Cross-commodity Guidelines and Resistance Management: Is There a Correlation?

J.C. Palumbo & P.C. Ellsworth
Cross-commodity Guidelines for Neonicotinoids in Arizona

Our Goal: Given the tremendous value of this insecticide class to all parties involved, secure the long-term efficacy of the neonicotinoids and protect growers’ interests in sustainable and economical whitefly management.
Defining a Crop Community

1) Multi-crop

2) Cotton Intensive

3) Melon/Cotton Intensive
Summary Guidelines: Maximum number of uses per crop season for neonicotinoids in three different cropping communities.

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<tr>
<th>Community</th>
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<td>0</td>
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<td>Cotton / Melon</td>
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<td>1*</td>
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<tr>
<td>Cotton-Intensive</td>
<td>2</td>
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*Soil only; **Soil or Foliar

http://ag.arizona.edu/crops
Fundamentals of Pest Management

Fundamental to any insect pest management program is a practical insecticide resistance management program.
Will Following the Cross-commodity Guidelines

Sustained long-term efficacy of *Neonicotinoids* in our complex cropping communities?
Those who forget the past are destined to repeat it.

George Santayana
### Resistance to Conventional Insecticides by the end of the 1980s

<table>
<thead>
<tr>
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<th>Resistance Ratio (cotton)</th>
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<td>OP</td>
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<td>Sudan</td>
<td>60-660</td>
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<tr>
<td>Turkey</td>
<td>19-300</td>
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<tr>
<td>Guatemala</td>
<td>28-400</td>
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*Source: Dittrich et al. 1990*
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
Neonicotinoid Chemistry

**Imidacloprid**  
(Bayer)  
1st used in AZ in 1993

**Thiamethoxam**  
(Syngenta)

**Acetamiprid**  
(Nippon Soda)

**Clothianidin**  
(Bayer/Takeda)

**Dinotefuran**  
(Mitsui Toatsu)

**Thiacloprid**  
(Bayer)

**Nitenpyram**  
(Takeda)
Almeria, Spain

- 30,000 ha of greenhouse vegetable production
- Enormous WF pressure & virus
- Imidacloprid introduced in 1993; applied as both drench and foliar applications
Response of whiteflies from Almeria Spain to neonicotinoids (16 ppm) in systemic bioassays compared to a susceptible strain (SUD-S)

Field Performance of Imidacloprid (foliar applied) in Almeria, Spain 1998

Neonicotinoid Resistance found in WF collected from greenhouses in Germany and Italy -1999-2000

Source: Nauen et al. 2002
Guatemala

Zacapa Valley - Mar 2000
Zacapa Valley - Jan 2001

- Monoculture of melons
- 40,000 ha, doubled cropped
- Imidacloprid used since at least 1996
Susceptibility of *Bemisia* Whiteflies to Imidacloprid
Collected on melons from Guatemala (2000)

Source: Steve Castle, USDA-ARS
Why Did Resistance Develop?

- Lack of Chemical Diversity
- Excessive Chemical Use
- Lack of Alternative IPM tactics
- Cropping System
- Whitefly Genetics
Transplant Drench
Wk 1

Drip application
Wk 3

Drip application
Wk 6
Neonicotinoid Foliar Application
Zacapa Valley, Guatemala 2001
Whitefly Genetics

*Bemisia tabaci*

Q-type  B-type

Populations
Spain
Italy
Germany
Israel

* Resistance is stable in Q biotype

Populations
Guatemala
USA
Whiteflies have not affected *Yield or Quality of* vegetables in Yuma where *Admire* has been used properly for the past 11 years.
Susceptibility to imidacloprid (Admire®/Provado®) of Arizona whiteflies collected from cotton

Corrected Mortality (SEM)

10 ug/ml

Imidacloprid Concentration

1995 (n=8)
1996 (n=18)
1997 (n=14)
1998 (n=12)
1999 (n=13)
2000 (n=15)
2001 (n=17)
2002 (n=12)
2003 (n=17)

Source: Dennehy et al. 2004
Thus the question?

“Given the situations in Spain & Guatemala, and the extensive use of Admire in Arizona Since 1993”

Why are the neonicotinoids still effective In Desert Cropping Communities?
De facto Resistance Management

- Cropping systems
- IPM practices
- Whitefly ecology & biology
Contributing Factors to the Sustained Efficacy of the Imidacloprid in AZ

- Segregation of neonicotinoids in vegetables and melons / IGRs in cotton

- Limitation of IGR uses (1 /crop) and Imidaclorpid (single soil or foliar use, not both)

- Spatial and Temporal Insecticide Rotations

- Exposure to and alternation with unrelated chemistries used for management of other key pests (ie., Endosulfan, Pyrethroids, Orthene)
Contributing Factors ..........

- Untreated host plants serve as refugia for unselected individuals (alfalfa, ornamentals)
- High WF population dispersal and mating to and from key crops - chemistries
- Bio-residual in Cotton with IGR’s; and to a lesser extent in melons with Admire.
- Inherent toxicity of soil-applied Imidacloprid
So what’s to be concerned about?

1) Expanded registrations of neonicotinoids:
   - Admire/Provado: melons, leafy vegetables
   - Centric / Platinum: cotton, melons
   - Intruder / Assail: cotton, leafy vegetables
   - Dinotefuron: pending on numerous crops

2) Multiple applications allowed by labels.

3) Risk of increased selection pressure on whiteflies
Strong evidence for **cross-resistance** among **neonicotinoids** has been documented.

Pro-active Resistance Management

Cross-commodity Guidelines for Neonicotinoids in Arizona
IRAC Mode of Action Classification v 3.3 October 2003

Insecticide Resistance Action Committee

IRAC
Mode of Action
Classification v 3.3
Revised and re-issued,
October 2003

http://www.irac-online.org/documents/moa/moa.pdf
1. **Based on IPM Principles**
   - Avoid Problems through Cultural Controls
   - Scouting, Sampling and Detection
   - Ensure Effective Chemical Use
2. **Limit insecticide use**
   * No more than 2 uses per year

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

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Resistance in Spain and Europe occurred where foliar sprays used in addition to soil drenches.
3. **Diversify Chemical Use**  
*Alternation of chemistries*

Cotton-Intensive Community

AZ Whitefly IPM Program

Relative Whitefly Population Abundance
IGRs

Conservation of natural enemies
BioResidual

Naranjo, 2001
3. Diversify Chemical Use
   * Exclusion (Neonicotinoid–Free Period)

- Melons
  - Neonicotinoid

- Vegetables

- Cotton
  - IGRs and Conventional

Relative Whitefly Population Abundance

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<th>Month</th>
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3. Diversify Chemical Use
   * New chemistries in the near future

Oberon (spiromesifen)  Flonicamid

- There are several other promising chemistries in the pipeline
Will Following the Cross-commodity Guidelines

Passive “defacto” IRM

Pro-Active IRM

Sustained long-term efficacy of *Neonicotinoids & IGRs* in our complex cropping communities.
Is This Pro-active Approach Important to Arizona Growers?

If so, how do we measure Success?