Continuing Education Units (CEU’s)

• What type of CEU’s are offered at conference?
  – Tuesday – Certified Crop Advisor (CCA)
  – Wednesday – Certified Crop Advisor (CCA)
  – Thursday – Certified Crop Advisor (CCA) and Department of Pesticide Regulations (DPR)

• Where are the CEU sign in sheets?
  – CEU sign in sheets will be in the back of each session
  – There are separate forms on Thursday for the CCA and DPR credits

• Special instructions for Thursday
  – PCA’s will need to pick up their scantrons in the morning before the first session of the day. They will also need to return the scantron at the end of the day to the CEU booth. This is in addition to signing in and out of each session.
Pollinator Health in California Almonds – A Collaborative Effort
Bob Curtis
Almond Board of California
AGENDA

• **Bob Curtis**, Consultant to ABC, moderator

• **Almond Board Funded Researchers**
  - Dennis vanEngelsdorp, Bee Informed Partnership
  - Brandon Hopkins, Washington State University
  - Reed Johnson, Ohio State University
  - Jody Johnson, Cullaborate
  - Billy Synk, Project Apis m.
  - Neal Williams, UC Davis
  - Elina Niño, UC Davis
Honey Bee Health

Key Almond Industry Objectives

• Assure a sufficient supply of strong hives for almond pollination by advancing bee health

• Assure almonds continue to be a good and safe place for bees
• **Speakers**
  - Dennis vanEngelsdorp, Bee Informed Partnership
  - Brandon Hopkins, Washington State University
  - Reed Johnson, Ohio State University
  - Jody Johnson, Cullaborate
  - Billy Synk, Project Apis m.
  - Neal Williams, UC Davis
  - Elina Niño, UC Davis
Ensure that almonds continue to be a good and safe place for bees

Resources
– Comprehensive “Honey Bee Best Management Practices for California Almonds”
  • With 2 “Quick Guides”: General-Decision Maker and Applicator-Specific
  • Available on Almond Board website www.Almonds.com/BeeBMPs
Key BMPs

Communication

- Communication should occur between all pollination stakeholders along the communication chain about pest control decisions during bloom
  - Agreements/contracts should include a pesticide plan that outlines which pest control materials may be used.
  - Contact beekeepers 48 hours before pesticide application. This includes beekeepers pollinating the orchard and beekeepers within one mile. Have the appropriate individual (e.g., applicator) use the crop management programs Agrian and CDMS, or contact Ag Commissioners directly to locate hives within a mile radius of the spray site.

- Beekeepers should register their hives through the Bee Where Program at [https://beewherecalifornia.com/](https://beewherecalifornia.com/) by Jan. 1 each year or upon arrival in California. As well, note hive locations via the Bee Where program and app, and update locations with any hive movement within 72 hours of the move.

- Report suspected pesticide related incidences to county ag commissioners as soon as possible. Bee health concerns cannot be addressed without data from potential incidents.

Pesticide Use During Bloom

- Avoid applying insecticides during almond bloom until more is known, particularly about their impact on bee adults and brood (young developing bees in the hive). The one exception is *Bacillus thuringiensis* (B.t.).

- Apply fungicides at bloom in the late afternoon and evening when, bees and pollen are not present. This avoids contaminating pollen with spray materials and spraying bees.
Bee Informed Partnership
Data Driven - Helping keep colonies alive

Dennis vanEngelsdorp
Bee Informed Partnership
University of Maryland
Overview of U.S. Honey Bee Health
Loss Rates

vanEngelsdorp et al., ‘07–’12; Spleen et al., ‘13; Steinhauser et al. ‘14; Lee et al. ‘15; Seitz et al. ’16; prelim ‘15–’16
Tech Teams
Total Loss by Season for Commercial BIP Tech Team or Not (2011-2015)
Tech team cost structure

• Costs
  – In 2014, $118,800 per TT member
  – In 2017, $90,000 per tech member

» a 24% reduction

• Income
  – 30% Beekeeper income
  – 20% Grants
  – 20% Contracts
  – 20% donations and sustaining support
Recording management practices

72 Criteria from 8 different domains

- Monitoring
- Equipment
- Beekeeper
- Seasonal
- Queens and New Colonies
- Feeding
- Non Varroa control Strategies
- Varroa control Strategies
- New Colonies
- Queens and
Identifying factors that matter
### Top ranking management criteria

<table>
<thead>
<tr>
<th>N=11,630</th>
<th>N=6,411</th>
<th>N=596</th>
<th>N=334</th>
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<tbody>
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</table>

<table>
<thead>
<tr>
<th>Action on Deadouts</th>
<th>Action on Deadouts</th>
<th>How started new colonies</th>
<th>Honey Produced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Varroa Treatment Y/N</td>
<td>How started new colonies</td>
<td>Honey Produced</td>
<td>Varroa Products Months Count</td>
</tr>
<tr>
<td>How started new colonies</td>
<td>Varroa Treatment Y/N</td>
<td>Varroa Products Type Count</td>
<td>Varroa Treatment Y/N</td>
</tr>
<tr>
<td>Comb Culling Technique</td>
<td>Honey Produced</td>
<td>Varroa Treatment Y/N</td>
<td>Amitraz use Season</td>
</tr>
<tr>
<td>Formic acid use Season</td>
<td>Varroa Monitoring Technique</td>
<td>Winter Prep</td>
<td>How started new colonies</td>
</tr>
</tbody>
</table>
Migratory >50 (sideline and commercial)

N=334

Honey Produced

Varroa Monitoring Technique

Winter Prep

How started new colonies

Amitraz use Season
Migratory >50 (sideline and commercial)

N=334

Honey Produced
Varroa Monitoring Technique
Winter Prep
How started new colonies
Amitraz use Season
Thank you to our Sponsors:

In collaboration with:
Using cold storage to stabilize honey bee supply

Brandon Hopkins
Washington State University
## Indoor Wintering vs Outdoor

### Colony strength – indoor wintering vs outdoor

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Frame Count (Oct 18)</th>
<th>Frame Count (Jan 25)</th>
<th>Frame Count (Feb 25)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA room</td>
<td>14.4</td>
<td>10.7 (^A)</td>
<td>14.1</td>
</tr>
<tr>
<td>Refrigerated room</td>
<td>14</td>
<td>10.9 (^A)</td>
<td>15</td>
</tr>
<tr>
<td>Outside (WA)</td>
<td>13.9</td>
<td>9.2 (^A)</td>
<td>10.9</td>
</tr>
<tr>
<td>Outside (CA)</td>
<td>14.3</td>
<td>5.7 (^B)</td>
<td>10.8</td>
</tr>
</tbody>
</table>
Advantages - Indoor wintering

- No spreading disease
- No robbing
- No feeding syrup and protein patties
- Get to be home with family
- No Bee Rustling
Fat Bees

Avg. lipid/bee (mg)

Control (fall bees) | Cont. Atmosphere | Outside (WA) | Outside (CA)
Head Protein

![Bar chart showing head protein levels for different conditions: Control, Cold Room, Cont. Atmosphere, Outside (WA), and Outside (CA). The bar for Cont. Atmosphere is the highest, followed by Cold Room, Control, Outside (WA), and Outside (CA).]
Summer Brood Break (August)

<table>
<thead>
<tr>
<th>Avg. Mites/100 bees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indoor</td>
</tr>
<tr>
<td>Outdoor</td>
</tr>
</tbody>
</table>

- Indoor: **0** mites/100 bees
- Outdoor: **6** mites/100 bees
Using CO2 to kill Varroa mites

![Graph showing percent mite mortality with 8% CO2 and control groups. The 8% CO2 group shows significantly higher mortality compared to the control group.](image-url)
Thank You
Insecticide-Fungicide-Adjuvant Combinations and Honey Bee Development

Chia-Hua Lin, Hilary Kordeki, Nick Kruse, Andrea Wade, and Reed Johnson

johnson.5005@osu.edu
Almond Bloom

2 million honey bee colonies
1 million queens produced
Bee problems reported (pesticide related?)

Queen breeders:
- Up to 80% of queens are dying during development in weeks after almond bloom

Pollinators:
- Classic adult “bee kills” observed occasionally
- Death of late-stage brood mortality in weeks following almond bloom
Which “Bee Safe” pesticides are applied to almonds during bloom?
CALIFORNIA PESTICIDE INFORMATION PORTAL (CALPIP)

CalPIP Home

**Note:** CalPIP is not able to process a full year of data without the user choosing other criteria that would limit their selections. Users who work with large PUR datasets (i.e. entire years or all products) should go to:

- Data Archives (FTP site) to download free copies (.zip files) of full years of Pesticide Use Data (1974 through most recent available), or
- DPR's Publications Order Form (PDF, 171 kb) to order the Annual Pesticide Use Report CD-ROM.

Not all CalPIP features work in all browsers. To take advantage of all features and to assure that you get the information that you need, Internet Explorer 5.5 or above with cookies and JavaScript enabled is recommended. If you receive an error like "retrieval of cached query failed" or if you experience any other problems with a page displaying, hit your browser's "Reload" button.

Introduction and Overview

Welcome to the California Pesticide Information Portal project (CalPIP). CalPIP now allows you to query from more than one data source to find information on pesticide related issues. This site delivers user-friendly Internet access to the Department of Pesticide Regulation's (DPR) extensive pesticide use and label information (PUR Data Source), Ground Water Protection Area information (GWPA Data Source), and the recently added Pesticide Regulation's Endangered Species Custom Realtime Internet Bulletin Engine (PRESCRIBE Data Source). [More...](#)

Known Issues

2014 Pesticide Use Report data has been added to the database.

Notes on version updates, bug fixes and known issues. [More...](#)

First Time Users

If this is your first visit to our site, you may want additional information to make your visit more successful. [More...](#)

About the Data Sources

...
Fungicides applied during bloom (Feb. 15 to Mar. 15)

- Tilt, Rally (propiconazole, DMIs)
- Rovral (iprodione)
- Abound (Qol)
- Vanguard, Scala (AP)
- Pristine (SDHI / Qol)
- other
- chlorothalonil
Fungicides applied during bloom (Feb. 15 to Mar. 15)
Peach Twig Borer (*Anarsia lineatella*)
96% of insecticides applied during bloom are in a tank mix with a fungicide.
Adjuvants applied during bloom
(Feb. 15 to Mar. 15)
MODIFIED VEGETABLE OIL SURFACTANT BLEND

PRINCIPAL FUNCTIONING AGENTS:
methyl esters of C16-C18 fatty acids, polyalkyleneoxide modified
  polydimethylsiloxane, alkylphenol ethoxylate .................................................. 99.0%
CONSTITUENTS INEFFECTIVE AS SPRAY ADJUVANT ............................................. 1.0%
TOTAL ..................................................................................................................... 100.0%

All ingredients are accepted for use under CFR 40, 180.
CAS #37281-78-0, 9003-11-6

**USE:**
May be applied by Ground, Aerial, CDA or aquatic spray equipment.

*Ground, Aquatic:* Use 3–5 pints per 100 gallons of spray solution.
*Aerial, CDA:* Use 3–5 fl. oz. in 1–5 gallons of spray solution.
Use 3 oz. in 1–3 gal. and 5 oz. above 3 gal.
<table>
<thead>
<tr>
<th>Insecticide</th>
<th>Fungicide</th>
<th>boscalid + pyraclostrob (Pristine)</th>
<th>iprodione (Rovral)</th>
<th>propiconazole (Tilt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>chlorantraniliprole (Altacor)</td>
<td>max lb. a.i. per acre</td>
<td>0.344</td>
<td>0.5</td>
<td>0.225</td>
</tr>
<tr>
<td>methoxyfenozide (Intrepid)</td>
<td>0.099</td>
<td>1 : 3.47</td>
<td>1 : 5.05</td>
<td>1 : 2.27</td>
</tr>
<tr>
<td>diflubenzuron (Dimilin)</td>
<td>0.25</td>
<td>1 : 1.38</td>
<td>1 : 2</td>
<td>1 : 0.90</td>
</tr>
</tbody>
</table>
Oral application

Collect frame of brood from colony

Uniformly aged cohort of young bees

Treat groups with varying doses of pesticides in pollen

Count living and dead bees daily for 7 days
Individual bees consumed ~2 mg pollen per day
<table>
<thead>
<tr>
<th></th>
<th>Insecticide alone</th>
<th>boscalid + pyraclostrobin (Pristine)</th>
<th>iprodione (Rovral)</th>
<th>propiconazole (Tilt)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fungicide alone</strong></td>
<td></td>
<td>&gt; 4000 ppm</td>
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<tr>
<td>chlorantraniliprole</td>
<td></td>
<td>&gt; 4000 ppm</td>
<td>4000 ppm</td>
<td>4 ppm</td>
</tr>
<tr>
<td>(Altacor)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
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<td>&gt; 4000 ppm</td>
<td>4000 ppm</td>
<td>&gt; 4000 ppm</td>
<td>4000 ppm</td>
</tr>
</tbody>
</table>

0.8% in final pollen mix
The Potter Tower

AN IMPROVED LABORATORY APPARATUS FOR APPLYING DIRECT SPRAYS AND SURFACE FILMS, WITH DATA ON THE ELECTROSTATIC CHARGE ON ATOMIZED SPRAY FLUIDS

By C. Potter
University of Rhode Island, Kingston, R.I., U.S.A., and the Department of Insecticides and Fungicides, Rothamsted Experimental Station, Harpenden, Herts

Annals of Applied Biology
Maintain bees in incubator with 50% sucrose syrup for 72 h.
Protocol for the in vitro rearing of honey bee (Apis mellifera L.) workers

Daniel R Schmehl, Hudson V V Tomé, Ashley N Mortensen, Gustavo Ferreira Martins and James D Ellis

Entomology and Nematology Department, University of Florida, Gainesville, FL, USA; Departamento de Entomologia, Universidade Federal de Viçosa, Viçosa, Brazil; Departamento de Biologia Geral, Universidade Federal de Viçosa, Viçosa, Brazil; (Current affiliation) Pollinator Safety, Bayer Crop Science, Research Triangle Park, NC, USA

Graft young larvae from brood frames

Tissue culture plates, Cells containing diet

Single exposure of pesticide top dose in diet

adult bee emergence and mortality recorded daily
In vitro larval rearing

12 trials with 16 individuals per trial
192 bees per treatment
Fungicides alone did not affect larval development

Pristine®
Fungicide

50 ppm pyraclostrobin
100 ppm boscalid

For use in disease control and plant health in the following crops: alfalfa; Bellem Prairie; bare; both; beans; carrot; celery; citrus; fruit; cucurbits; vegetables; ginseng; grass; hops; honeysuckle; melons; ches; onion; strawberry; and tree nut

Active Ingredients:
- pyraclostrobin®: (2S)-(-)-[1-isopropyl-5-methyl-3-pyrazolyl]acetic acid, 10 ppm
- boscalid®: (2(R)-[1-(3,4-dimethoxyphenyl)-2-methylpropyl]phenoxyacetic acid, 50 ppm
- iprodione®: (3R)-3-pentanecarboxamide, 2-chloro-N-(4'-chloro-3,5'-diphenyl)propyl, 20 ppm
- propiconazole®: 90 ppm

Other Ingredients:

Total: 100%

EPA Reg. No. 7998-199
EPA Est. No. 1

roval® brand
4 Flowable Fungicide

200 ppm iprodione

Fungicide

Broad-spectrum fungicide for control of plant diseases

Active Ingredient:
- Propiconazole®: 41.6%

Other Ingredients:
- 58.1%

Total: 100.1%

Fungicides alone
P = 0.37

larvae surviving to adult (%)

neg. control
pyraclostrobin
boscalid
iprodione
propiconazole
An adjuvant alone can kill larvae
Summary

- The combination of chlorantraniliprole (Altacor) and a DMI fungicide, propinocazole (Tilt), is toxic to worker honey bee larvae, adults and queens (see the poster session)
- Altacor + Tilt + Dyne-Amic kills adult worker bees at the field application rate
- Diflubenzuron (Dimilin 2L) kills worker and queen larvae
- The spray adjuvant Dyne-Amic by itself has the potential to kill worker larvae

- No evidence, to date, that addition of Dyne-Amic causes synergistic toxicity in pesticides that don't already have a toxic potential
Acknowledgements

College of Wooster
Andrea Wade
Bridget Gross
Emily Walker

The Ohio State University
Hilary Kordeki
Nicolas Kruse
Colin Kurkul
Ashley Cordle
Can Application Time Limit Fungicide Exposure to Honey Bees in Almonds?

Jody Johnson
Cullaborate, LLC, Baltimore MD

G. Wardell, Wonderful Orchards, Lost Hills, CA,
D. Lopez, USDA Bee Res. Lab, Beltsville, MD,
P. Snyder – Stevenson Univ., Owings Mills, MD
H. Boncristiani, USDA Bee Res. Lab, Beltsville, MD
J. Pettis, Pettis and Associates, LLC, Salisbury, MD

Study duration Feb 6 -12 2018
Chemical structures of fungicides used in this study

Propiconazole- Tilt (CA) (100-617-ZG, 41.80% prop)

Cyprodinil- Vanguard WG (CA) (100-828-ZB75.00% cyp)
Orchard orientation

300 acres, ~ 5151ft x 2,542ft

33,950 almond trees with each tree 18 ft. apart in rows 22-24 ft. apart

600 hives along the bee roads

Prevailing winds from the northwest.

This orchard is completely surrounded by other orchards and is edged by asphalt and hard packed dirt roads
Measurements

We measured 5 metrics before and after AM and PM applications:

Forager counts of:  
(a) bees visiting flowers within a given area and  
(b) all returning foragers to hive  
(c) pollen-bearing bees returning to hive.

Fungicide conc. in:  
(a) pollen sampled from anthers  
(b) pollen collected at hive (traps)

As a check on conditions, we also monitored bloom progress and weather.
Weather was calm and consistent for study. Bloom was approaching peak bloom.

<table>
<thead>
<tr>
<th>Day</th>
<th>Highest temp °C/time</th>
<th>Lowest Temp °C/time</th>
<th>Rel. Humid. High/low</th>
<th>Avg Wind Speed mph</th>
<th>Highest wind speed mph</th>
<th>% clear day</th>
<th>Atm Press High/low in Hg</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>23.9/13:54</td>
<td>10/23:54</td>
<td>69/32</td>
<td>6</td>
<td>14</td>
<td>100</td>
<td>29.43/29.30</td>
</tr>
<tr>
<td>2</td>
<td>22.2/14:54</td>
<td>5.6/6:54</td>
<td>64/17</td>
<td>4.9</td>
<td>16</td>
<td>100</td>
<td>29.49/29.21</td>
</tr>
<tr>
<td>3</td>
<td>15.6/14:54</td>
<td>5.6/3:54</td>
<td>73/33</td>
<td>5.3</td>
<td>11</td>
<td>54</td>
<td>29.44/29.29</td>
</tr>
</tbody>
</table>
Air blast rig

R-11® Spreader-Activator (2935-50142) spreader with an 8000 Ga tank and a nozzle size 16. The spray rate of the spreader was 2.5 mph.
Control Day, Day 1

ppb= parts per billion
Cyp= Cyprodinil
Prop= Propiconazole
Anther= anther pollen
N.D.= not detected
LCMSMS = method to detect fungicide concentrations

The PM spray took place at 6PM on Day 1 after control data had been collected.
The PM spray had taken place 6pm on Day 1 (the previous evening)
Post AM spray, Day 3

The AM spray took place at 7 am on this day, Day 3
Analysis of all returning foragers was not significantly different across the three day study.
Analysis of all returning pollen-bearing foragers was not significantly different across the three day study.
Analysis of foragers visiting blooms was significantly different across the three day study.
Does application time make a difference on exposure level to bees?

| Post PM Prop concentrations in blooms were 16% lower than post AM Prop concentrations. | Post PM Cyp concentration levels in blooms were only 2% different after PM versus after AM spray. |
| Prop might be degrading overnight? | Over the next 24 hrs, the prop concentrations in the PM spray area dropped 46% within the PM spray area. |
| Over the next 24 hrs, the cyp concentrations in the PM spray area dropped 61% within the PM spray area. |

Could the chemistries of the fungicides cause one to degrade faster in the presence of nighttime dew and the other to degrade faster in sunlight?
Did the bees respond differently to application time? Perhaps

Of the hives closest to the spray areas,

| bees collected 0.75% of the post PM prop concentration on Day 2. | bees collected 8.5% of the post PM cyp concentration on Day 2 |
| bees collected 7.3% of the post AM prop concentration on Day 3 | bees collected 2.5% of the post AM cyp concentration on Day 3 |

Hive pollen concentrations that were sampled closest to the PM spray areas decreased (84% Cyp, and 79% Prop) from Day 2 to Day 3, a result that may reflect forager avoidance learning.

Several factors may be contributing: application time, degradation rates of the fungicides, learning, changing bloom density.
Thank you especially to

My field research team-Dawn Phoebe, Humberto
Almond Board of California for supporting this study!
Dr. Gordon Wardell for invaluable help and direction
Erik Wilkins, Mark Szczzerba, Doug Blair, Mike
Mendes, Wonderful
Elias, Uriel, Emmanuel spray team
Will Nesson
Steve Cook, Jonathan Barber, Marie Denski USDA
Debye Hunter, Bob Curtis, Gabriele Ludwig, ABC
Seeds for Bees: Improving bee and soil health where it matters most

Billy Synk
Director of Pollination Programs
Goals for Healthy Bees, Smart Farming, and Changing Practices

1. **Feed bees** – Increase diverse, nutritious forage for honey bees pollinating California’s Specialty crops.

2. **Feed the soil** – Improve soil conditions in and around orchards, farms, and ranches.

3. **Educate & Assist** – Build grower, beekeeper, and industry stakeholder knowledge of the benefits of cover crops by providing subsidized seed mixes and technical advice.
Colonies provided natural forage have lower pathogen loads and higher overwinter survival than those fed protein supplements [1].

When reared in pollen limited hives, bees communicate less efficiently thus potentially harming yield [2].

Mustards positively affect bee population growth leading to increased forager numbers [3].

Why Should Growers Plant Bee Forage?

It creates a positive feedback loop!
In addition to stronger colonies, bee forage benefits include:

- Increased **organic matter**
  - Prevents erosion
- Increase **water infiltration**
  - Increase nitrogen
  - Suppress weeds
  - Suppress nematodes
- Decomposition of mummy nuts
1% organic matter = 19,000 gallons per acre of water holding capacity!
Woodland, CA January 8th 2017

Raindrops seal soil surface → runoff

Protected from raindrops → Roots assist infiltration

Photos courtesy of Tony Rolfes
Woodland, CA January 15th 2017 (one week later)

Sealed Soil Surface, Soil Particles Dispersed

Retains granular surface structure

Photos courtesy of Tony Rolfes
Soil temperature

Soil microbes begin to die at temperatures above 90°

Photo courtesy of Jay Brandt. Fairfield, Ohio
4 seed options
   • PAm Mustard Mix
   • PAm Clover Mix
   • Woollypod Vetch
   • PAm Wildflower Mix

Cost share structure
   • 1st year enrollees are eligible for a $2,000 discount off their total seed purchase (50-120 acres)
   • 2nd year enrollees are eligible for a $1,000 discount off their total seed purchase

Enrollees who participate for more than 2 years receive:
   • wholesale pricing
   • free shipping
This win-win situation benefits both beekeeper and grower.

Forage program focused in California

Total Acres Planted:
27,887
Contact us!
Billy Synk
Director of Pollination Programs
Billy@projectapism.org
www.projectapism.org
Alternative Forage Plantings to Support Honey Bees

Flower borders and Cover crops in almond landscapes

Neal M. Williams
University of California, Davis
Overview

Challenge for bees/beekeepers: Insufficient forage to support bees during key times of the season. Specifically preceding and following almond bloom.

Goal: Identify viable strategies to supplement forage for bees within almond landscapes.

Challenge for pollination/growers: Require reliable pollination during short bloom window. High quality visits integration of wild bees which synergize honey bee pollination.

Goal: Can floral enhancements benefit almond yield? At least not compete with orchard for bee visits.
Overview: Research Aims

1. Identify bee forage planting schemes that benefit bees
   - Floral borders (2017 & 2018)
   - Cover crops (2018)

2. Identify plants that benefit bees
   - Native wildflower mix
   - Bee friendly mustard mix

Impact on Bee Health E. Niño
Floral Borders: (2017-2018) Study Locations and Site types

- Mustard mix
- Wildflower mix
- Typical border
- Riparian border

25 sites
Data collected

1. Measure bloom timing of bee forage plantings
   How do forage mixes perform and can they support bees at key times of the season?

2. Document bees’ use of forage plantings
   Do bees use them?

3. Quantify impacts of forage plantings on almond yield
   Do plantings benefit yield and not compete with orchards?
Mix Flowering Performance

Average Floral Area (cm²/m²)

2017
- Wildflower mix
- Mustard mix
- Riparian border
- Typical border

2018
- almond bloom

Feb | Mar | Apr
--- | --- | ---
0   | 0   | 0   
500 | 500 | 500 
1000| 1000| 1000
1500| 1500| 1500

Apr 2017 and Apr 2018 show significant increases in average floral area compared to Feb and Mar. The almond bloom period is indicated, with a peak in floral area observed in Apr 2018.
Bees use of Forage Mixes

Honey bee visits

Wild bee visits

Bee per m² per min

2017

2018

Feb  | Mar  | Apr  | Feb  | Mar  | Apr

Wildflower mix | Mustard mix

2017

2018

Feb  | Mar  | Apr  | Feb  | Mar  | Apr
Impacts on Yield

Nut set (Standardized z-score)

2017

-1.0 -0.5 0.0 0.5 1.0

Edge Interior

2018

-1.0 -0.5 0.0 0.5 1.0

Edge Interior

Wildflower mix
Mustard mix
Riparian border
Typical border

2018
2017
Cover Crops (2018)

• Partnering with Soils team (A. Gaudin and soils team).
• Forage planted between tree rows
• North, Central, Southern regions

2 mixes
• “Soil Health” = mustard + vetch + rye grass
• “Pollinator” = modified mustard mix
• Bare ground control
• Control orchard – spatial independence
Study Design

- Partnering with Soils team (A. Gaudin and soils team).
- Forage planted between tree rows
- North, Central, Southern regions

2 mixes
- “Soil Health” = mustard + vetch + rye grass
- “Pollinator” = modified mustard mix
- Bare ground control
- Control orchard – spatial independence
Data Collected

1. Measure bloom timing of cover crop plantings

2. Document bees’ use of cover crop plantings

3. Quantify impacts of cover crops on almond yield
Mix Flowering Performance

North

Central

South

Average Floral Area (cm²/m²)

Feb
Mar
Apr

Feb
Mar
Apr

Feb
Mar
Apr

Feb
Mar
Apr

“Pollinator” mix
Soil mix
Bare
Control Orchard

almond bloom

almond bloom

almond bloom
Bees use of Forage Mixes

• Honey bees used all flowering species within the mixes

• Preferred Brassica and mustards over vetch
Impacts on Yield

North

Central

South

Nut set proportion set / flw

poll soil con nt

poll soil con nt

poll soil con nt
Continuation - Cover Crop 2019

• 2018 was a preliminary study
• Expand numbers of sites
  – 7 cover orchards
  – 7 control orchards
• Partnering with PAm – Seeds for Bees Program
• Integrated project with assessment of colony health, E. Niño, UC Davis
• Proposed addition of pest and natural enemy assessment H. Wilson, UCR
Summary

Border plantings appear to support honey bees and wild bees.

Can benefit yield – no evidence of negative effect.

Cover plantings also support bees.

Impact on pollination and bees is to be determined.

KEY: Timing of plantings is critical to achieve benefits.
Thank you! for your support

Growers
Erdman Family Farms
DH Long Farming
CL5 Ranch
T. Barrios
Shane Tucker

Project Apis m.

Maisie & Jane's Sunnshine

California Almonds
AlmondBoard.com
Evaluation of honey bee colonies with access to supplemental forage plantings

Elina L. Niño

UC ANR/UC Davis
Stress factors in honey bee populations

Farmer practices
- Monoculture
- Field size

Bee food supply
- Less variety
- Less quantity

Climate & weather
- Planting season
- Spring timing
- Winter severity

Pesticides
- Application procedures
- Translocation
- Dust-off

Pathogens
- Viruses, bacteria, parasites, Other diseases
- Varroa mite
- Increased transmission of other diseases
- Resistance development to treatments

Beneficial microbes
- Susceptible to disease control agents
- Competition with pathogens

Acaricides*
- & other disease control agents

Bee keeper practices
- Attitudes
- Pollination services
- General care
- Disease management

Residues in bee products
- Hive foundations
- Pollen/ Wax

*Pesticides which kill mites

Source: OPERA Bee health in Europe, 2013
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Residues in bee products
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*Pesticides which kill mites

Source: OPERA Bee health in Europe, 2013
Value of optimal nutrition

• Better nutrition (diversity and availability) improves immune/detox response of honey bees
  – Bees respond better to infections and pesticide exposure (e.g., Alaux et al. 2009; Di Pasquale et al. 2013; Schmehl et al. 2014)
Supplemental forage mixes

Matching controls with no planted supplemental forage
2017
2 X 4 treatments/4 sites
Total of 32 colonies

2018
4 X 4 treatments/4 sites
Total of 64 colonies
• Colonies evaluated before, during and after almond bloom for various parameters

• After bloom, colonies moved to a stationary site
  – 2017: California
  – 2018: California and Oregon

• Monitoring continued every 4-6 weeks
Parameters tracked

• Resource use, pollen ID (Williams)

• Colony parameters
  – Adult population
  – Brood
  – Varroa mite infestation
  – Forager collections
    • Pathogen load and bee gut microbiome (McFrederick)
    • Immune competence (Anderson)
  – Survival
  – 2018: pollen pesticide analysis
Encountered challenges both years
Highlights for 2017

• Sampling showed diversity of pollen collected (Williams)
  – Wildflower collected only after bloom

• 2017: significantly higher brood and adult population at almond bloom in mustard group; higher survival in mustard group; no differences in Varroa mite infestation

• No statistical differences in pathogen load (McFrederick)
• Immune gene expression underway (Anderson)
Preliminary results for 2018

- Percent change in adult population pre- to post-bloom ($P = 0.0447$)

- Frames of brood ($P = 0.0441$)
- ~3 frame difference
Preliminary results for 2018

• Percent survival (P > 0.05) between all groups

• When evaluating mustard vs. its control (P = 0.05)

• Data from both years supports the idea that planting supplemental forage near orchards can provide immediate and longer term benefits for colonies

• Further analysis is underway as well as the 3rd year of the project
Acknowledgements

**The Niño Bee Lab**
- Bernardo Niño
- Many students
  - Joe Tauzer
  - Rae Purrington

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- Charley Nye

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- Neal Williams Lab (UCD)
- Quinn McFrederick Lab (UCR)
- Kirk Anderson Lab (USDA-ARS)

**Beekeepers and growers**

**Funding sources, donors, volunteers**
Research Poster Sessions

Tuesday, December 4
5:30 – 6:30 p.m.

Featured topics:
- Pollination and bee health
- Soil health
- Nutrient and nitrogen management
What’s Next

Tuesday, December 4 at 12:00 p.m.
• Speed Talks: Nutrient, Salinity and Soil Health – Room 308-309
• Almond Breeding: Is There a Role for New Genetic Technologies? – Room 312-313
• FSMA Scorecard: How Does Your Operation Stack Up? – Room 306-307

Tuesday, December 4 at 12:30 p.m.
• Almonds in the Global Marketplace – Room 314
Join the social media conversation at #AlmondConf
What’s Next

Tuesday, December 4

• State of the Industry – Hall C at 4:15 p.m.
• Research Poster Session – Hall A+B at 5:30 p.m.

Be sure to join us at 5:30 p.m. in Hall A+B for Dedicated Trade Show Time and Opening Reception, sponsored by FMC Agricultural Solutions