Alfalfa Aphid Management

The 2nd Arizona Alfalfa & Forage Crops Workshop

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Aphid Biology

• Soft-bodied insect; family Aphididae
• Piercing-sucking mouthparts suck sap from plant roots, stems or leaves; worldwide distribution
• More than >4,867 known species; ~250 are crop pests
• Winged (alates) and wingless (apterae)
• Exhibit parthenogenesis and vivipary; females are born pregnant and when mature, can birth 10-12 nymphs/day
• 20+ generations/year
Aphid Biology

• Under optimal conditions, a single aphid can produce 600 billion descendants in one season (Stephen A. Marshall, Univ. Guelph)

• Natural factors that reduce aphid populations: predation from beneficial arthropods & birds, diseases, temperature
Aphid Damage

- Inject salivary toxins
  - blue alfalfa aphid
  - spotted alfalfa aphid
  - cowpea aphid
- Contamination
  - honeydew
  - sooty mold
  - unpalatable hay
  - gummed-up equipment
- Stunted plants
- Reduced hay yields
Aphids

In the low desert region of southern California and Arizona, spotted alfalfa aphid, Therioaphis maculata, pea aphid, Acyrthosiphon pisum, blue alfalfa aphid, Acyrthosiphon kondoi, and cowpea aphid, Aphis craccivora must be managed for successful alfalfa hay production.

Considerable progress has been made toward the control of the aphid pests via host plant resistance, but insecticide applications are commonly needed to maintain population densities of aphids below damaging levels.
Identification is Important

- Spotted alfalfa aphid is yellowish in color and the only alfalfa aphid with spots.
- Cowpea aphid is the only aphid in alfalfa that is black.
- Adult cowpea aphids are shiny black with whitish legs and antennae with black at the joints and tips.
- Cowpea aphid nymphs appear to be gray due to wax secretions.
Identification is Important

- Pea aphid & blue alfalfa aphid are green aphids so similar in appearance that they may easily be confused.
- The antennae provide the distinguishing characteristic.
- Antennae of pea aphid have narrow dark bands at the tip of each segment.
- Blue alfalfa aphid antennae are uniformly brown.
Blue Alfalfa Aphid (BAA) Problems

- **BAA**: a serious pest of alfalfa for the past 40 years
- Managed by IPM practices;
  - host plant resistance
  - economic treatment thresholds
  - Natural enemies (aphid parasites and generalist predators)
  - insecticides.
- Spring of 2013, BAA once again causing severe economic loss
- Proposed reasons for the recent outbreaks have been included:
  - host plant resistance breaking strain
  - development of insecticide-resistance
  - depletion of aphid natural enemies (e.g. predator and parasite) caused by increased use of broad spectrum insecticides
  - climate change; may be related to drought in western U.S.
Aphid Management

Host Plant Resistance
- Plant resistant varieties
- Resistant varieties may need to be sprayed, but are not stunted and do not die from BAA feeding

Biological Control (preserve aphid natural enemies)
- Many predators (lady beetles, lace wings, syrphid fly larvae, minute pirate bug, bigeyed bug, etc.)
- Several parasites (Aphidius smithii, A. ervi, Lysiphlebus spp. and Diaraetiella spp.)
- Entomopathogenic fungi

Insecticides: we need alfalfa labels for new efficacious insecticides that are safer for aphid natural enemies.
APHID-RESISTANT VARIETIES

Severe aphid infestations retard growth, reduce yield, and may even kill plants.

Damage can also reduce the alfalfa's feed value.

Hay palatability is reduced by the fungi (sooty molds) that grows on the honeydew that aphids excrete.

Planting varieties resistant to aphids is the most effective means of control.
ENCOURAGE NATURAL ENEMIES OF APHIDS FOR BIOLOGICAL CONTROL

Convergent lady beetle

Sevenspotted lady beetle

Aphid parasite

Minute Pirate bug

Bigeyed bug

Lysiphlebus spp.

Syrphid fly

Green lacewing larva

Adult green lacewing

Diaraetiella spp.
<table>
<thead>
<tr>
<th>Aphid Type</th>
<th>Less than 10&quot;</th>
<th>10-20&quot;</th>
<th>More than 20&quot;</th>
<th>Summer</th>
<th>Spring</th>
<th>After last fall cutting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pea aphid</td>
<td>40-50</td>
<td>70-80</td>
<td>100+</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Blue alfalfa aphid</td>
<td>10-12</td>
<td>40-50</td>
<td>40-50</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Cowpea aphid</td>
<td>10-12</td>
<td>40-50</td>
<td>40-50</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Spotted alfalfa aphid</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>40*</td>
<td>20*</td>
<td>50-70</td>
</tr>
</tbody>
</table>

* Do not treat if there are 4 or more adult lady beetles or 3 or more lady beetle larvae per sweep for every 40 aphids counted per stem (on stubble this ratio is 1 larva/sweep to every 50 aphids/stem).
What happened in 2013-2015?
<table>
<thead>
<tr>
<th>Level at which aphids occur (vs. normal)</th>
<th>Location</th>
<th>Timing (vs. normal)</th>
<th>Which aphids?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Larger</td>
<td>Imperial</td>
<td>Earlier</td>
<td>BAA, CPA</td>
</tr>
<tr>
<td>Very much larger</td>
<td>La Paz</td>
<td>Much earlier</td>
<td>BAA, CPA</td>
</tr>
<tr>
<td>Very much larger</td>
<td>S. Bernardino</td>
<td>Earlier</td>
<td>BAA, CPA</td>
</tr>
<tr>
<td>Normal</td>
<td>Riverside</td>
<td>Earlier</td>
<td>BAA</td>
</tr>
<tr>
<td>Very much larger</td>
<td>Maricopa</td>
<td>Much earlier</td>
<td>BAA, PA</td>
</tr>
<tr>
<td>Larger</td>
<td>Yuma</td>
<td>Earlier</td>
<td>PA</td>
</tr>
<tr>
<td>Larger</td>
<td>Pinal</td>
<td>Normal</td>
<td>BAA</td>
</tr>
<tr>
<td>Very much larger</td>
<td>Imperial</td>
<td>Earlier</td>
<td>BAA</td>
</tr>
<tr>
<td>Normal</td>
<td>Riverside</td>
<td>Much earlier</td>
<td>BAA</td>
</tr>
<tr>
<td>Normal</td>
<td>Imp, Riv, LaPaz</td>
<td>Normal</td>
<td>BAA</td>
</tr>
<tr>
<td>Larger</td>
<td>Riverside</td>
<td>Earlier</td>
<td>BAA</td>
</tr>
<tr>
<td>Larger</td>
<td>Riverside</td>
<td>Earlier</td>
<td>BAA, CPA</td>
</tr>
</tbody>
</table>

BAA = blue alfalfa aphid, PA = pea aphid, CPA = cowpea aphid
Cause of the Outbreak?

- Climatic conditions conducive to aphid build-up
- Decline in number of natural enemies
- Host plant resistance breaking down
- New blue alfalfa aphid biotype
- Insecticide resistance development

Godfrey et al., 2013. Western Alfalfa and Forage Symposium, Reno, NV.
Lab study - aphids exposed to dilute solutions of Lorsban Advanced

- Aphids collected from affected areas
  1. Kern # 1 – Hwy46 / Leonard WL525 HQ.
  2. Kern # 2 – Hwy46 / Leonard WL66D.
  3. Kern # 3 – Hwy46 / Leonard WL000
  4. Fresno # 1 – Brinco / Laguna
  5. Fresno # 2 – Merrill / Evans

- Lorsban Advanced collected from customer in Firebaugh
  1. Untreated (water dip)
  2. 32 oz Lorsban / 100 gal (1:10 field rate)
  3. 8 oz Lorsban / 100 gal (1:40 field rate)
  4. 2 oz Lorsban / 100 gal (1:160 field rate)
  5. 1 oz Lorsban / 100 gal (1:320 field rate)
Lab Study Cont’d

4 Replicate sprigs per treatment

Aphids survived on sprigs kept in water
Lab Study Cont’d

Sprigs dipped 10 sec for full coverage

Majority of aphids remained on the stems
Lab Study Cont’d

Nearly 100% survival in controls

Lowest rate of Lorsban Advanced killed the aphids
Survival of aphids collected in Kern and Fresno Counties

Survival (%) 15 hours after treatment

Rate of Lorsban Advanced

- Kern Co. Population #1
- Kern Co. Population #2
- Kern Co. Population #3
- Fresno Co. Population #1
- Fresno Co. Population #2

Water dip
1 oz / 100 Gal
2 oz / 100 Gal
8 oz / 100 Gal
32 oz / 100 Gal
What about low VOC insecticide formulations? Does Lorsban Advanced demonstrate the same level of redistribution activity that Lorsban 4E has shown?
Redistribution Action of Lorsban 4E and Lorsban Advanced

No. aphids/10 stems

Formulation (lb a.i./acre)

<table>
<thead>
<tr>
<th>Formulation</th>
<th>Uncovered</th>
<th>Covered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated</td>
<td>20</td>
<td>31</td>
</tr>
<tr>
<td>L4E 0.25</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>L-A 0.25</td>
<td>10</td>
<td>0.5</td>
</tr>
<tr>
<td>L4E 0.5</td>
<td>2</td>
<td>0.5</td>
</tr>
<tr>
<td>L-A 0.5</td>
<td>2</td>
<td>0.5</td>
</tr>
</tbody>
</table>

L4E = Lorsban 4E
L-A = Lorsban Advanced
Lorsban Action on **Cowpea Aphid** in Alfalfa, 7DAT, E. Natwick, Holtville, CA, 2009.

![Graph showing the number of aphids per 10 stems for different treatments.](image)

**Formulation (lb a.i./acre)**

- **L4E** = Lorsban 4E
- **L-A** = Lorsban Advanced

L4E = Lorsban 4E  
L-A = Lorsban Advanced
Sprays applied Jan 17, 2013

- Check
- Sivanto 200SL @ 10.5 fl oz/a
- Transform WG @ 1.5 oz/a
- Dimethoate 2.67EC @ 16 fl oz/a
- Malathion 8 @ 16 fl oz/a
- Beleaf 50SG @ 2.24 oz/a
- Mustang @ 4.3 fl oz/a
- Stallion @ 11.75 fl oz/a
- Lorsban Advanced @ 32 fl oz/a
- Cobalt 2.54EC @ 24 fl oz/a
- Centric 40WG @ 3.5 oz/a
- Warrior CS @ 1.92 fl oz/a
- Endigo ZC @ 4 fl oz/a

Mention of any pesticide in this presentation is not a recommendation.

Sprays applied Jan 17, 2013

No. aphids/10 sweeps

- Cobalt Adv 24
- Centric 3.5
- Endigo 4
- Mustang 4.3
- Lorsban Adv 32
- Stallion 11.75
- Warrior 1.92
- Dimethoate 16
- Beleaf 4.3
- Malathion 16
- Sivanto 10.5
- Transform 1.5
- Untreated

oz/acre

- 5dat
- 8dat
- 11dat
- 14dat

Sprays applied Jan 17, 2013

No. aphids/10 sweeps

- Cobalt Adv 24
- Centric 3.5
- Endigo 4
- Mustang 4.3
- Lorsban Adv 32
- Stallion 11.75
- Warrior 1.92
- Dimethoate 16
- Beleaf 4.3
- Malathion 16
- Sivanto 10.5
- Transform 1.5
- Untreated

oz/acre

- 5dat
- 8dat
- 11dat
- 14dat

Sprays applied April 5, 2013

Mention of any pesticide in this presentation is not a recommendation.

Sprays applied April 5, 2013

No. aphids/10 sweeps

Transform 1
Sivanto 14
Endigo 4
Centric 3.5
Beleaf 2.24
Dimethoate 16
Fulfill 5.5
Mustang+dime...
Lorsban Adv 32
Stallion 11.75
Cobalt Adv 24
Malathion 16
Untreated

oz/acre
Blue Alfalfa Aphids per Stem, Holtville, CA, February 2014

Sprays applied Feb 5, 2014

- Check
- Cobalt Advanced @ 26 fl oz/a
- Lorsban Advanced @ 26 lb/a
- Transform WG @ 0.75 oz/a
- Transform WG @ 1.5 oz/a
- Sivanto 200SL @ 7 fl oz/a
- Sivanto 200SL @ 10 fl oz/a
- Cyclaniliprole 50 SL 16.4 fl oz/a
- Cyclaniliprole @ 20 fl oz/a
- Cyclaniliprole 50SL @ 10.9 fl oz/a + Beleaf 50SG @ 1.71 oz/a
- Assail 30SG @ 3 oz/a
- Assail 30SG @ 5 oz/a
- Assail 30SG @ 7 oz/a

Mention of any pesticide in this presentation is not a recommendation.
Sprays applied Feb 5, 2014

oz/acre

Transform 1.5
Assail 5
Cyclan+Beleaf...
Sivanto 10
Sivanto 7
Transform 0.75
Cobalt Adv 24
Lorsban Adv 26
Untreated

No. aphids/10 sweeps

5dat
7dat
14dat
21dat

4000

Applications on Feb 2\textsuperscript{nd}

- **Sivanto 10**
- **Transform 1.0**
- **Pyrifluquinazon 1.6**
- **Beleaf 2.8 + COC**
- **Pyrifluquinazon 3.2**
- **Beleaf 2.8 + NIS**
- **Cobalt Advanced 28**
- **BAS 31056 I 2.85**
- **BAS 31065 I 2.28**
- **Untreated**

<table>
<thead>
<tr>
<th>Product</th>
<th>3dat</th>
<th>7dat</th>
<th>10dat</th>
<th>14dat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sivanto 10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transform 1.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pyrifluquinazon 1.6</td>
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<tr>
<td>Beleaf 2.8 + COC</td>
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<td>Pyrifluquinazon 3.2</td>
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<tr>
<td>Beleaf 2.8 + NIS</td>
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<tr>
<td>Cobalt Advanced 28</td>
<td></td>
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</tr>
<tr>
<td>BAS 31056 I 2.85</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>BAS 31065 I 2.28</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Untreated</td>
<td>7000</td>
<td>8000</td>
<td>5000</td>
<td>6000</td>
</tr>
</tbody>
</table>

No. aphids/10 sweeps
Applications on Feb 9th

- Transform 0.75
- Transform 1.0
- Beleaf 2.8
- Stallion 11.75
- Sivanto 10
- Sivanto 7
- Warrior II 1.28
- Dimethoate 16
- Untreated

oz/acre

No. aphids/5 sweeps

3dat
8dat
10dat
14dat
18dat

Applications on Feb 9th
Change in BAA control percentages and trend lines from 2004 to March 2015 for organophosphate insecticides

\[ y = -0.0097x + 465.02 \]

\[ R^2 = 0.2431 \]
Change in BAA control percentages and trend lines from 2005 to 2015 for Pyrethroid insecticides

\[ y = -0.0074x + 374.33 \]
\[ R^2 = 0.1588 \]
Change in BAA control percentages and trend lines from 2012 to March 2015 for Flonicamid

\[ y = 0.0068x - 216.11 \]

\[ R^2 = 0.0616 \]
Change in BAA control percentages and trend lines from 2012 to March 2015 for IRAC group #4 (nAChR agonists; Sivanto & Transform) against BAA

\[ y = -0.0222x + 1000.2 \]
\[ R^2 = 0.4385 \]
Change in BAA control percentages and trend lines from 2009 to March 2015 for chlorpyrifos + pyrethroid

\[ y = -0.0371x + 1592.3 \]

\[ R^2 = 0.3821 \]
What were the aphid population dynamics in the untreated plots during the duration of the studies?
What has changed allowing BAA to cause widespread damage to western alfalfa?

Several reasons for the recent outbreaks have been proposed:
- Has a host plant resistance breaking strain of BAA emerged in the U.S., as was described in Australia (Humphrie et al. 2012)?
- Have aphid natural enemies been depleted by broad spectrum (Ops & Pyrethroids) insecticides allowing a BAA outbreaks?
- Has a biotype of insecticide-resistant BAA developed in the U.S.?

It was correctly stated (Godfrey et al., 2013) that for many years, alfalfa has been a model system for the development, implementation, and use of IPM tactics in the southwestern U.S.

IPM programs in the southwestern United States depend on alfalfa as a source of natural enemies that help keep pest insects in check in a diverse array of crops including cotton, grain crops, sugarbeet and vegetable crops.
Potential Aphid Management Approaches

- Don’t spray, rely on beneficials
- Tank or in-can insecticide mixtures
- Stubble treatment before first water fb foliar treatment 10-14 days later

Beleaf 50WG → Sivanto
Summary

• Aphids are amazing creatures!
• Four species of alfalfa aphids
• Aphid control problems from the central valley to the desert
• New products are showing good efficacy
• IPM crucial for managing aphids
CONCLUSIONS?

- A BAA control problem became apparent in the Imperial Valley, CA in the late spring of 2013 and has continuing through the spring of 2015.
- Control percentages began to drop for organophosphate insecticides, pyrethroid insecticides and combinations of the two chemistries late in the spring of 2013 and continued to be low in the spring of 2015.
- The BAA problem quickly spread throughout California, the southwestern U.S. and north to southern Utah by the summer of 2014.
- The drop in control percentages was not nearly as dramatic for newer chemistries (Sivanto 200SL, Transform 50WG and Beleaf 50SG).
- What is not confirmed from the insecticide efficacy studies is insecticide-resistance, but it is certainly suggested.
- It is unclear if there is a host plant resistance breaking strain of BAA that has developed or been introduced into the western United States.

Mention of any pesticide in this presentation is not a recommendation.
Questions?