Entomology: A Perspective on Insecticide Efficacy Research

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Entomology research and extension from South Texas to South Florida

- Field crops and vegetables
  - Sugarcane, rice, field corn, sorghum, soybeans
  - Sweet potatoes, sweet corn, lettuce
Two main types of activities result in a successful trial

• Planning the trial based on protocol objectives
  - Determining resources needed
  - Developing experimental design in space and time

• Conducting the trial
  - Practical aspects of obtaining the results
What does the protocol tell us?

• Scale of the study
  - Non-replicated demonstration
    Acceptable for visual support of previous results
    Demonstration of new application technologies
    No additional value
  
  - Replicated demonstration or large plot trial (≥ 2 reps)
    Mimics commercial production practices
    Results can be analyzed and used for inference
    Often impractical and sometimes expensive
What does the protocol tell us?

- **Scale of the study**
  - Conventional small plot evaluation (most common)
    - Numerous can be evaluated under the same conditions
    - Results can be analyzed and used for inference
    - Does not always mimic commercial practices
    - Effects of treatments can be “diluted”
What does the protocol tell us?

• **Treatments evaluated**
  - Untreated check
  - Standard (commercial or known efficacy)
  - Novel active ingredient
  - Premix of widely used AI
  - New use of a widely used AI
  - Rate
  - New formulation
  - Adjuvant

• **Target crop**
  - Field crops, vegetables, ornamentals
What does the protocol tell us?

• **Target arthropod pests…**
  - **Hemiptera** (stink bugs, aphids, whiteflies, scale insects)
  - **Lepidoptera** (defoliating worms, fruiting structure-eating worms, stalk borers)
  - **Coleoptera** (rootworms, wireworms, defoliating beetles, fruiting structure-eating beetles)
  - **Diptera** (leafminers, fruit flies)
  - **Thysanoptera** (thrips)
  - **Acari** (spider mites, rust mites)
What does the protocol tell us?

- ... and beneficial arthropods
  - **Natural enemies** (lady beetles, lacewings, minute pirate bugs, assassin bugs, stink bugs, parasitic wasps, ants, spiders, earwigs)
  - **Pollinators**
Scale of study * Treatments evaluated
* Crop * Target arthropods
→ Endless combinations of entomology trials!!!
What to do if you are not familiar with the crop and target arthropod(s)?

• Call an entomologist!

• Review the literature!
  - ESA’s Arthropod Management Tests reports
  - Peer-reviewed publications if you have access
ESA’s Arthropod Management Tests reports

https://academic.oup.com/amt
CORN (Sweet): *Zea mays* (L.), ‘Summer Sweet 8102R’

**Insecticidal Control of Fall Armyworm on Sweet Corn, 2015**

*Philip A. Stansly* and *and Barry C. Kostyk*

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1Corresponding author, e-mail: pstansly@ufl.edu

Section Editor: Mark Abney

Corn (hybrid, maize, sweet) | *Zea mays*
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Fall armyworm | *Spodoptera frugiperda*

Fall armyworm (FAW): *Spodoptera frugiperda* (J.E. Smith)

FAW is a key pest of sweet corn in Florida with larvae feeding successively in whorls, tassels, silks, and ears. New chemistries are constantly being sought to provide better and more sustainable FAW control. The trial was conducted at the Southwest Florida Research and Education Center in Immokalee Florida on two beds 32 inches wide and 420 ft long on 6 ft centers that were prepared and fertilized with Picher 60 EC on 18 Aug. Fertilizer (10-2-10) was incorporated at 100 lbs N, and beds were provided with two drip tape irrigation lines with 8 inch emitter spacing as they were covered with white polyethylene mulch. Corn was direct seeded 14 Sep at 10 inch spacing with two seeds per hole, and a 7-2-7 liquid fertilizer was injected through the drip using a Dosatron® over the growing season. Five treatments were assigned in an RCB design with four replicates. Each plot contained 40 plant spaces with 10 plant spaces left between plots as a buffer. The center row of the three-bed set was left untreated as a pest refuge and buffer area between treated rows. Applications were made with a high-clearance sprayer traveling at 2.3 mph equipped with 4 ceramic Alhuz® “yellow” hollow cone tips each delivering 10 gpa at 180 psi for a total of 40 gpa. This trial was designed to test the products for ear protection only, therefore Xentari (2 lbs) on 7 Oct, Intrepid (8 oz) on 12, 16, and 26 Oct and Belt (3 oz) on 19 and 22 Oct were applied to get plants to the silk stage before initiating comparative treatments (Table 1). The dominant ear on 20 plants was harvested on 17 Nov and graded into three categories: no damage, minor tip damage, and significant ear damage. Marketable ears were weighed as a group.

All treatment programs significantly increased the number of marketable ears compared to the untreated check, and there were no significant differences among them. The two Temitri treatments also reduced the number of culls due to ear damage compared to the check although not compared to the other treatments. No phytotoxicity was observed (Table 2).

### Table 1

<table>
<thead>
<tr>
<th>Product</th>
<th>Rate (acre)</th>
<th>30 Oct</th>
<th>2 Nov</th>
<th>5 Nov</th>
<th>9 Nov</th>
<th>13 Nov</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated</td>
<td>3.0 oz</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Intrepid</td>
<td>8.0 oz</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Radiant SC</td>
<td>5.0 oz</td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Temitri</td>
<td>12.0 oz</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Radiant SC</td>
<td>5.0 oz</td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
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<td>Temitri</td>
<td>30.0 oz</td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Radiant SC</td>
<td>5.0 oz</td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Declare</td>
<td>1.54 oz</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
</tbody>
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### Table 2

<table>
<thead>
<tr>
<th>Product</th>
<th>Rate/acre</th>
<th>Marketable ears</th>
<th>Tip damaged</th>
<th>Ear damaged</th>
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</thead>
<tbody>
<tr>
<td>Untreated</td>
<td>3.0 oz</td>
<td>5.23 b</td>
<td>9.00 ab</td>
<td>3.75 a</td>
</tr>
<tr>
<td>Intrepid</td>
<td>8.0 oz</td>
<td>13.00 a</td>
<td>3.25 b</td>
<td>3.75 ab</td>
</tr>
<tr>
<td>Radiant SC</td>
<td>5.0 oz</td>
<td>12.25 a</td>
<td>6.25 a</td>
<td>1.50 b</td>
</tr>
<tr>
<td>Temitri</td>
<td>15.0 oz</td>
<td>13.00 a</td>
<td>4.75 b</td>
<td>2.25 b</td>
</tr>
<tr>
<td>Radiant SC</td>
<td>3.0 oz</td>
<td>12.50 a</td>
<td>4.25 b</td>
<td>3.25 ab</td>
</tr>
<tr>
<td>Declare</td>
<td>1.54 oz</td>
<td>5.25 a</td>
<td>3.75 ab</td>
<td>2.25 b</td>
</tr>
</tbody>
</table>

Means within columns followed by same letter are not statistically different (LSD, P > 0.05).
Scholar Google search for peer-reviewed publications (e.g., J. of Economic Entomology, Florida Entomologist, Crop Protection, etc.)
Preparation of experimental area: Target crop and arthropods impact trial design

• Know your crop and environment
  - Need for buffers or border rows if edge of trial different

• Know your arthropods and environment
  - Mobile arthropods require larger plots
  - Arthropods with clumped distributions may require larger plots or more replications
Sugarcane aphids infesting sorghum

Effective treatment  Non-treated
Consider manipulating infestations

- **Natural infestations may not cooperate**
  - Too low, too high too quickly
  - Too early, too late…
  - In the fungicide trial across the road…

- **Increase target pest populations**
  - Decrease natural enemy levels
    - Low rate of pyrethroids or OPs to kill beneficials and flare worms or aphids
    - Ant bait to suppress fire ant populations to increase worm and stalk borer infestations
Consider manipulating infestations

- Increase target pest populations
  - Release fall armyworms in sweet corn
Consider manipulating infestations

• Increase target pest populations
  - Release wireworms in plastic tubs
Consider manipulating infestations

• **Increase target pest populations**
  - Increase N fertilization
    Mexican rice borer infestations increase with N fertilization
  - Increase plant stress (drought stress)
    Mexican rice borer infestations increase with drought stress
Manage infestations of non-target arthropods

- Use selective insecticides/miticides if possible
  - Lepidopteran worms can be controlled in stink bug or aphid trials
  - Aphids controlled can be controlled in lepidopteran worm trials
  - Some stink bugs may not be well controlled in lepidopteran worm trials
Knowledge of insecticides/miticides is key
The IRAC Mode of Action Classification

The definitive, global scheme on the target sites of acaricides and insecticides.

The IRAC Mode of Action (MoA) classification provides growers, advisors, extension staff, consultants and crop protection professionals with a guide to the selection of acaricides or insecticides for use in an effective and sustainable acaricide or insecticide resistance management (IRM) strategy.

See the list of references describing established target site mutations.

Browse the Classification

Browse online now

The MoA Classification is available as an interactive searchable eTool allowing you to browse and filter chemical groups, classes and actives.

Get the classification to go

Download the IRAC MoA application from the Apple iTunes or Google Play App Stores for quick access to reference information on the move.

Print the MoA Structures Poster

The MoA poster with the chemical structures is available for download from the website in various languages including Chinese & Japanese.

> Download the Classification Scheme in PDF

The complete MoA Classification document is available to view or download. This 23-page document provides full details of the scheme with lots of supplementary information and guidance.

Keep Up To Date

Subscribe to updates

Subscribe to receive a notification when IRAC updates the Mode of Action Classification.

> Submit an active

Submit an active you think should be included in IRAC’s Mode of Action Classification.

> View the MoA video

Our team of technical experts are charged with maintaining the classification and it’s status.

> Meet the team and see more resources

Review all of our Mode of Action documentation.
<table>
<thead>
<tr>
<th>Class</th>
<th>MOA No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organophosphates</td>
<td>1</td>
</tr>
<tr>
<td>Carbamates</td>
<td></td>
</tr>
<tr>
<td>Pyrethroids, Pyrethrins</td>
<td>3A</td>
</tr>
<tr>
<td>Nicotinoids, Sulfoximines, Butenolides</td>
<td>4A, C, D</td>
</tr>
<tr>
<td>Spinosyns</td>
<td>5</td>
</tr>
<tr>
<td>Avermectins</td>
<td>6</td>
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<tr>
<td>Fenoxycarb, Pyriproxifen</td>
<td>7</td>
</tr>
<tr>
<td>Pyridine azomethine derivatives</td>
<td>9</td>
</tr>
<tr>
<td>Bt</td>
<td>11</td>
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<tr>
<td>Benzoylureas</td>
<td>15</td>
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<tr>
<td>Buprofezin</td>
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<tr>
<td>Cyromazine</td>
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<tr>
<td>Diacylhydrazines</td>
<td>18</td>
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<tr>
<td>METI acaricides &amp; insecticides</td>
<td>21</td>
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<tr>
<td>Tetronic &amp; tetramic acid derivative</td>
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<tr>
<td>Diamides</td>
<td>28</td>
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<tr>
<td>Flonicamid</td>
<td>29</td>
</tr>
</tbody>
</table>
Treatment applications

• **Timing and threshold**
  - At-planting
  - During the growing season
    
    *Based on periodical sampling and recommended or experimental thresholds*
    
    *Based to crop phenology and historical pest numbers*
Treatment applications

• **Foliar applications**
  - Equipment: Backpack, small plot, self-propelled sprayer, commercial equipment
  - Volume of application, tip type and spacing, pressure, speed of application
  - Use of adjuvant

• **Soil applications**
  - In-furrow liquid or granular
  - Drench

• **Mimic commercial practices as much as possible**
Additional considerations for treatment applications

• **Contact vs. translaminar vs. systemic**
  - Do we have the information?
  - Should we change my application method?
  - Does it impact our sampling method?

• **Rainfastness**
  - Consider rain chances before applications
  - Consider chemicals tested

• **Safety and PPE**
  - If available: SDS or Label (signal word, REI)
Treatment evaluations: Pre-treatment vs. post-treatment

- **Overall experiment estimation**
  - Random samples throughout experimental area
  - Small number of samples for each plot

- **Individual plot estimation**
  - Same as post-treatment evaluation
Treatment evaluations: Sampling methods

• Determine infestation levels
  - Methods:
    *Direct counts*
    *Sweep net sampling*
    *Beat sheet sampling*
    *Extraction*
  - Variables: no. insects or mites / plant, sweep net sample, lens field
Treatment evaluations: Sampling methods

- Determine infestation levels
  - Provides reliable information on arthropod numbers, species composition, and size/stages
  - Can impact the integrity of the plots
  - Can be time consuming
  - Requires insect identification expertise
  - Can be biased relative to the people who collect data
Treatment evaluations: Sampling methods

- Infestation levels
  - No. banded cucumber beetles / sweep
Treatment evaluations: Sampling methods

- Infestation levels
  - No. sugarcane aphids / leaf
Treatment evaluations: Sampling methods

- Infestation levels
  - No. green stink bugs / sweep
  - No. brown stink bugs / sweep

Phytophagous stink bugs

Photo: Marlin Rice
Treatment evaluations: Sampling methods

- Infestation levels
  - No. small, medium, large fall armyworms / plant
Treatment evaluations: Sampling methods

- Extension publications or apps
  Featured Creatures: http://entnemdept.ufl.edu/creatures/

- Bugguide: https://bugguide.net

- Entomology books and field guides
Treatment evaluations: Sampling methods

- **Injury** (inspection of fruits, seeds, leaves, stalks, roots)
  - Direct measurement vs. estimation or rating
  - Direct measurements are relatively unbiased but may not be practical
  - Ratings are quick and convenient but can be biased

- Collecting injury ratings without infestation data can work, especially if we want to determine whether the product “works” or “doesn’t”
Sugarcane bored internodes
Defoliation estimation/ratings
Corn silk flies

0 to 5 rating scale for ear injury

0: no injury
1: silks injured
2: ear tip injured
3: top 25% of ear injured
4: top 50% of ear injured
5: below top 50% of ear injured
Silk fly insecticide efficacy, 2018

Bars with the same letter are not different ($P > 0.05$)
Silk fly insecticide efficacy, 2018

% ear area with injury

Bars with the same letter are not different ($P > 0.05$)
A Perspective on Insecticide Efficacy Research

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