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

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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

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>
<th>Resistance Ratio (cotton)</th>
<th>OP</th>
<th>PYR</th>
<th>Fan/Bif</th>
<th>Aldicarb</th>
<th>Endo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sudan</td>
<td>60-660</td>
<td>30-38</td>
<td>1-3</td>
<td>3</td>
<td>11</td>
</tr>
<tr>
<td>Turkey</td>
<td>19-300</td>
<td>29-208</td>
<td>6-8</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Guatemala</td>
<td>28-400</td>
<td>760-2000</td>
<td>300-460</td>
<td>9</td>
<td>14</td>
</tr>
</tbody>
</table>

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

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

Whitefly Genetics

* Resistance is stable in Q biotype

Susceptibility to imidacloprid (Admire®/Provado®) of Arizona whiteflies collected from cotton

Source: Dennehy et al. 2004

Whiteflies have not affected Yield or Quality of vegetables in Yuma where Admire has been used properly for the past 11 years.
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 Imidacloprid (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 (i.e., Endosulfan, Pyrethroids, Orthene)

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
Evaluation of New Insecticide Chemistries For Insect Management in Melons

Pro-active Resistance Management

Strong evidence for cross-resistance among neonicotinoids has been documented

Source: Ebert & Nauen (2000)

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

Resistant 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

<table>
<thead>
<tr>
<th>Cotton</th>
<th>I</th>
<th>II</th>
<th>III</th>
</tr>
</thead>
<tbody>
<tr>
<td>IGRs</td>
<td>Neo</td>
<td>Pyr</td>
<td></td>
</tr>
</tbody>
</table>

Relative Whitefly Population Abundance

- Melons
- Vegetables
- Cotton

IGRs and Conventional

3. Diversify Chemical Use

* Exclusion (Neonicotinoid-Free Period)

IGRs

Conservation of natural enemies

BioResidual

Relative Whitefly Population Abundance

- Melons
- Vegetables
- Cotton

IGRs and Conventional

3. Diversify Chemical Use

* New chemistries in the near future

Oberon (spiromesifen)

Flinicamid

- 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?