THE UNIVERSITY OF ARIZONA
COLLEGE OF AGRICULTURE AND LIFE SCIENCES

A Grower Initiated Approach for Sustaining Neonicotinoid Efficacy Across Commodities

John C. Palumbo
Peter C. Ellsworth

Sweetpotato Whitefly

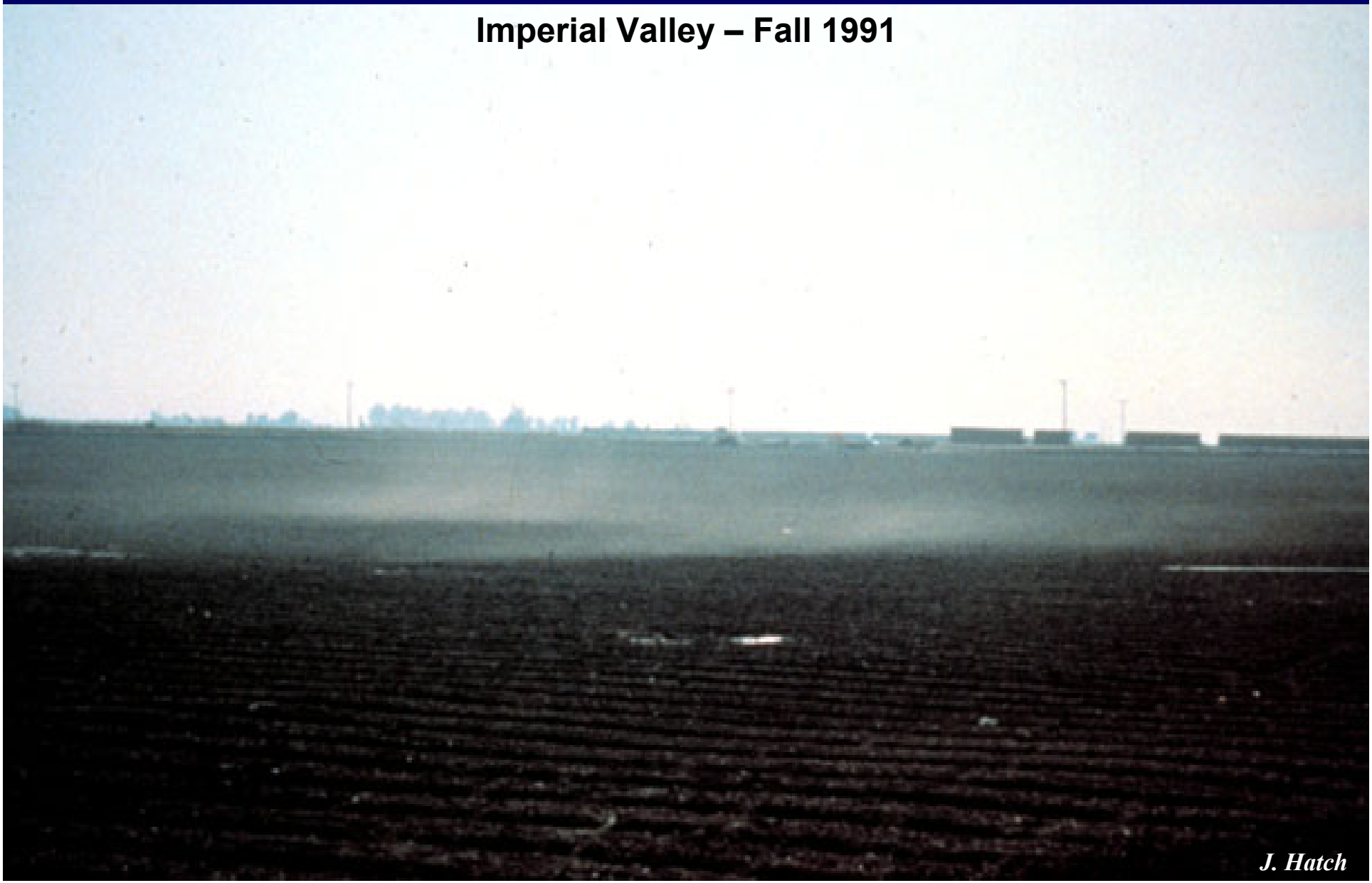
Bemisia tabaci – B biotype

From 1991-1993 in AZ and CA, outbreaks of whiteflies caused > $ 500 million worth of damage to cotton, melons & vegetables.

- **Adults very mobile**

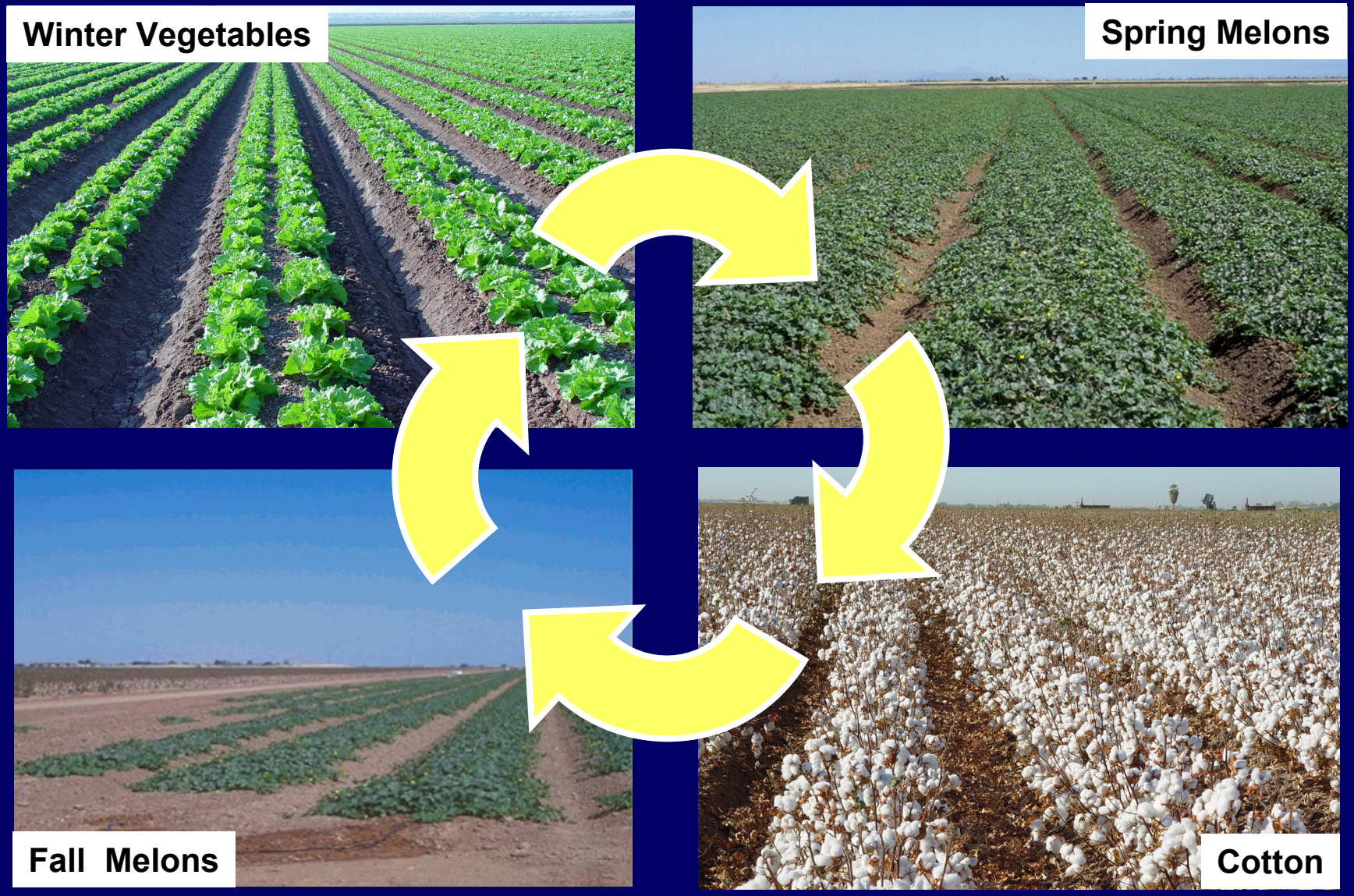
Whitefly “cloud” over newly established produce field

Imperial Valley – Fall 1991



Highly Mobile Pest in Diverse, Cropping system

Shared Whiteflies Among Key Whitefly Hosts



Imidacloprid Admire®

Neonicotinoid

Ideal Whitefly Control :

- Pre-plant injection
- Drip Chemigation
- Immediate plant protection

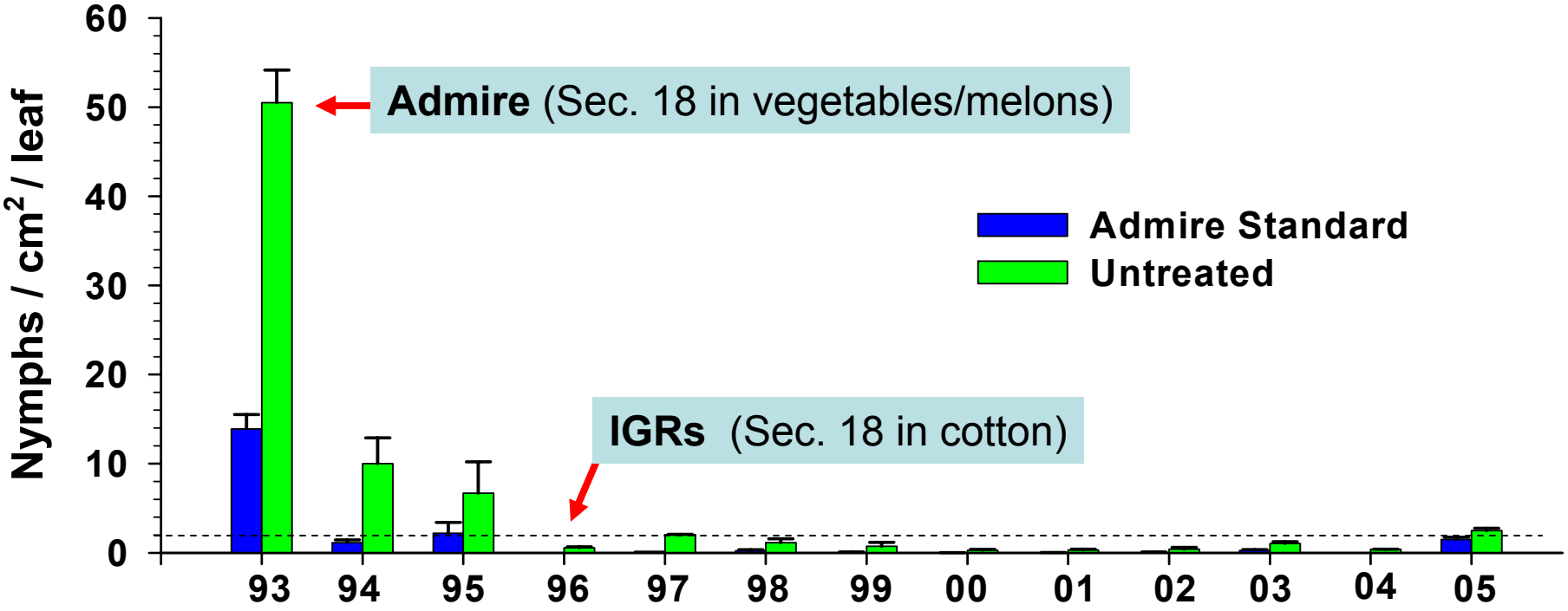
45-60 d residual control

Synergized Pyrethroids in Arizona Cotton -1995

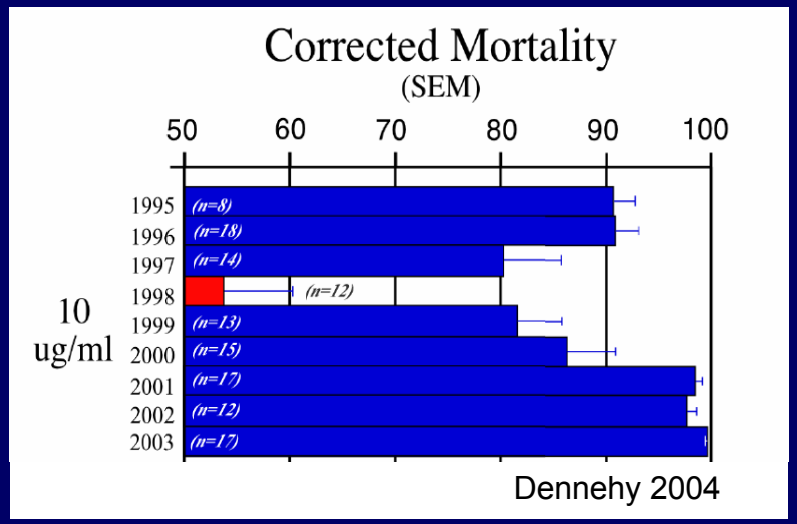
- Documented reduction in susceptibility in lab bioassays
- Reports of poor field performance in Central Arizona
- Prompted the Section 18 registrations of IGRs in 1996

Impact of Admire and IGRs on Whitefly Suppression

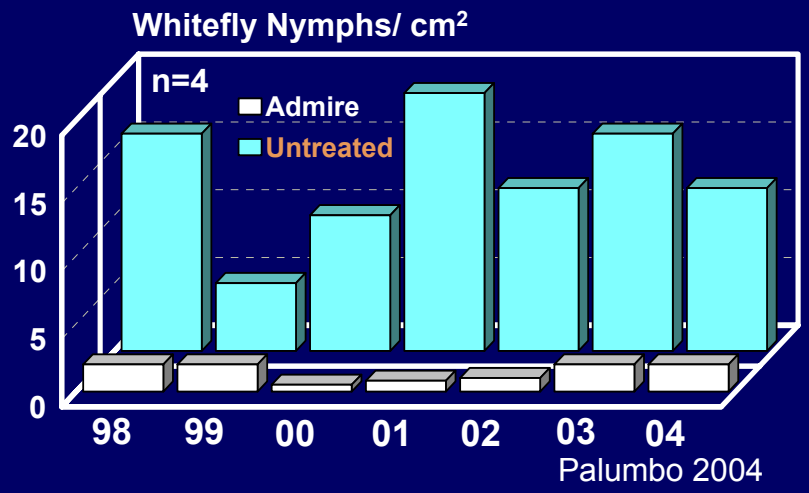
Palumbo, in press



Sustained Susceptibility



Sustained Efficacy in Commercial Broccoli



<u>Whiteflies</u> have not affected *Yield or Quality* in Yuma for the past 13 years where Admire has been applied properly.

Passive "*de facto*" Management

Cropping system

- Large acreages of untreated host plants serve as refugia
- Alfalfa, seed crops, weeds, ornamental landscape

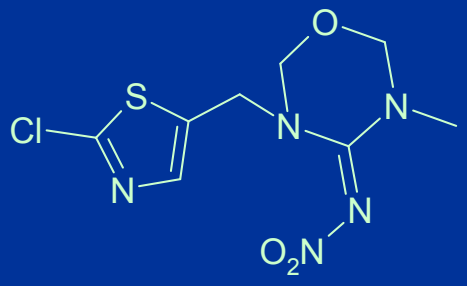
Whitefly biology and ecology

- Polyphagy, mating behavior, and dispersal capability

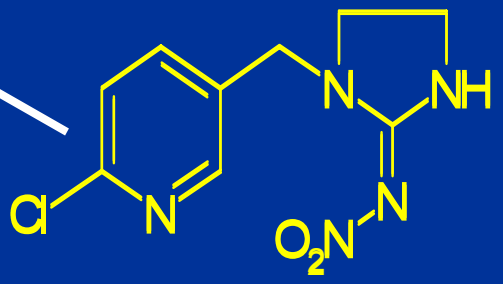
IPM Practices

- Limitation and segregation of chemistries
  - 1 use of imidacloprid in vegetables and melons
  - 1 use of IGR's in cotton
- Spatial and Temporal Insecticide Rotations
- Exposure to other non-neonicotinoid a.i.s for other pests. (acephate, chlorpyrifos, endosulfan, methomyl)
- **Foliar Neonicotinoids (Provado) not used in cotton, Not labeled in melons**

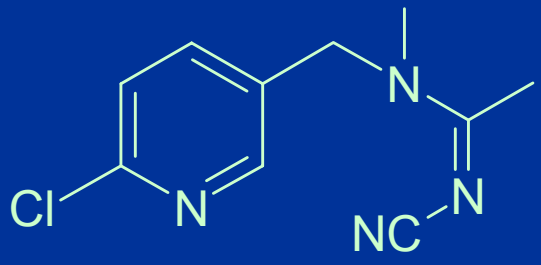
Expansion of the Neonicotinoid Chemistry



Thiamethoxam

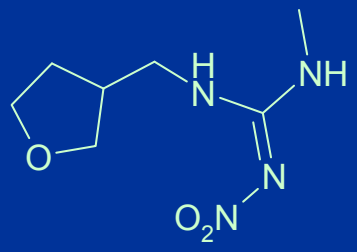


Imidacloprid

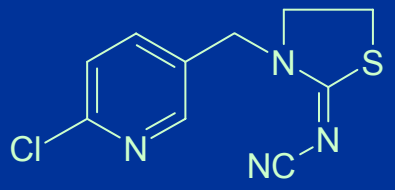


Acetamiprid

Clothianidin



Dinotefuran



Thiacloprid

Neonicotinoid Registrations in Arizona - 2005

A.I.	Product	Application	Crops Uses
acetamiprid	Assail , Intruder	Foliar	Lettuce, Cole, Cotton
dinotefuran	Venom	Foliar, Soil	All
imidacloprid	Admire, etc.	Soil	Melons, Lettuce, Cole
imidacloprid	Gaucho, etc.	Seed	Cotton
imidacloprid	Provado, etc.	Foliar	Lettuce, Cole (Cotton)
thiamethoxam	Centric	Foliar	Cotton
thiamethoxam	Cruiser	Seed	Cotton
thiamethoxam	Platinum	Soil	Melons

Arizona Cross-Commodity Working Group

- Arizona Cotton Growers Association
- AZ Cotton Research & Protection Council
- Cotton Incorporated

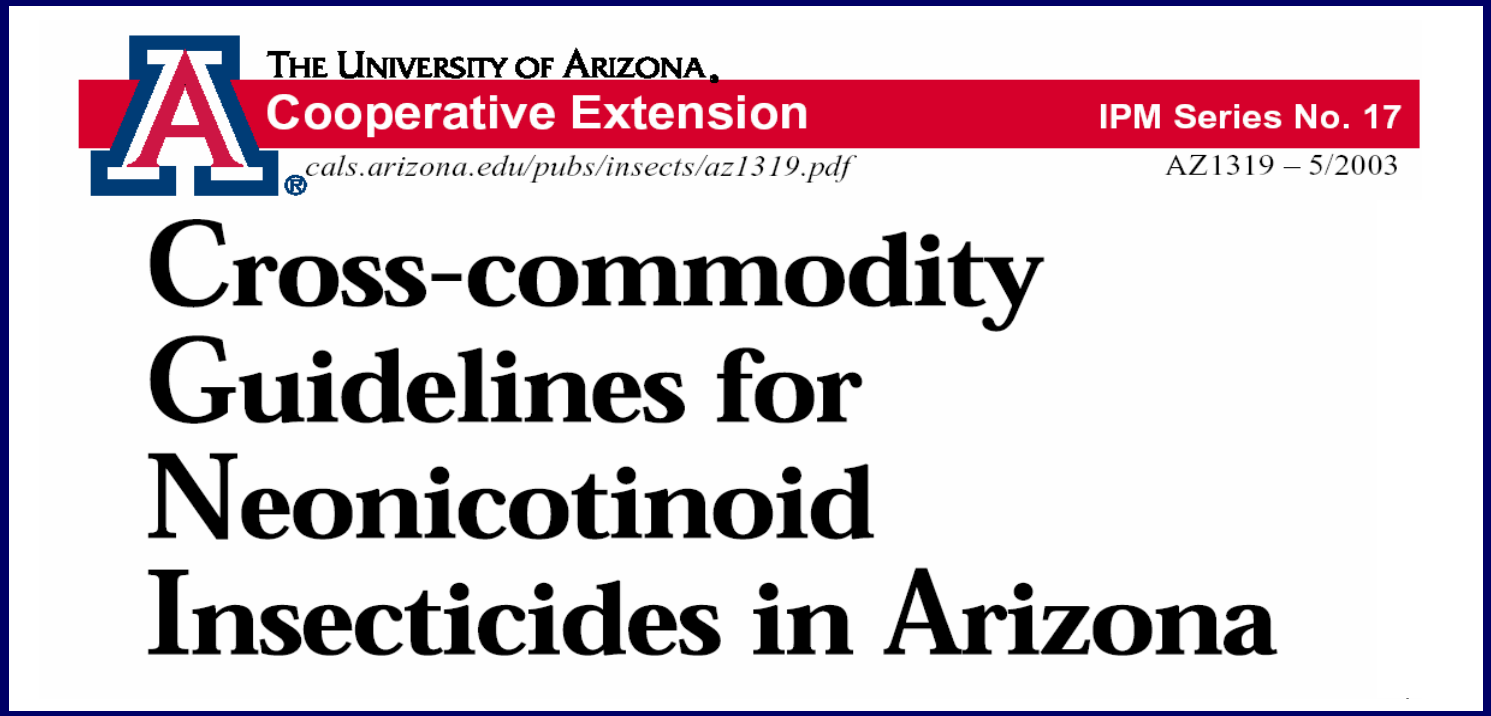
- Western Growers Association
- Arizona Veg Growers Association
- Yuma Vegetable Shippers Association

- Arizona Crop Protection Association

- Arizona Department of Agriculture
- University of Arizona

- AgriChemical Industry

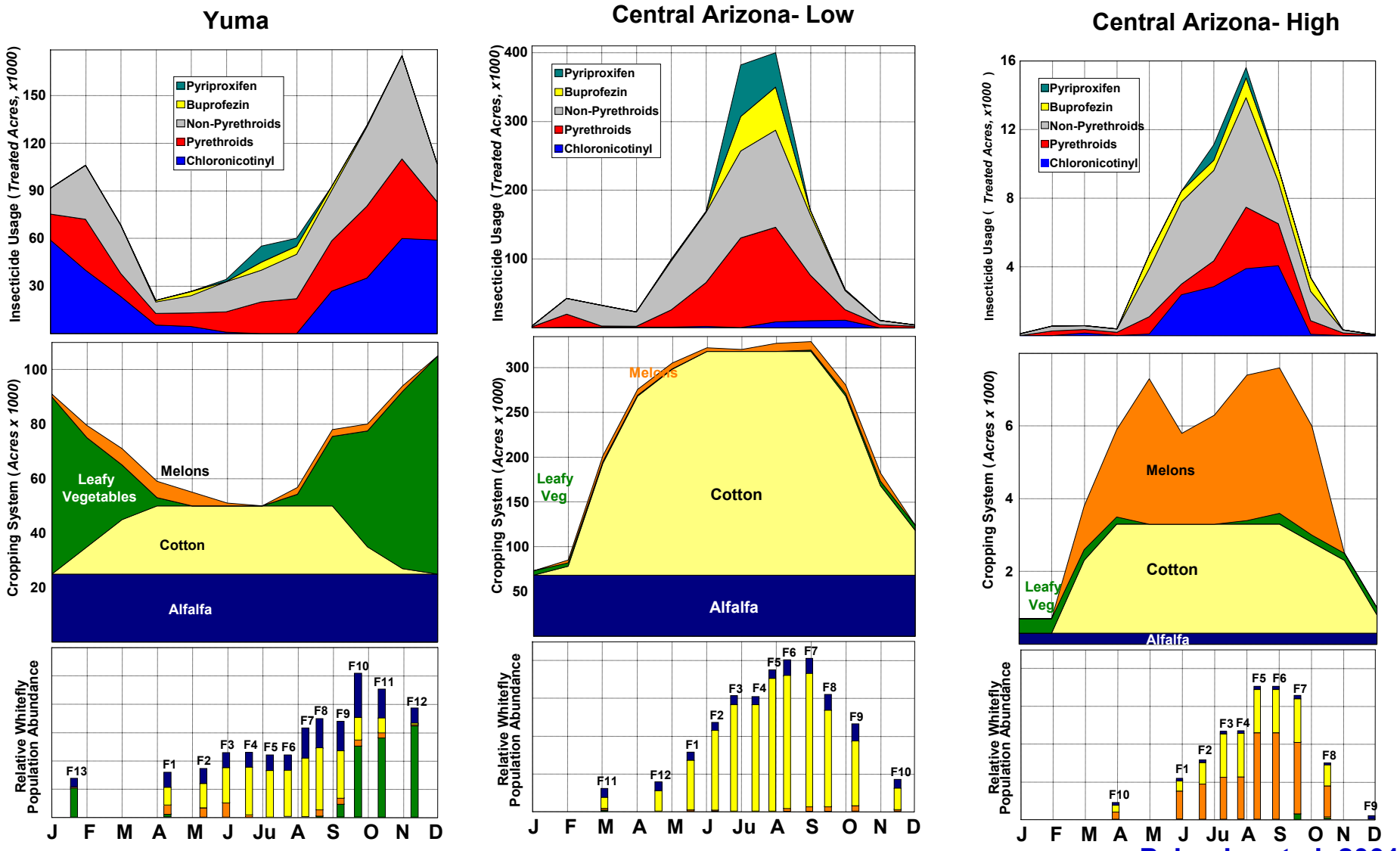
Proactive Management



“ We can’t rely on a *de facto* system anymore “

Understanding Cropping Systems

- Insecticide Use Patterns
- Seasonal Crop Diversity
- WF Population Dynamics



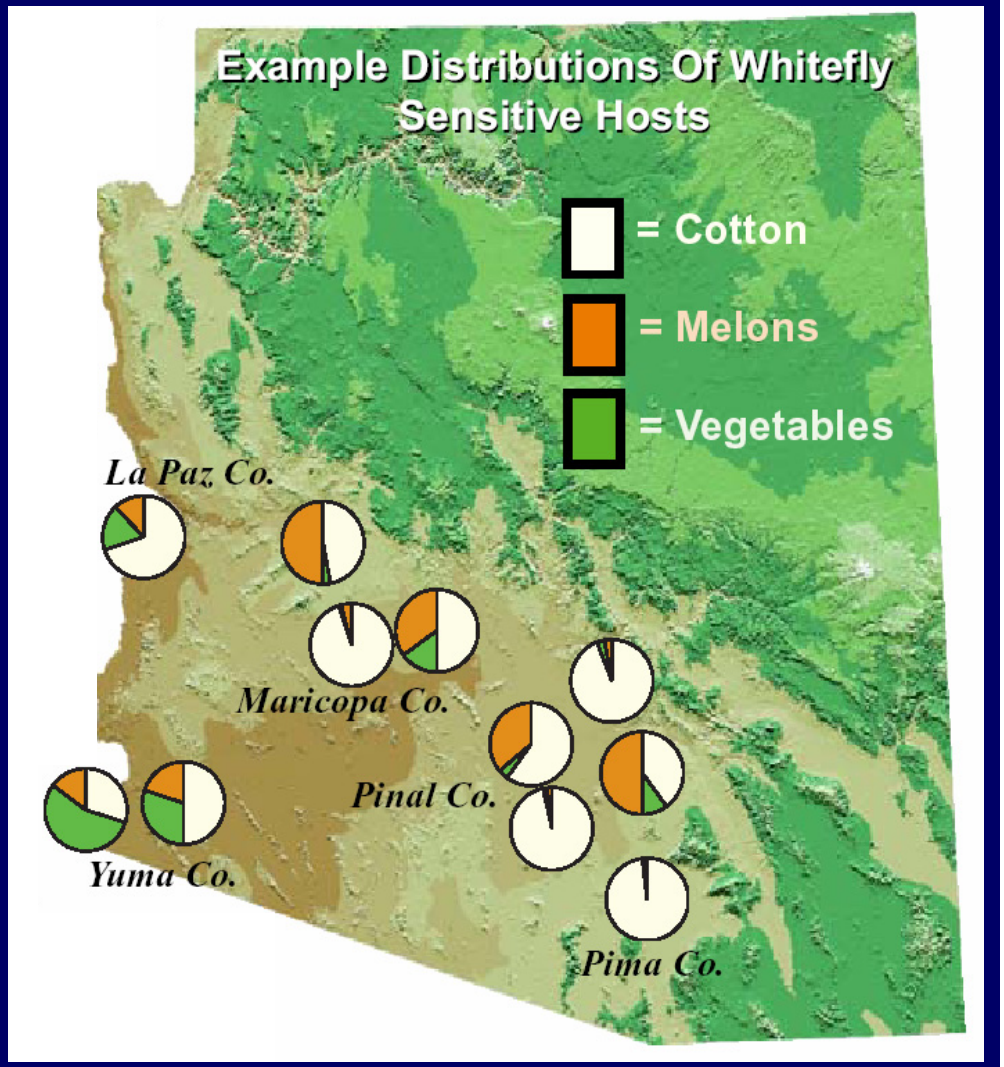
Palumbo et al. 2001

Defining a Crop Community

1) **Multi-crop Community**
   - Cotton
   - Melons
   - Vegetables

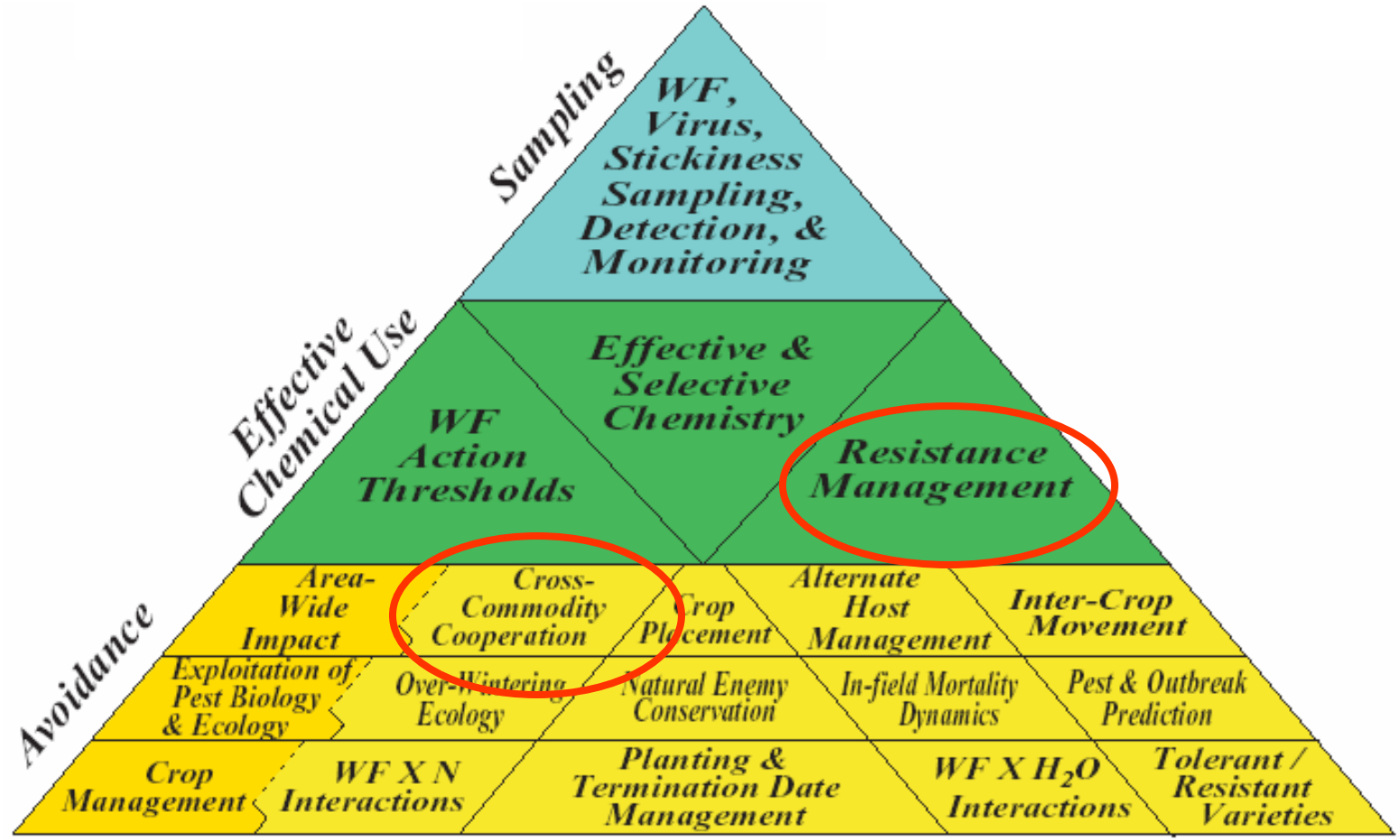
2) Cotton Intensive

3) Melon / Cotton Intensive



1. Fundamentals of Whitefly Management

- Avoid Problems through Cultural Controls
- Scouting, Sampling and Detection
- Ensure Effective Chemical Use



Ellsworth 2001

THE UNIVERSITY OF ARIZONA,
Cooperative Extension
IPM Series No. 17
cals.arizona.edu/pubs/insects/az1319.pdf
AZ1319 – 5/2003

***Summary Guidelines**: Maximum number of uses per crop season for neonicotinoids in three different cropping communities.*

Community	Cotton	Melons	Vegetables
Multi-Crop	0	1*	1**
Cotton / Melon	1	1*	—
Cotton-Intensive	2	—	—

**Soil only; **Soil or Foliar*

http://ag.arizona.edu/crops

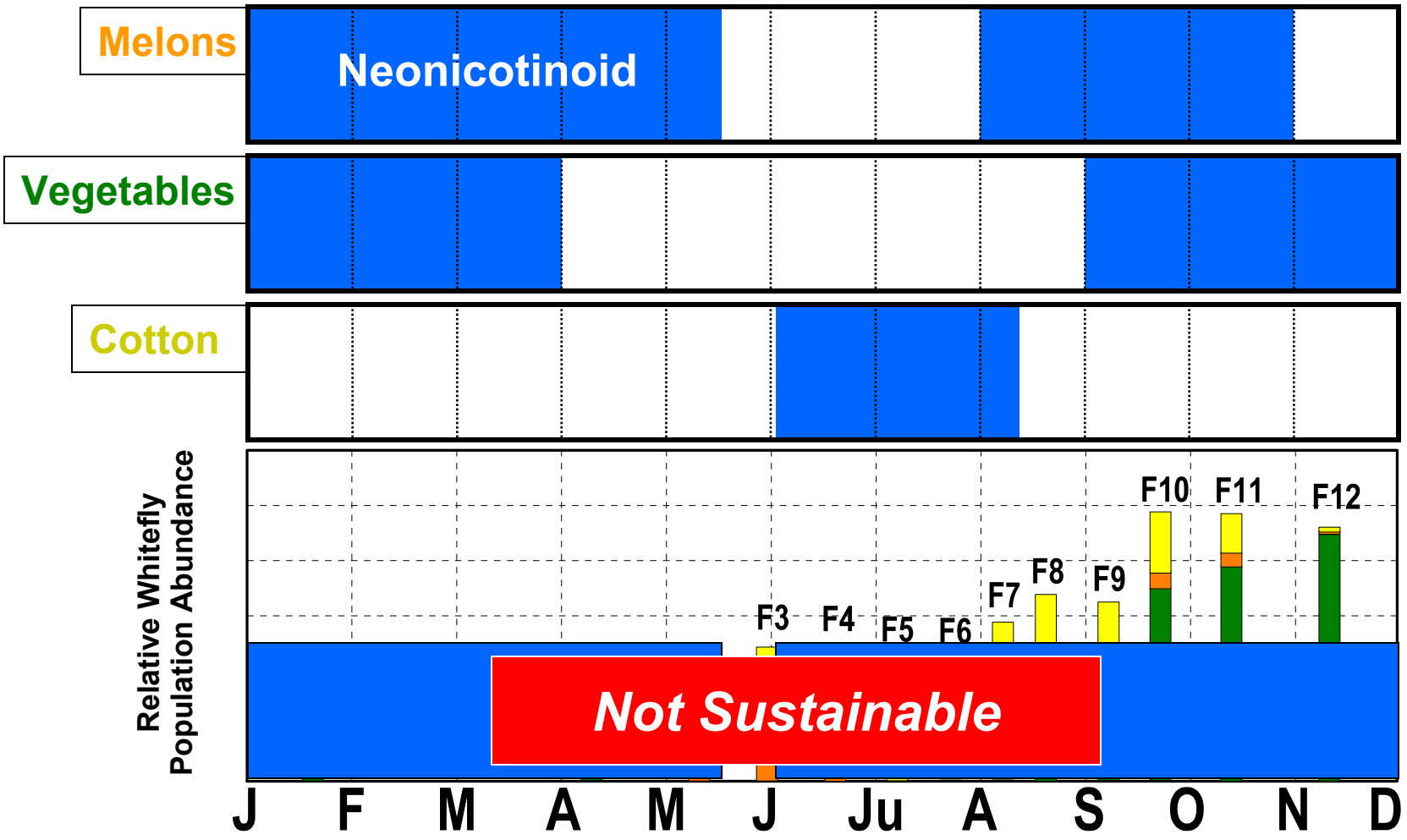
2. Limit Neonicotinoid Use

Multi-crop Community

- Not more than one use per crop in melons and vegetables.
- Soil at-planting recommended.
- Split applications are not recommended
- Do not apply any neonicotinoid product to cotton

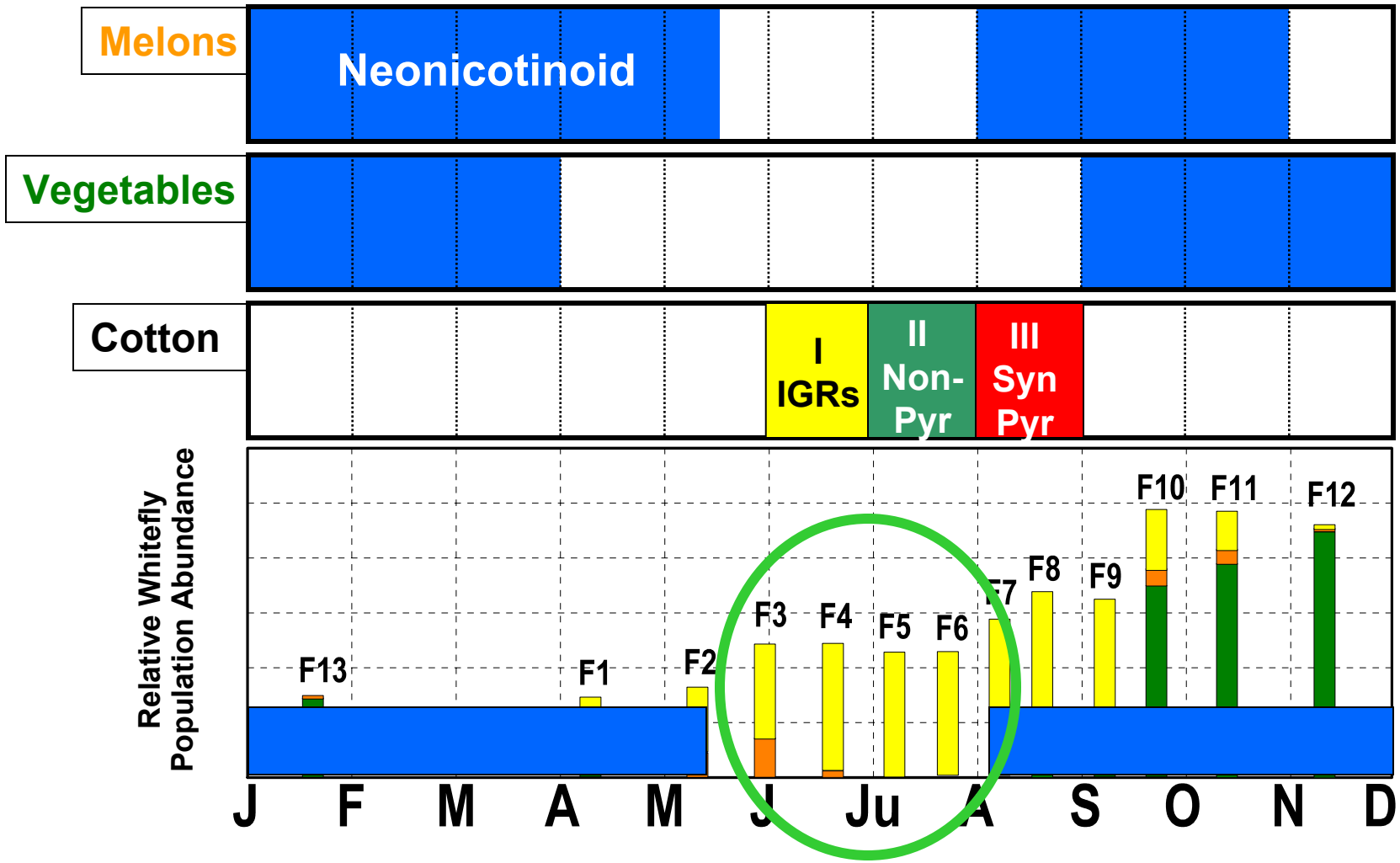
Resistance Risks Associated with Shared Neonicotinoid Uses in a Multi-Crop Community

(eg., Yuma – potential usage)



3. Exclusion

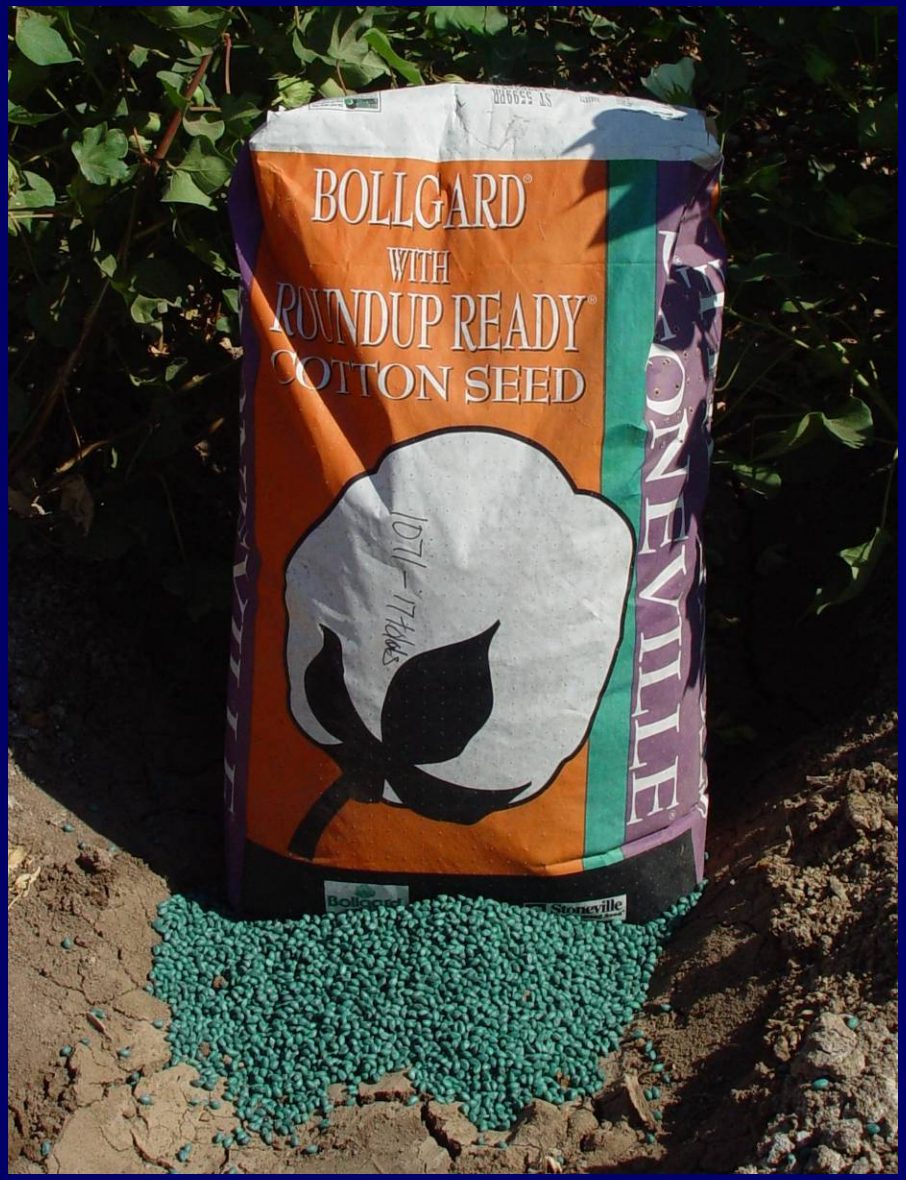
Preserve a *Neonicotinoid-free Period* in MCC



3. Exclusion

- **Do not apply a foliar applied neonicotinoid following the use of a soil applied neonicotinoid**

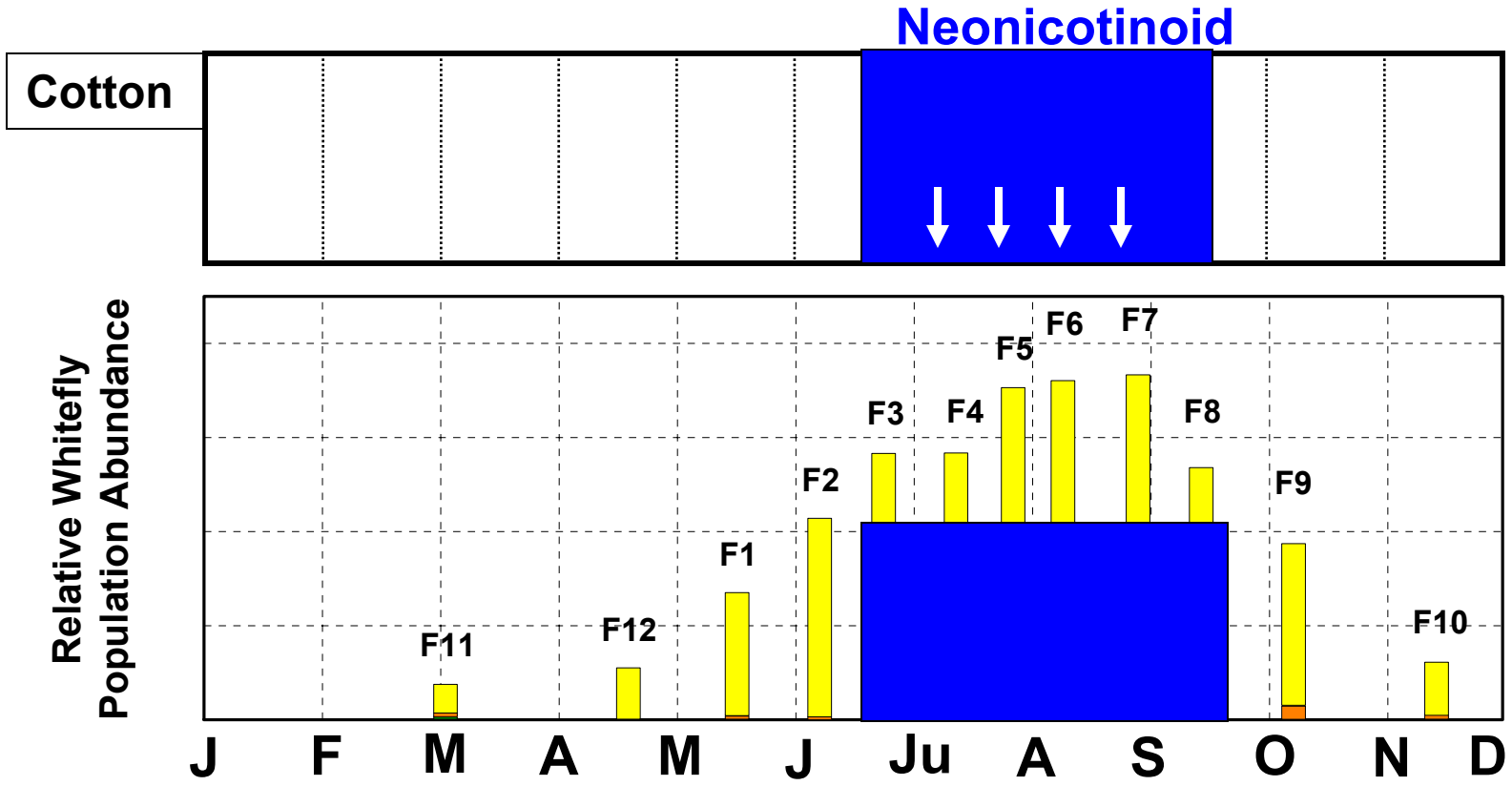
2. Limit Neonicotinoid Use



Cotton- Intensive Community

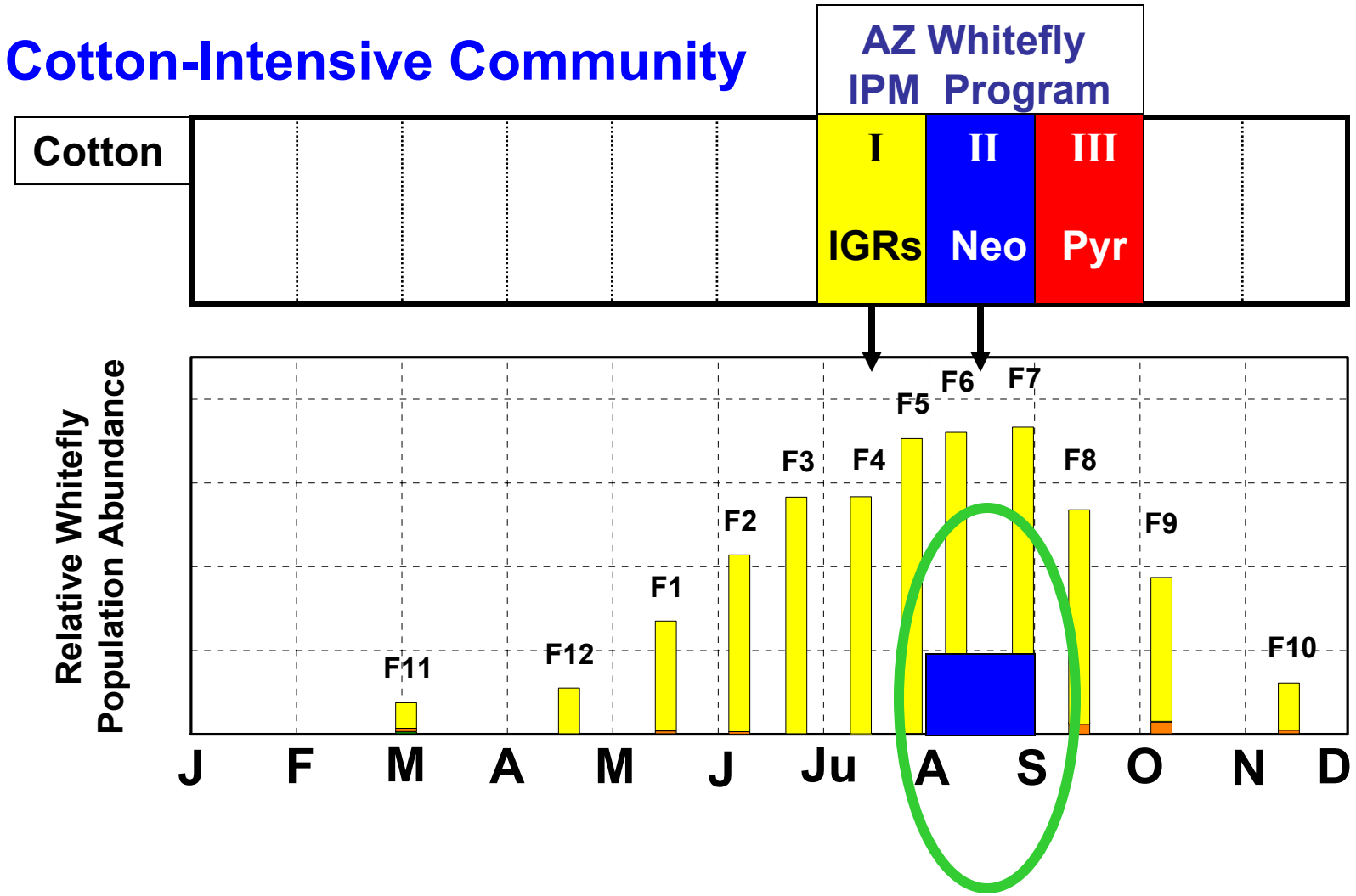
- No more than two neonicotinoid uses per cotton crop
- *This includes seed treatment*
- Sprays should not be applied consecutively, but rotated with alternative chemistry

Resistance Risks Associated with Neonicotinoid Uses in a Cotton-Intensive Community



4. Harmonize Chemical Use

- Rotation of chemistries



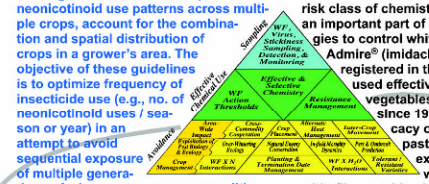
Cross-commodity Guidelines for Neonicotinoid Insecticides in Arizona

John C. Palumbo[1], Peter C. Ellsworth[2], Al Fournier[2], Timothy J. Dennehy[3], Robert L. Nichols[4]

University of Arizona, Department of Entomology & Arizona Pest Management Center,
[1]Yuma, AZ, [2]Maricopa, AZ, [3]Tucson, AZ, [4]Cotton Incorporated, Cary, NC

Situation

Voluntary limitations on cross-commodity use of neonicotinoids were developed with and proposed for the user community (table, lower right). The resulting common-sense guidelines, based on specific neonicotinoid use patterns across multiple crops, account for the combination and spatial distribution of crops in a grower's area. The objective of these guidelines is to optimize frequency of insecticide use (e.g., no. of neonicotinoid uses / season or year) in an attempt to avoid sequential exposure of multiple generations of a key pest across commodities and minimize selection pressure on these shared populations. Our goal is to *proactively manage a neonicotinoid-free period,* while still sustaining key uses of this important class of chemistry.



Silverleaf whitefly (*Bemisia tabaci* Genn. [Biotype B] = *B. argentifolii* Bellows &Perring), a mobile, multivoltine key pest of cotton,

melons and vegetable crops, depends on an annual cropping cycle that allows populations to move sequentially among host plants and increase over generations.

Arizona growers presently enjoy a sustained recovery from the devastating whitefly is a shared pest among crops, growers and pest managers have shared concerns about, and responsibility for, resistance management.

Neonicotinoids are a valuable, reduced-risk class of chemistry that has become an important part of effective IPM strategies to control whiteflies in Arizona. Admire® (imidacloprid), the first registered in this class, has been used effectively in melons and vegetables for whitefly control since 1993. Sustained efficacy of Admire over the past 13 years exceeds expectations of many who speculated that whiteflies would quickly develop resistance. Sustainability of this system (i.e., intensive imidacloprid use) is due in part to "de facto" resistance management: preservation of a neonicotinoid-free period between production seasons (July – August), when multiple, successive generations are not exposed to Admire (see figure A, below).

Since Admire, additional neonicotinoids have been introduced for pest control in vegetables, melons, and cotton (table, far right), including thiamethoxam (in 2002), acetamiprid (in 2003), and dinotefuran (in 2005). Their registration and potential year-round use on multiple crops raises new concerns about

Dialog

Cross-commodity guidelines (Palumbo et al. 2003) were developed by the University of Arizona's Cross-commodity Research & Outreach Program (CROP), a multidisciplinary working group, including research and extension scientists, growers and pest control advisors representing the diverse crops involved. Guidelines were developed through a feedback-driven process based on stakeholder input, accounting for the unique needs of each cropping community, the biology of this insect, and shared concerns about neonicotinoid resistance and sustainable whitefly management.

The CROP group developed a comprehensive set of guidelines with the fundamentals of IPM at their foundation (IPM pyramid, at left). Within these guidelines, simple rules provide voluntary limitations on all neonicotinoid uses adapted for three different cropping communities prevalent in Arizona (table, below right, and in detail, lower half of the poster). *The essence of these recommendations is to maintain at least four successive generations of whiteflies in an annual cycle that are not exposed to neonicotinoids in any cropping system.*

The most unique aspect of the guidelines is that they account for spatial and temporal considerations related to pest biology and the cropping patterns. Pest managers must base management decisions on proximity of other whitefly hosts and likelihood of nearby chemical use patterns. The guidelines are flexible, providing three sets of rules that fit most cropping situations in Arizona, rather than applying a single set of rules statewide that does not factor in the local ecological and biological contexts.

These practical, easy-to-implement rule sets were taught to growers and pest managers in a series of statewide meetings and workshops, in a detailed color bulletin, and through web-based information. This collaborative, area-wide approach may serve as a model for addressing new threats in the future (e.g., Q-biotype infesting protected agriculture).

Concept

A crop community is defined by its production of whitefly-sensitive host crops over an annual cycle. *A 2-mile radius represents an effective "community" based on the whitefly's ability to migrate and reproduce among nearby crops.* Three major types of crop communities in Arizona have been defined as Cotton-Intensive, Cotton / Melon, & Multi-Crop, which consists of cotton, melons and vegetable crops.

*Neonicotinoid Registrations in Arizona**

Active Ingredient	Product	Application	Crops Uses
acetamiprid	Assail	Foliar	Lettuce, Cole (Melons**)
acetamiprid	Intruder	Foliar	Cotton
dinotefuran	Venom	Foliar, Soil	All
imidacloprid	Admire, etc.	Soil	Melons, Lettuce, Cole
imidacloprid	Gaucho, etc.	Seed	Cotton
imidacloprid	Provado, etc.	Foliar	Lettuce, Cole (Cotton***)
thiamethoxam	Centric	Foliar	Cotton
thiamethoxam	Cruiser	Seed	Cotton (Lettuce & Cole**)
thiamethoxam	Platinum	Soil	Melons (Lettuce & Cole**)

*Future registrations for clothianidin are expected in Arizona
**An Arizona registration on these crops is anticipated in the future
***Registered for use, but not recommended in Arizona

Three major data sources went into the development of the cross-commodity IPM model (see lower half of poster):

(1) Description of Cropping Systems. The seasonal abundance of whitefly-sensitive host crops in each cropping community was estimated using the Arizona Agricultural Statistics for Yuma and Maricopa Counties (1997-8). Data were supplemented by estimates from pest control advisors.

(2) Description of Insecticide Usage. Data consisted of amount of each insecticide class or key compound used on each crop during each growing season. Estimates were based on data provided by the Arizona Agricultural a technical committee. To derive specific insecticide usage (treatment-acres), the no. of acres estimated for that time period was multiplied by estimated insecticide (%) used.

(3) Seasonal Whitefly Population Abundance. *Bemisia* generation times for each region were estimated using a simulation model (DeGrande-Hoffman & Naranjo, unpubl.) and temperature data based on 30-yr normals. For each generation, relative whitefly abundance for each crop was estimated by multiplying an index value by no. of crop acres present. The index and seasonal values were derived from multiple field trials.

Initial response of grower communities to the guidelines has been positive, including endorsements from Arizona Crop Protection Association, Arizona Cotton Growers Association, Cotton

Neonicotinoid Limitations:*

Poster # 427

Will Adoption of the Cross-commodity Guidelines

Passive "*defacto*" IRM

Pro-Active IRM

Sustain the long-term efficacy of *Neonicotinoids* in our cropping communities

???

Adoption / Assessment

Anecdotal Evidence

- Guidelines have definitely created *awareness* of the issue

"I apologize, I sprayed some Intruder on my cotton today"

Yuma PCA –July 2003

Survey Data

- 2005 Cotton Insect Losses Workshop

Yuma Co., 8 PCAs responded (4987 acres)

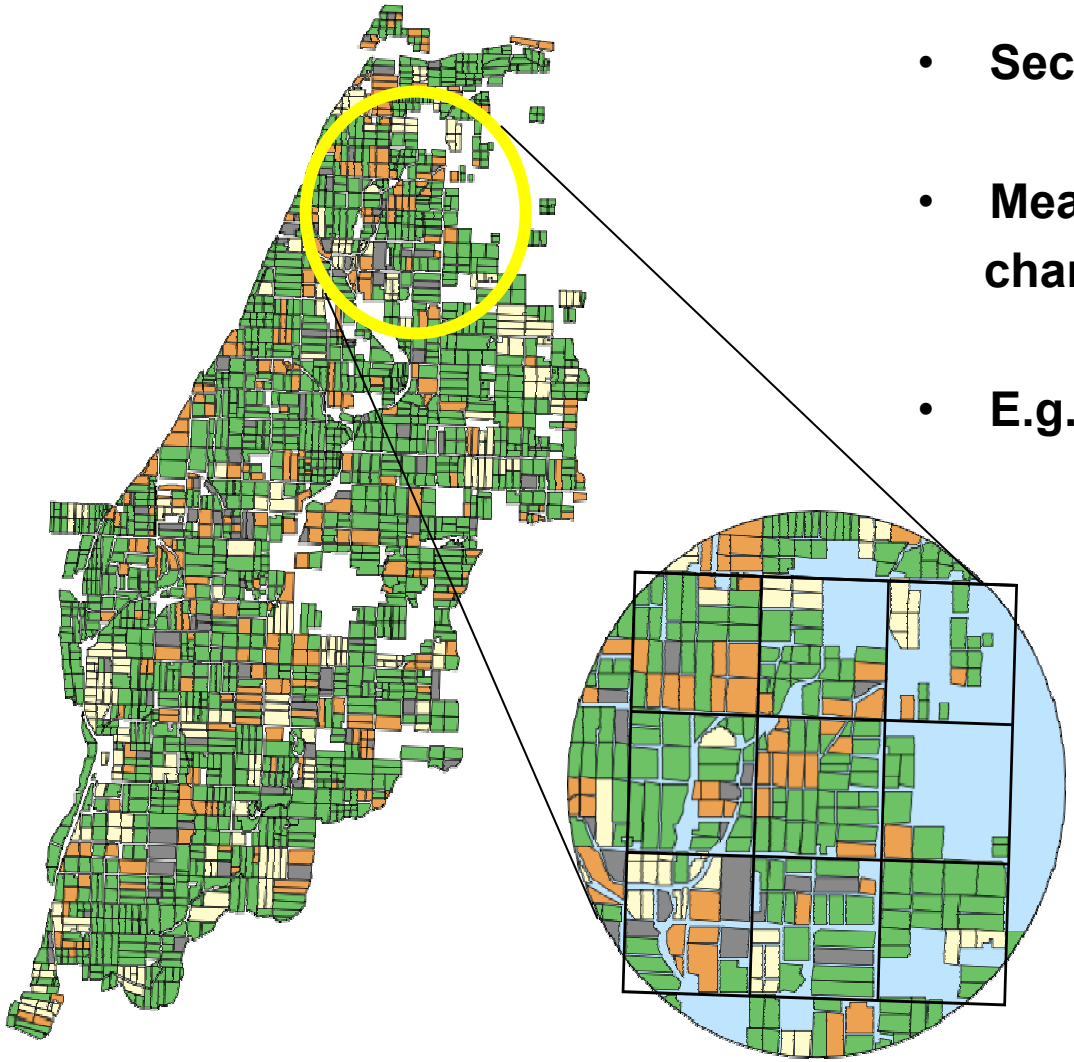
- 4 had used Intruder in cotton
- on 27% of the acres, 1.3 sprays

Novel Measurement of Group Adoption of IPM in Diverse Cropping Communities

Peter C. Ellsworth[1], John C. Palumbo[2], Al Fournier[1], Yves Carrière[3] & Christa Ellers-Kirk[3]

University of Arizona, Department of Entomology & Arizona Pest Management Center,

[1]Maricopa, AZ, [2]Yuma, AZ, [3]Tucson, AZ



- **Section level pesticide records**
- **Measure temporal & spatial changes in adoption**
- **E.g., neonicotinoid usage in cotton**

CI: 2

CM: 1

MC: 0

Poster # 428

Challenges and Constraints to Sustained Efficacy

A. Generic imidacloprid

- Lower cost could mean more use or higher rates
- Confusion in class recognition

B. Expansion of neonicotinoid labels

- Products – effective seed and foliar alternatives
- Crop labels– acetamiprid on melons
- New A.I.s - clothianidin

C. Market forces

- Cotton - cost of IGR's relative to cotton prices
  - free demo product
- Lettuce/Cole/ Melons – cost of Admire vs. Generics

Challenges and Constraints to Sustained Efficacy

D. New Chemistry in the Pipeline

- Trends toward selective chemistries
- *Grower:* " Industry always comes through with new technology"
- *Industry*: " Resistance is a source of innovation "

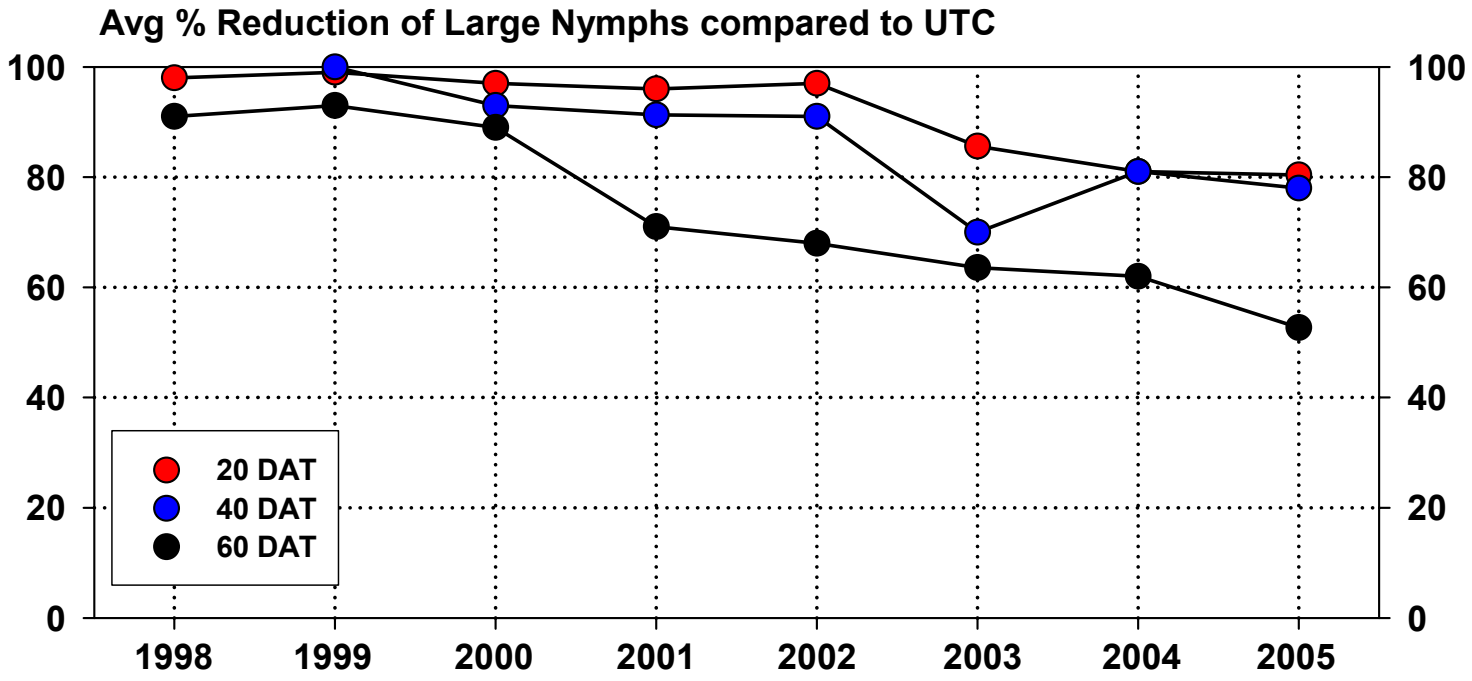
E. Grower-consultant complacency and apathy

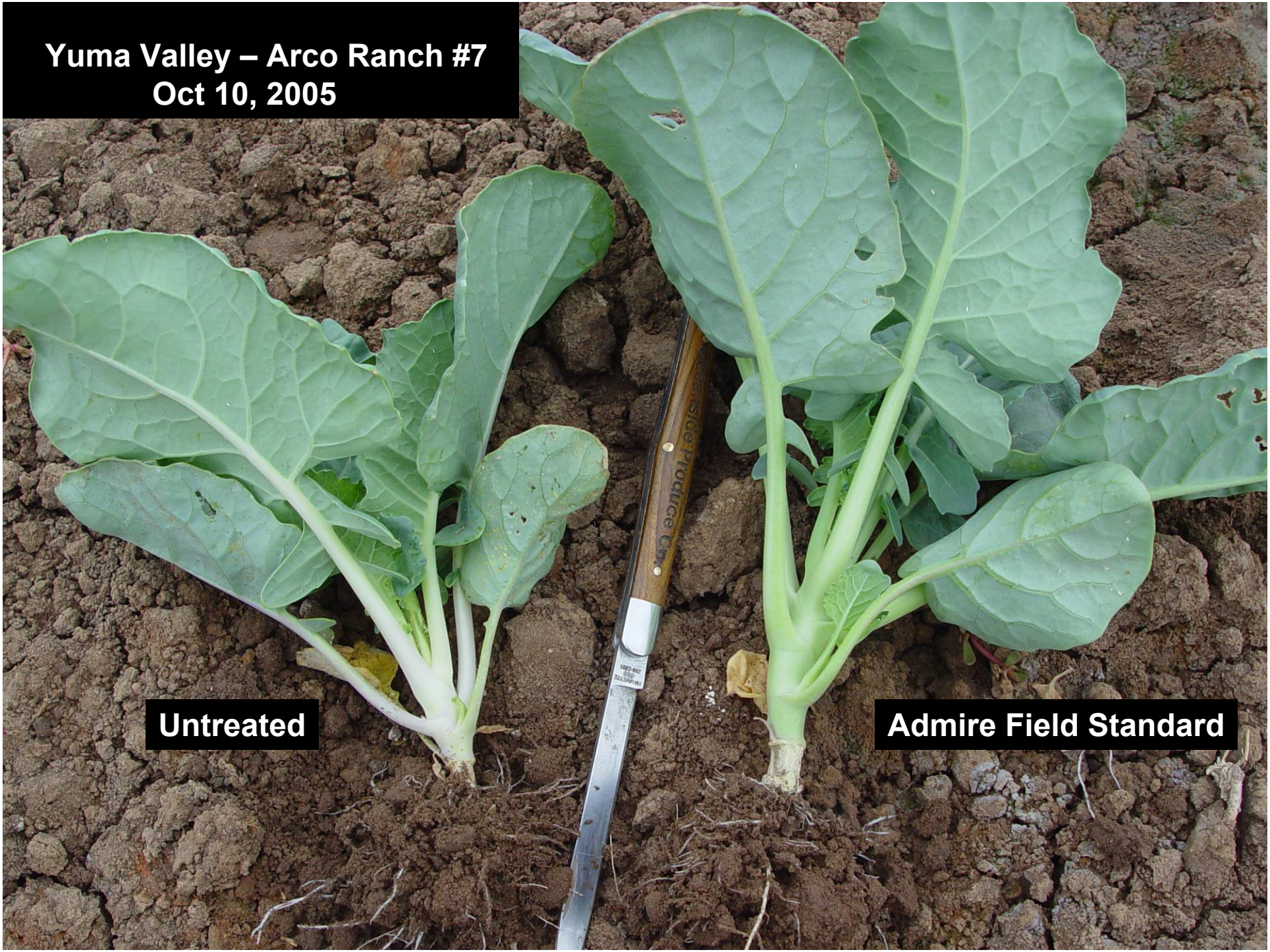
- " Little Suzy Needs New Shoes "
- Reduced rates / split (multiple) applications
- Sloppy soil applications on vegetables and melon

Admire® Efficacy in Commercial Broccoli

1998-2005

n = 5- 9 field sites / year




Yuma Valley – Arco Ranch #7
Oct 10, 2005
Untreated
Admire Field Standard

All *IPM* Programs are Local