Conservation Biological Control: Can it Work in the Cotton System?

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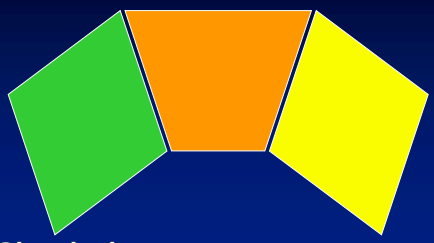
Conservation Biological Control

" Manipulation of the environment to favor natural enemies, either by removing or mitigating adverse factors or by providing lacking requisites."

DeBach 1974

Biological Control - Approaches

Conservation

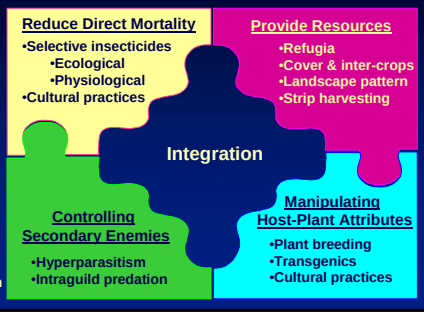


Classical

Augmentation

Conservation Biological Control

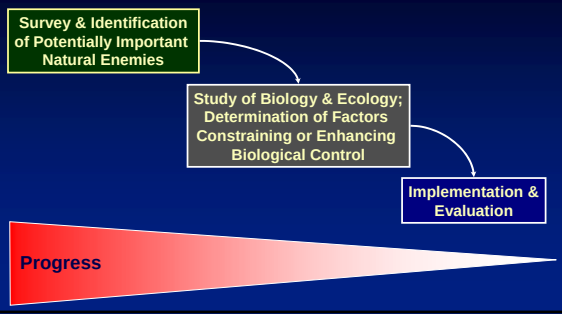
Approaches



After Rabb, Stinner & van den Bosch 1976

Conservation Biological Control

Components



Survey

Is there potential for natural biological control?

Natural Enemy Complex -Western U.S.

Parasitoids
30+ species

Hyposter
Copidosoma
Microplitis
Lysiphlebus
Chelonus
Eretmocerus
Encarsia
Anaphes
Leiophron

Predators
50+ species

Geocoris
Orius
Nabis
Zelus
Collops
Hippodamia
Drapetis
Chrysoperla
Misumenops

Pathogens
Various viruses, bacteria & fungi

Natural Enemies – *Pectinophora gossypiella*

Arizona/California

Predators
≈23 species described
9 species (immunological ID)

Parasitoids
4 native species described (rare)
16 exotic species introduced
(0 established)

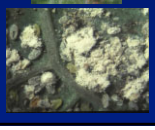
Pathogens
3+ Viruses and bacteria

Natural Enemies – *Bemisia tabaci*

Worldwide

- 114+ Predators (various methods)

- 50+ Parasitoids



- 11+ Fungi

Arizona Cotton

- 20 Predators (immunological ID)
- 3 Native parasitoids
- Many exotic parasitoids introduced
  - 2 established
- 2 Fungi?

Natural Enemies – *Lygus hesperus*

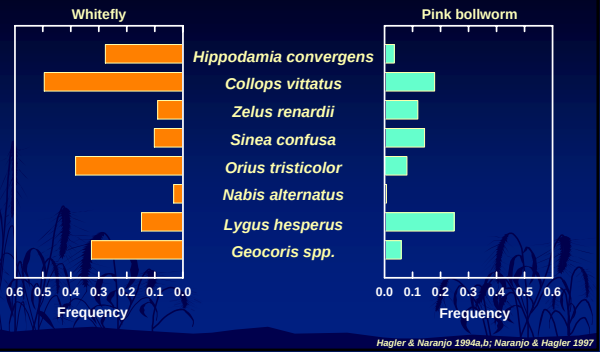
Arizona/California

Predators
10+ species described
5 species (immunological ID)

Parasitoids
3 native species described
2 exotic species introduced
(both established in CA)

Pathogens
2+ Fungi

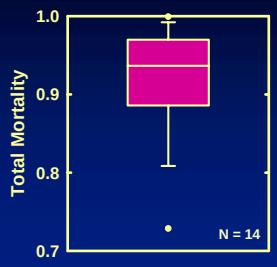
Qualitative Gut Analyses

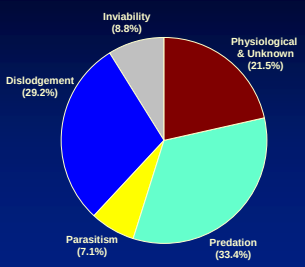


Hagler & Naranjo 1994a,b; Naranjo & Hagler 1997

Natural Mortality of Bemisia

(Arizona Cotton)

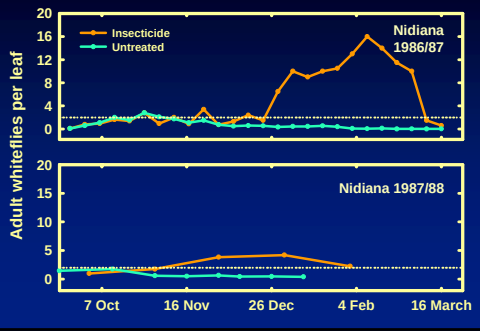




Naranjo & Ellsworth (in prep)

Biological Control Potential?

(Sudan Cotton, Abdelrahman & Munir 1989*)*



Biological Control Potential?

(some more examples)

- Elveens et al. 1973. Secondary outbreak induction of beet armyworms by experimental insecticide application in cotton in California. *Environ. Entomol. 2:497*
- Ehler et al. 1973. An evaluation of some natural enemies of cabbage looper on cotton in California. Environ. Entomol. 2: 1009
- Stoltz & Stern. 1978. Cotton arthropod food chain disruption by pesticides in the San Joaquin Valley, California. *Environ. Entomol. 7: 703 (Thrips, beet armyworm, cabbage looper)*
- Trichilo & Wilson. 1993. An ecosystem analysis of spider mite outbreak: physiological stimulations or natural enemy disruption. *Exp. Appl. Acarol. 17: 291*

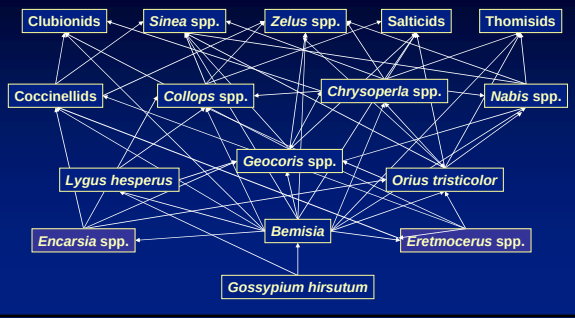
Reducing Constraints

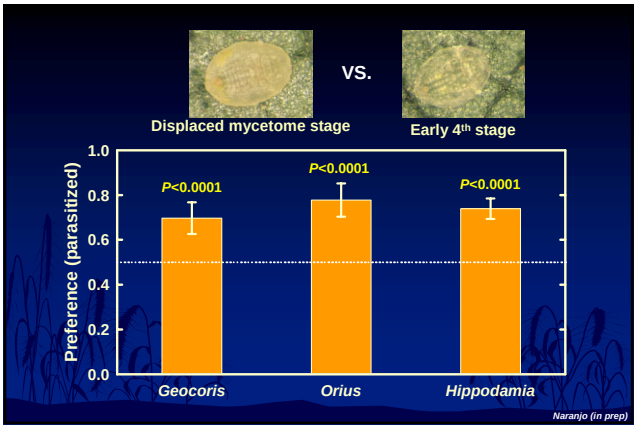
Controlling Secondary Enemies

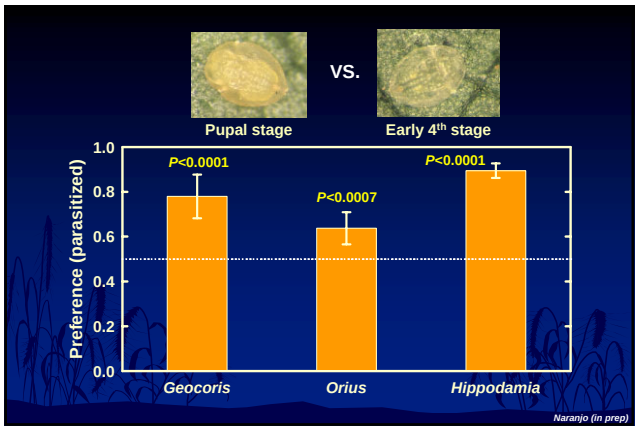
- **Hyperparasitism**
- **Intraguild predation**

Encarsia* parasitizing *Eretmocerus* in *Bemisia

Sorting out the Players

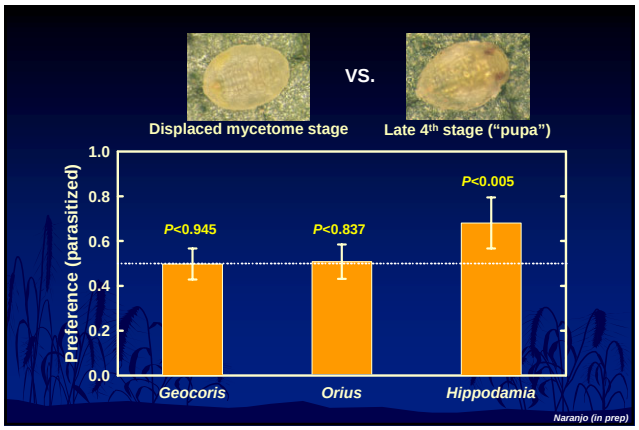






Visual Predators?

- Late 4th Stage WF ("pupa")
- Displaced mycetomes stage
- Parasitoid pupa
- Early 4th Stage WF

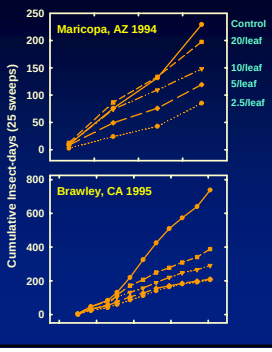


Reducing Constraints

Can insecticides be managed to promote biological control?

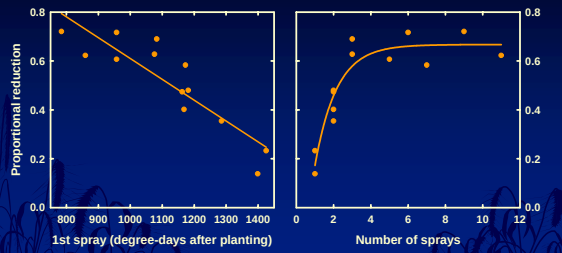
Compatibility?

Conventional Insecticides (by Threshold)



Naranjo et al. 2002. J. Econ. Entomol

Conventional Insecticides *(by Threshold)*



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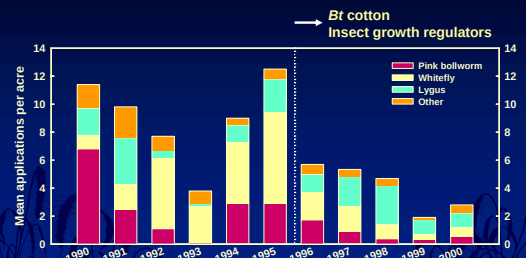
Insecticide Use Patterns

Arizona Cotton



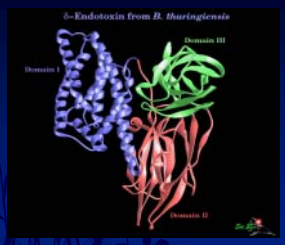
Ellsworth & Jones 2000

Selective Insecticides?

- ***Bt*** **Transgenic Cotton**

- **Applaud (Chitin Inhibitor)**
- **Knack (Juvenoid)**

Science or Emotion?



- **Resistance management**
- **Food safety**
- **Non-target effects**

Non-Target Effects

- ***Natural enemy abundance***
- ***Natural enemy diversity***
- ***Natural enemy function***

Natural Enemy Abundance

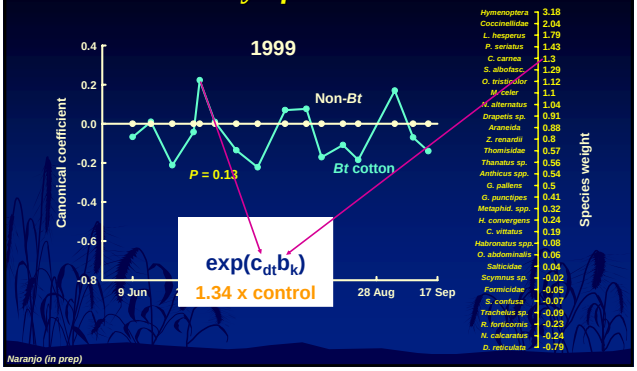
	1999			2000			2001		
Hymenoptera	●	●	0.76	●	●	0.53	●	●	0.47
Drapetis sp.	●	●	0.19	●	●	0.95	●	●	0.34
Chrysoperla carnea	●	●	0.21	●	●	0.28	●	●	0.71
Pseudatomoscelis seriatus	●	●	0.11	●	●	0.25	●	●	0.33
Lygus hesperus	●	●	0.20	●	●	0.42	●	●	0.81
Nabis alternatus	●	●	0.14	●	●	0.69	●	●	0.40
Zelus renardii	●	●	0.22	●	●	0.11	●	●	0.12
Orius tristicolor	●	●	0.45	●	●	0.54	●	●	0.49
Geocoris pallens	●	●	0.42	●	●	0.12	●	●	0.73
Geocoris punctipes	●	●	0.25	●	●	0.72	●	●	0.86
Hippodamia convergens	●	●	0.16	●	●	0.57	●	●	0.56
Collops vittatus	●	●	0.39	●	●	0.13	●	●	0.75
Misumenops celer	●	●	0.63	●	●	0.92	●	●	0.59
Lepidoptera	●	●	0.04	●	●	0.01	●	●	0.01

Naranjo 2002, in prep

Principal Response Curves Analysis

- Time-dependent multivariate analysis
- Derived from redundancy analysis (constrained form of principal component analysis)
- Provides a simple means of visualizing and testing the overall response of a biological community to an environmental disturbance

Selectivity of Bt cotton



Naranjo (in prep)

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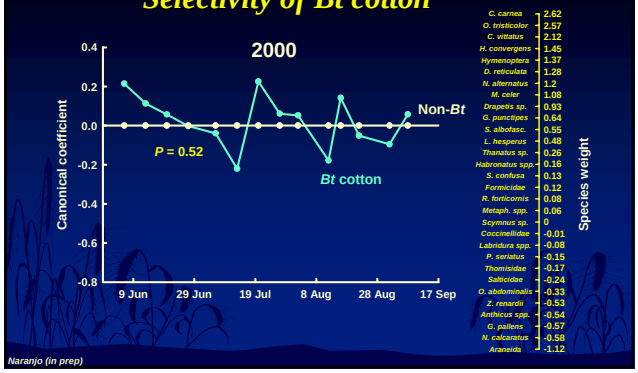

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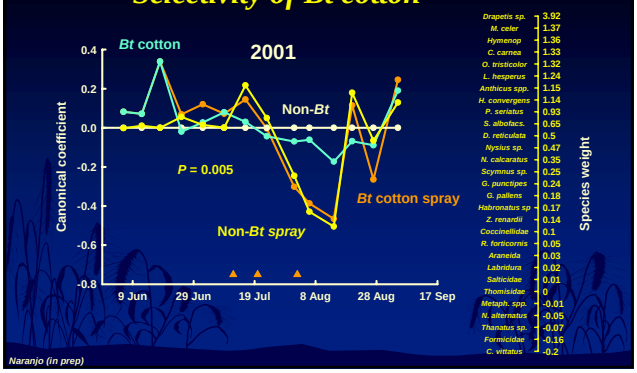

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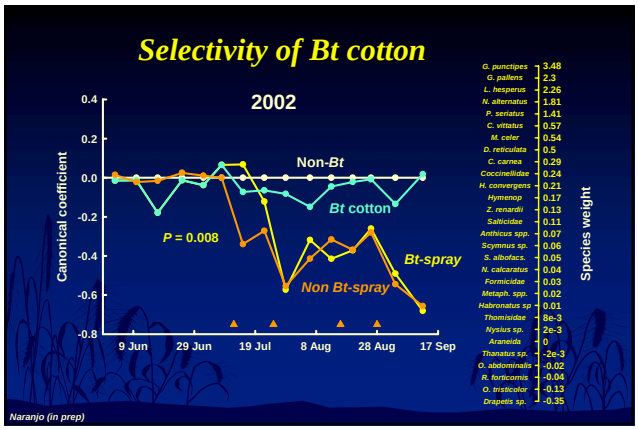
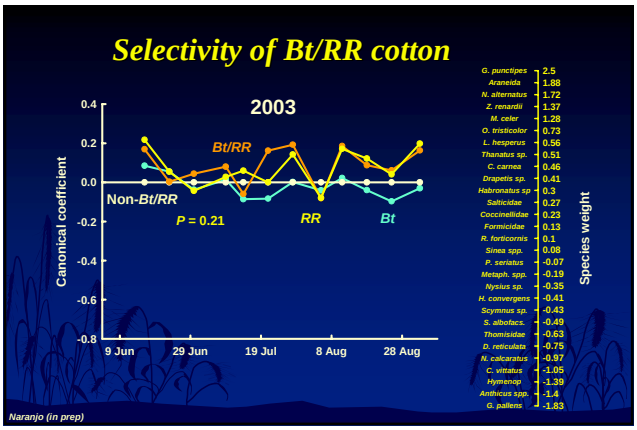


Naranjo (in prep)

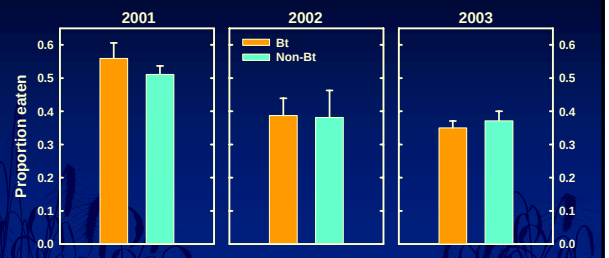
Selectivity of Bt/RR cotton



Naranjo (in prep)

Natural Enemy Function

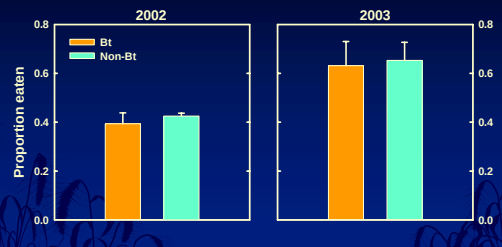
Predation on Pink Bollworm Eggs



Naranjo 2002, in prep

Natural Enemy Function

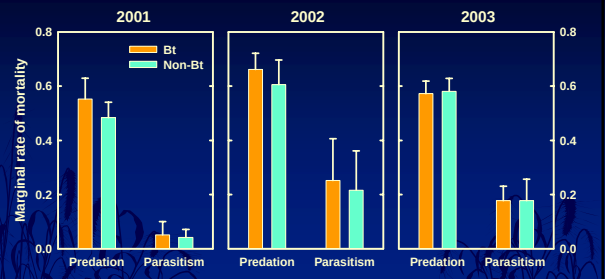
Predation on Pink Bollworm Pupae



Naranjo (in prep)

Natural Enemy Function

Mortality of Whitefly Nymphs



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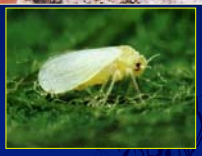
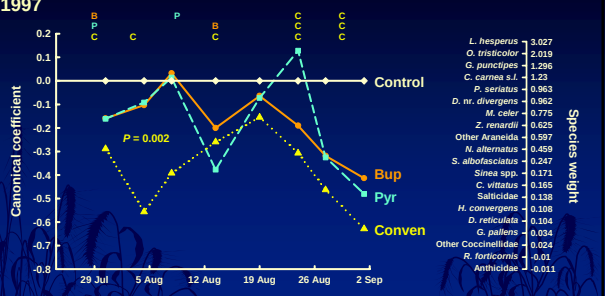


Selectivity of IGRs

1997



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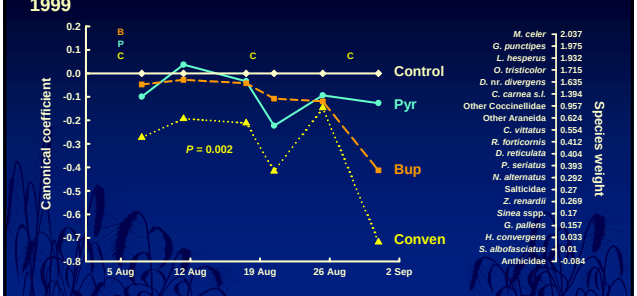
Selectivity of IGRs

1999



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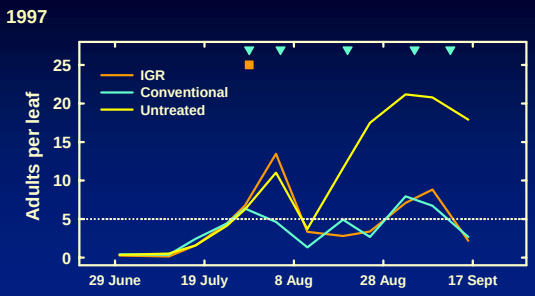
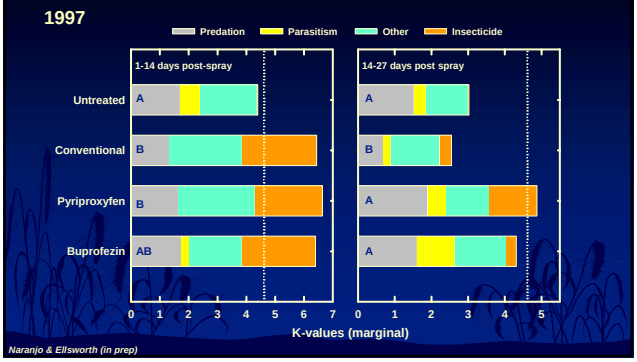
Implementation & Evaluation

Can conservation contribute to pest control?

Whitefly Pest Management



Life Table Analyses



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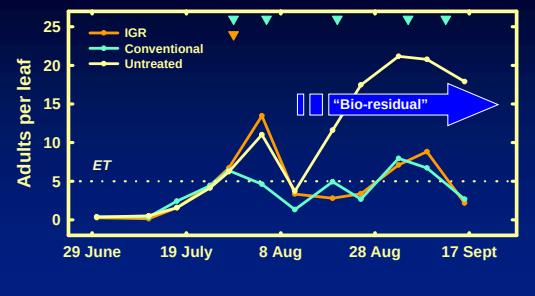
Impact of Conservation



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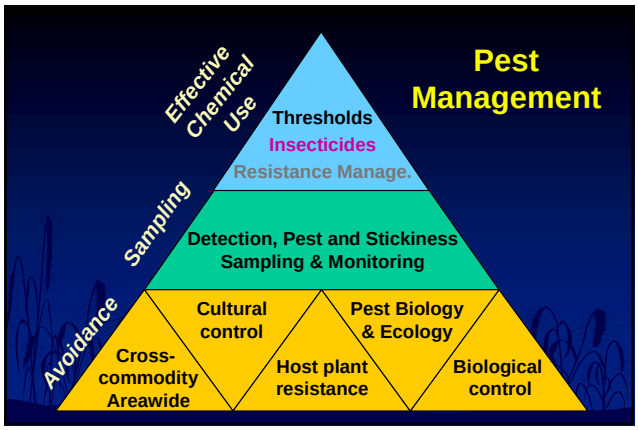
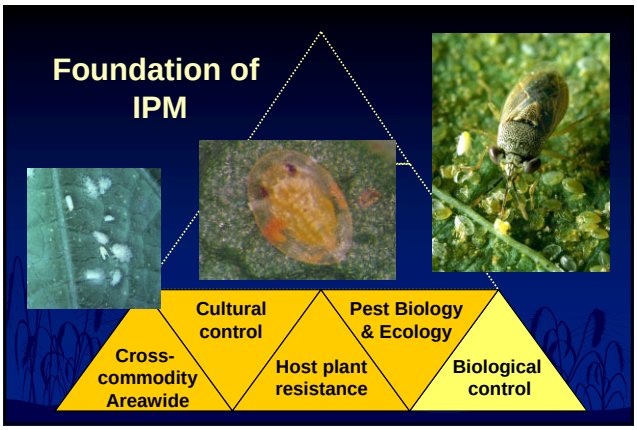
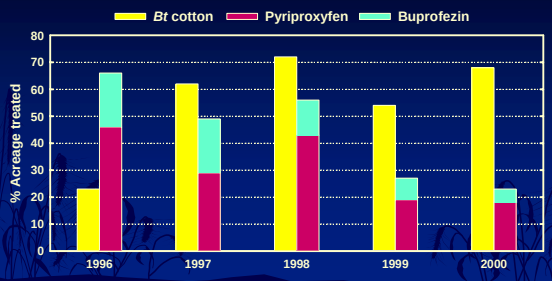




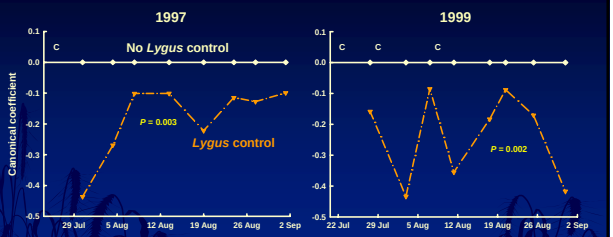
Some mitigating factors

Selective Insecticide Use

Arizona Cotton



Lygus Control - no selective options!



Naranjo et al. 2003 Biological Control (in press)

Thanks to

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