INSECT PEST MANAGEMENT
ISSUES IN ALFALFA--
CHALLENGES AND QUESTIONS

2013 Western Alfalfa & Forage Symposium
December 12, 2013

University of California
Agriculture and Natural Resources
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Overview

• Recent challenges in alfalfa IPM
  ▪ Lep. larvae
  ▪ Cowpea aphids
  ▪ Alfalfa weevil
  ▪ Alfalfa stem nematode

• 2013 alfalfa IPM
  ▪ Egyptian alfalfa weevil/alfalfa weevil
  ▪ Blue alfalfa aphid
  ▪ Other aphid species
Pest Management in Alfalfa

2013
Origin of Integrated Pest Management (IPM)
• basic ideas setting the groundwork for IPM
• some of these came from observations in the alfalfa system

HILGARDIA
A Journal of Agricultural Science Published by the California Agricultural Experiment Station

Vol. 29 OCTOBER, 1959 No. 2

THE INTEGRATED CONTROL CONCEPT
Vernon M. Stern, Ray F. Smith, Robert van den Bosch, and Kenneth S. Hagen

All organisms are subjected to the physical and biotic pressures of the environments in which they live, and these factors, together with the genetic make-up of the species, determine their abundance and existence in any given area. Without natural control, a species which reproduces more than the parent stock could increase to infinite numbers. Man is subjected to environmental pressures just as other forms of life are, and he competes with other organisms for food and space.
**Origin of Integrated Pest Management (IPM)**

**IPM in the 1950’s to 1970’s –**

- developing as a scientific field
- many of the studies that contributed to the underlying foundation of IPM were conducted in alfalfa
- also extended to growers and implemented leading to a cost-effective and sustainable IPM
- identification of pest and natural enemy species, pest biology (number of generations, overwintering, etc.), sampling techniques and protocols, treatment thresholds, degree-day models, pest distribution over the state

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**Management tactics developed**

1.) biological control methods, 3.) host plant resistance
2.) cultural control measures 4.) insecticides
Pesticide Use - Alfalfa

The top 100 sites used by cumulative acres treated statewide in 2011 (all pesticides combined).

<table>
<thead>
<tr>
<th>Site</th>
<th>Rank</th>
<th>Pounds</th>
<th>Num. Apps.</th>
<th>Acres</th>
</tr>
</thead>
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<td>338,771</td>
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<td>9,576,148</td>
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<td>14,035,941</td>
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<td>61,246</td>
<td>4,266,557</td>
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<td>53,459</td>
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<td>WALNUT</td>
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<td>3,951,571</td>
<td>119,386</td>
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<tr>
<td>ORANGE</td>
<td>10</td>
<td>10,059,959</td>
<td>124,416</td>
<td>3,363,324</td>
</tr>
</tbody>
</table>
Pesticide Use - Alfalfa

- lambda-cyhalothrin - Warrior, etc.
- dimethoate
- chlorpyrifos - Lorsban, etc.
- beta-cyfluthrin - Baythroid, etc.
- indoxacarb - Steward
- methoxyfenozide - Intrepid
Recent challenges in alfalfa IPM

- Lep. larvae/summer worms
  - significant problem during some years
  - appears to be a more common problem
  - used to be more efficiently controlled with natural enemies
Recent challenges in alfalfa IPM

- Cowpea aphids
  - developed into a pest of alfalfa ~15 years ago
  - marched across the US – reported in Oklahoma, Iowa, Wisconsin, etc. - ~2005-09
  - Used to be a pest only of cowpeas
  - Can be controlled with insecticide treatments
    - applications disrupt natural enemies
  - What caused this?
Recent challenges in alfalfa IPM

- Alfalfa stem nematode
Recent challenges in alfalfa IPM

- Alfalfa weevil
  - Increasing populations in some areas
    - Intermountain areas – used to have sporadic problems with AW
  - Now it is an annual problem and populations reach 75-100 larvae per sweep
Alfalfa IPM

2013
2013 alfalfa IPM

- Alfalfa weevil
  - increasing length of infestation
    - Small area in Tulare Co. with 2\textsuperscript{nd} generation (Summers)
    - 2013 – 2\textsuperscript{nd} generation reported from Merced, San Joaquin, Fresno Co.
    - some treatments required on 2\textsuperscript{nd} generation
    - Davis campus – weevil larvae in mid-August
2013 alfalfa IPM

- Alfalfa weevil
  - difficulties in managing weevil larvae for 1st generation
    - Tank mixes - Cobalt®, Stallion®, etc.
    - Second application
Recent challenges in alfalfa IPM

- Recent challenges in alfalfa IPM
  - Lep. larvae
  - Cowpea aphids
  - Alfalfa weevil
  - Alfalfa stem nematode

- 2013 alfalfa IPM
  - Egyptian alfalfa weevil/alfalfa weevil
    - Blue alfalfa aphid
    - Other aphid species
Blue Alfalfa Aphid Outbreak
2013
Observations on:

Spotted Alfalfa Aphid populations 2013

Pea Aphid populations 2013
# Aphid Biology

## Aphid Species and Distribution

<table>
<thead>
<tr>
<th>Aphid Species</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
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<tbody>
<tr>
<td>Alfalfa Weevil</td>
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<td>Pea Aphid</td>
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<td>Blue Alfalfa Aphid</td>
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<td>Spotted Alfalfa Aphid</td>
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<td>Cowpea Aphid</td>
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</tbody>
</table>
Common Aphids in Alfalfa

• **Blue Alfalfa Aphid**
  – Antenna uniformly brown

• **Pea Aphid**
  – Narrow dark bands at tip of each segment
Common Aphids in Alfalfa

• **Cowpea Aphid**
  – Adult: shiny black
  – Nymph: slate grey

• **Spotted Alfalfa Aphid**
  A small, pale-yellow or grayish aphid with four to six rows of spined black spots on its back
Which of These Aphids is Blue Alfalfa Aphid?

Blue Alfalfa

Cowpea

Pea Aphid

Pink Form Pea
How Would You Know?

• Alfalfa Blog, UC Davis - 
  http://ucanr.edu/blogs/Alfalfa/index.cfm
• IPM Identification Tips in Alfalfa PMG
• Additional Guides:
  – Barlow & Godfrey Aphid Guide
  – http://ucanr.edu/sites/CottonIPM/Useful_Resources/
<table>
<thead>
<tr>
<th>Pea Aphid – Acyrthosiphon pisum</th>
<th>Blue Alfalfa – Acyrthosiphon kondoi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring and fall populations</td>
<td>Late winter or spring only</td>
</tr>
<tr>
<td>More widely distributed on plant</td>
<td>Prefers terminal area of plant</td>
</tr>
<tr>
<td>Feeding does NOT result in stunting</td>
<td>Injects feeding toxin, stunts plants, especially young</td>
</tr>
<tr>
<td>Action Thresholds (under 10”) – 40-50 aphids per sweep</td>
<td>Action Thresholds (under 10”) – 10-12 aphids per sweep</td>
</tr>
<tr>
<td>Less tolerant of cool temperatures</td>
<td>More tolerant of cool temperatures</td>
</tr>
<tr>
<td>Some resistance in commercial alfalfa varieties</td>
<td>Resistance common in commercial alfalfa varieties</td>
</tr>
</tbody>
</table>
History - Aphids in Alfalfa

• **Pea Aphid** - in the western U.S. for 100+ years
• **Spotted Alfalfa Aphid** – first found in 1950’s
• **Blue Alfalfa Aphid** - first found in CA in Kern Co. near Bakersfield in 1974 and Imperial Co. in 1975
• **Cowpea Aphid** – started damaging alfalfa ~15 years ago
## Management - Aphids in Alfalfa

<table>
<thead>
<tr>
<th></th>
<th>Insecticides</th>
<th>Cultural</th>
<th>Biological</th>
<th>Host Plant Resistance</th>
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<tr>
<td>Pea Aphid</td>
<td>X</td>
<td></td>
<td>XX</td>
<td>X</td>
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<tr>
<td>Blue Alfalfa Aphid</td>
<td>X</td>
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<td>XX</td>
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<tr>
<td>Spotted Alfalfa Aphid</td>
<td>X</td>
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<td>X</td>
<td>XX</td>
</tr>
<tr>
<td>Cowpea Aphid</td>
<td>XX</td>
<td></td>
<td>X</td>
<td></td>
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</table>
Outbreaks Are Complex Events

Variety Selection
Host Plant Resistance
Production Practices
Insecticide Use & Pattern

Aphids

Development of Tolerance
Change in behavior

Conditions Favorable for Outbreak
Conditions not favorable for cutting or treating
Reduced Natural Enemy Activity

Conditions Favorable for 1st Cutting
Enhanced Natural Enemy Activity

Us
Environment
Outbreaks Are Complex Events

- Conditions Favorable for Outbreak
- Conditions Not Favorable for Cutting or Treating
- Reduced Natural Enemy Activity

- Some years have the perfect environmental conditions for the build-up of certain pest species
- 2013- levels of several aphid and leafhopper species were very high, also whiteflies
- May be due to increased reproduction by pest species
- Or due to reduced activity of natural enemies

- Lady beetle predator
- *Aphidius* parasitic wasp
- *Entomophthora* fungus killed aphid
Outbreaks Are Complex Events

Conditions Favorable for Outbreak
Conditions Not Favorable for Cutting or Treating
Reduced Natural Enemy Activity

<table>
<thead>
<tr>
<th></th>
<th># per 50 sweeps</th>
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<tr>
<td></td>
<td>2012</td>
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<tr>
<td>BEB adults</td>
<td>6.25</td>
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<tr>
<td>BEB nymphs</td>
<td>1.0</td>
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</table>

Bigeyed bugs
Outbreaks Are Complex Events

Aphids

Development of Tolerance
Change in behavior

Variety Selection
Host Plant Resistance
Production Practices
Insecticide Use & Pattern

Conditions Favorable for Outbreak
Conditions not favorable for cutting or treating
Reduced Natural Enemy Activity

Conditions Favorable for 1st Cutting
Enhanced Natural Enemy Activity

Us

Environment
Outbreaks Are Complex Events

• Alfalfa varieties have been selected to have a level of host plant resistance to SAA and BAA
Host Plant Resistance to Blue Alfalfa Aphid

Source: NAFA 2013
Outbreaks Are Complex Events

Development of Tolerance  
Change in Behavior

• Alfalfa varieties have been selected to have a level of host plant resistance to SAA and BAA  
• This approach had been used for SAA in the 1950’s  
• CUF 101 was developed with BAA resistance  
• Mainstay of management since BAA and SAA introductions  
• Host Plant Resistance - antibiosis is involved  
  • compound bred into alfalfa that aphids cannot tolerant
Outbreaks Are Complex Events

- Aphids attempt to “evolve” to overcome resistance
- When this happens they reproduce successfully – build-up numbers

- Host plant resistance is virtually lost at 60F
- Host plant resistance is very active at 70F and above
- HPR poorly expressed under cool temperatures and BAA reproduces best under cool conditions
Outbreaks Are Complex Events - Cause of Outbreak?

- Failure of Host Plant Resistance
  - Not likely to ramp up in one year
- New Type of Aphid / New Biotype
  - “Nebraska” strain
  - pursued lead but found no evidence
- RR alfalfa
  - No evidence
Outbreaks Are Complex Events

Aphids

Development of Tolerance
Change in behavior

Variety Selection
Host Plant Resistance
Production Practices
Insecticide Use & Pattern

Conditions Favorable for Outbreak
Conditions not favorable for cutting or treating
Reduced Natural Enemy Activity

Conditions Favorable for 1st Cutting
Enhanced Natural Enemy Activity

Us

Environment
Outbreaks Are Complex Events -
Cause of Outbreak?

- Insecticide Resistance - ??
- Aphids attempt to “evolve” to overcome insecticide toxicity
- When this happens they reproduce successfully – build-up numbers
- How?
  - “Poor control”
  - Poor knockdown
  - Poor residual control
  - Higher populations
Outbreaks Are Complex Events - Cause of Outbreak?

- Insecticide Resistance - ??
- Dow AgroSciences conducted quick “dip assay”
  - No evidence of increased tolerance to chlorpyrifos
EAW & Aphid Trial, Davis
March 2013

Source: Godfrey & Long
EAW & Aphid Trial, Davis
March 2013

Source: Godfrey & Long
EAWS & Aphid Trial, Davis
March 2013

Source: Godfrey & Long
Aphid Trial,
Imp. Valley 2013

Source: Natwick
Aphid Trial,
Imp. Valley 2013

Source: Natwick
Aphid Trial, Imperial Valley
17 January 2013

Percent of Check, Post Treatment Average

Source: Eric Natwick
Characteristics of 2013 Outbreak

- Good weevil control, usual aphid materials
- Resurgence of BAA, 1-2 weeks post weevil
- Retreatment required
- Control difficult, residual control lacking
- “Numbers game”
- Spotty, not widespread
- Timing of outbreak varies by location
- Some noted low abundance of natural enemies
- Damage substantial in some cases
- Lingering effect of toxin not known
Outbreaks Reported 2013
Outbreaks Are Complex Events

- Variety Selection
- Host Plant Resistance
- Production Practices
- Insecticide Use & Pattern

Development of Tolerance
Change in behavior

- Conditions Favorable for Outbreak
- Conditions not favorable for cutting or treating
- Reduced Natural Enemy Activity

Conditions Favorable for 1st Cutting
Enhanced Natural Enemy Activity

Us
Environment
Damage: stunting, reduced vigor

Dos Palos, Merced Co

9 inches tall
30 days post 1st cutting

High Desert, Lancaster, CA
What Losses Did People Report Due to BAA?

<table>
<thead>
<tr>
<th>Region</th>
<th>Acres Infested</th>
<th>Loss</th>
<th>Stand Age</th>
<th>Damage Severity Ranking 1 low, 5 high</th>
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</thead>
<tbody>
<tr>
<td>Imperial Valley</td>
<td>&gt; 1000 acres</td>
<td>$70/ac, 1/3 ton</td>
<td>3rd Year</td>
<td>4</td>
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<tr>
<td>Dos Palos</td>
<td>500-1000 acres</td>
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</tr>
<tr>
<td>Dos Palos</td>
<td>&gt;1000 acres</td>
<td>$250/ac for 2 cuttings</td>
<td>3rd Year</td>
<td>5</td>
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<tr>
<td>Dos Palos</td>
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<tr>
<td>Buttonwillow</td>
<td>&gt;1000 acres</td>
<td>½ - ¾ bale</td>
<td>2nd &amp; 3rd Yr.</td>
<td>3</td>
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<td>Dos Palos</td>
<td>85 acres</td>
<td>$90/ac</td>
<td>second</td>
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<tr>
<td>Dos Palos</td>
<td>100-500</td>
<td>40% reduction</td>
<td>3-5th</td>
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<td>Palo Verde Valley</td>
<td>&gt; 1000</td>
<td>$100/acre</td>
<td>2 months to 3rd Year</td>
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<tr>
<td>Palo Verde Valley</td>
<td>&gt; 1000</td>
<td>$125/acre</td>
<td>4th Year</td>
<td>5</td>
</tr>
</tbody>
</table>
Outbreaks Are Complex Events - Cause of Outbreak?

- Insecticide Resistance
- Failure of Host Plant Resistance
- Change in biological control
- Unusual weather/winter
- New Biotype
It’s a Numbers Game

• 95% efficacy may leave too many aphids, especially if being concentrated in windrows (e.g. “early cutting”)
• Use of broad spectrum insecticides reduce your biocontrol assets in the field
• Population more likely to rebound
• OPs did not sufficiently control BAA
It’s a Numbers Game

• What if…..
  – You found only 60 aphids just before 1\textsuperscript{st} cutting?
  – Did not recognize them as BAA, thinking they were Pea Aphids
  – Cut (possibly earlier), thereby concentrating BAA into windrows, even if 50% mortality
  – That leaves 30/stem on stubble and already at 75% of Action Threshold
  – And creates a pattern in the field of stunted regrowth where the windrow lay