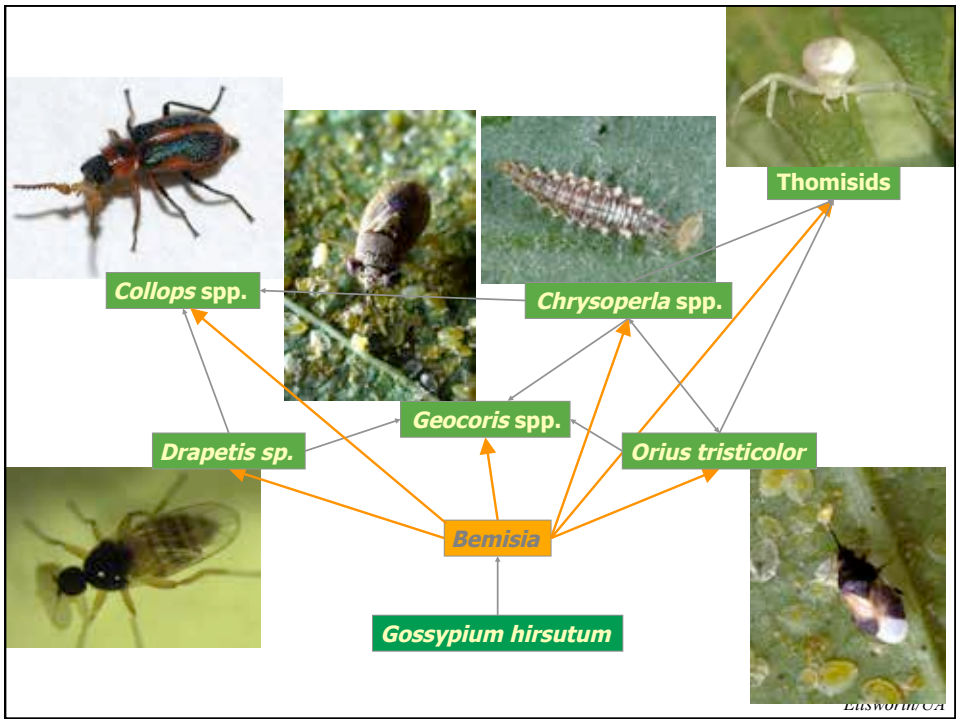


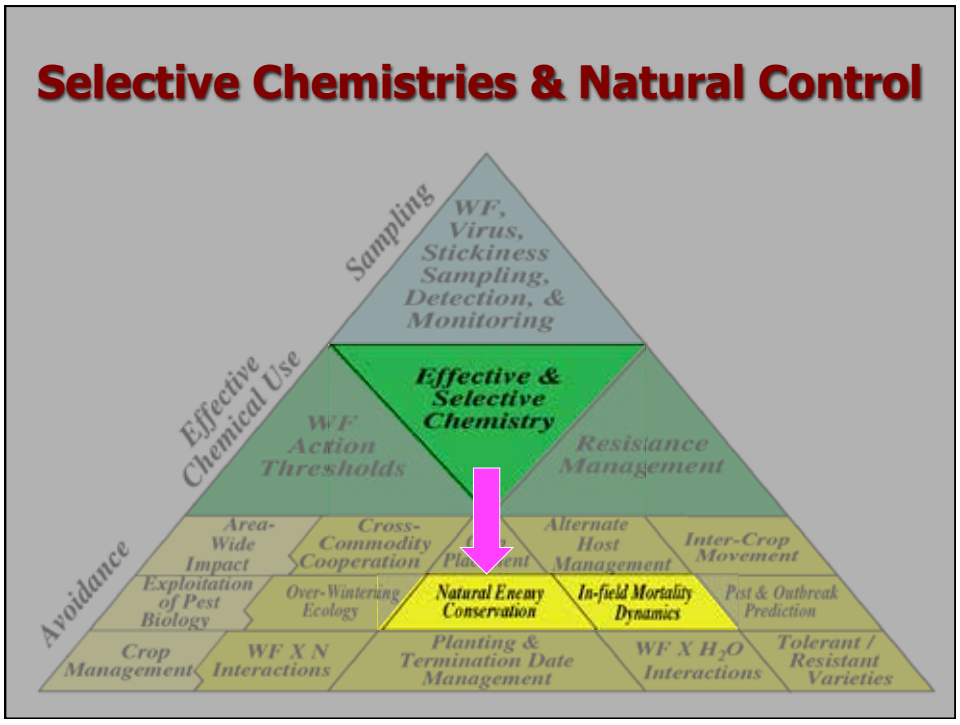
Ellsworth/UA

Pyrifluquinazon



Ellsworth/UA


Thomisids
Collops spp.
Chrysoperla spp.
Geocoris spp.
Drapetis sp.
Orius tristicolor
Bemisia
Gossypium hirsutum


Selective Chemistries & Natural Control
Sampling
WF, Virus, Stickiness Sampling, Detection, & Monitoring
Effective Chemical Use
Effective & Selective Chemistry
WF Action Thresholds
Resistance Management
Avoidance
Area-Wide Impact
Cross-Commodity Cooperation
Alternate Host Management
Inter-Crop Movement
Exploitation of Pest Biology
Over-Wintering Ecology
Natural Enemy Conservation
In-field Mortality Dynamics
Pest & Outbreak Prediction
Crop Management
WF X N Interactions
Planting & Termination Date Management
WF X H2O Interactions
Tolerant / Resistant Varieties

Integration of Chemical and Biological Tactics

Ecological and Agronomic Considerations

Selectivity and Efficiency of Insecticides

Fully Selective

Buprofezin (Courier)
Pyriproxyfen (Knack)
*Spiromesifen (Oberon)

**cyazypyr (DuPont)
**spirotetramat (Bayer)

Partially Selective

Acetamiprid (Intruder)

Dinotefuran (Venom)

*Spiromesifen (Oberon)

Thiamethoxam (Centric)

**pyrifluquinazon (Nichino)

Broad Spectrum

Pyrethroids synergized With O.P's

*dose-dependent; **experimental, preliminary results

Selectivity is key System-specific research needed!

Ellsworth/UA