



Pest Management: Protecting Blooms and Bees

December 8, 2016



Pest Management: Protecting Blooms and Bees


Danielle Veenstra, Almond Board of
California (Moderator)

Reed Johnson, Ohio State University

Jody Johnson, Cullaborate

Emily Symmes, UCCE IPM Advisor



A close-up photograph of several green almonds on a branch, surrounded by vibrant green leaves. The background is softly blurred, showing more of the tree and some indistinct figures in the distance. The lighting is bright and natural, highlighting the texture of the almonds and the sheen on the leaves.

**Danielle Veenstra,
Almond Board of California**



Reed Johnson,
Ohio State

Effects of Insecticide and Fungicide Combinations on Honey Bees

Reed M. Johnson and Chia-Hua Lin
Department of Entomology



Acknowledgements

- Eric Percel, Natalia Riusech, Andrea Wade, Bridget Gross, Ashley Cordle, Michael Wransky, Juan Quijia-Pillajo (Ohio State University)
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- Darin Allred (Chemtura)
- The California Bee Breeders Association



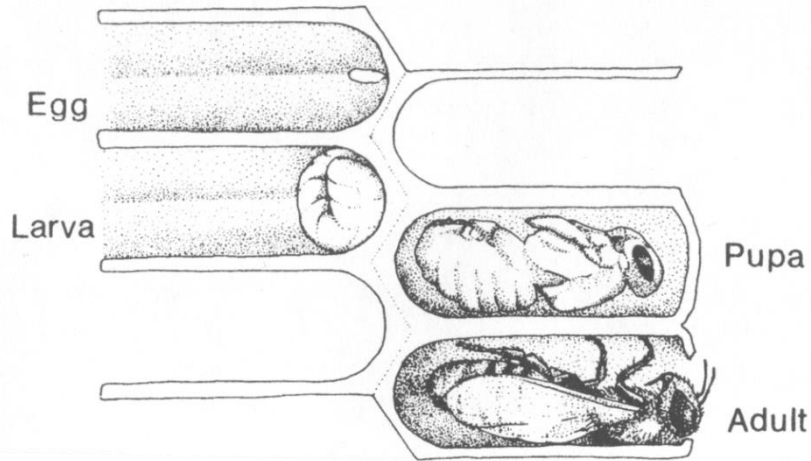
HONEY BEE BEST MANAGEMENT PRACTICES FOR CALIFORNIA ALMONDS



HONEY BEES AND INSECTICIDES

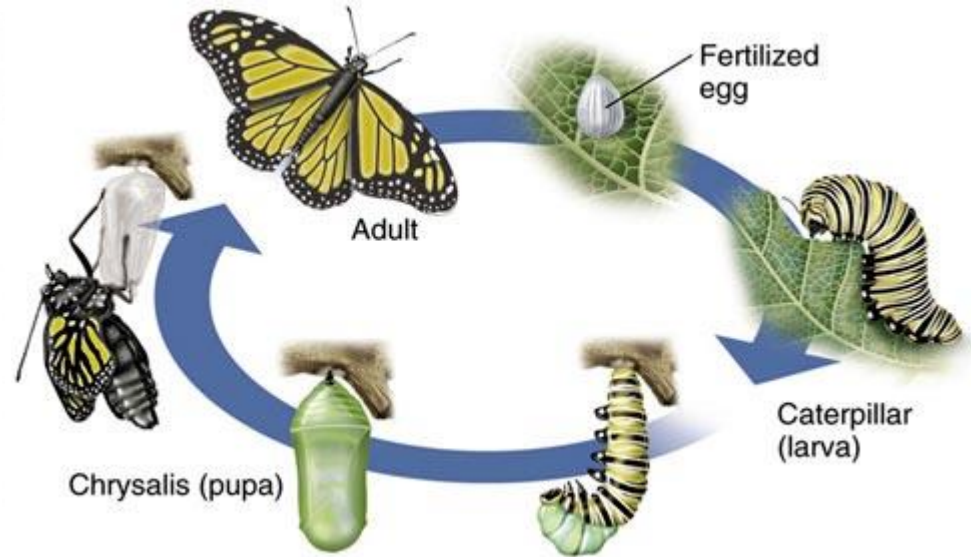
All parties involved in almond pollination and/or applying pesticides should follow the precaution of not applying insecticides during bloom. Bee losses appear to have occurred in almonds as a result of tank-mixing insecticides with bloom-time fungicides. While the losses could have other causes, there is a scientific basis for concern; this is based on field experience that is being substantiated with controlled studies.^{6,7} Currently, most bee label warnings are only based on adult acute toxicity studies; however, recent information indicates some may be harmful to young developing bees in the hive (bee brood). Until recently, the U.S. EPA has not required data for possible effects on bee brood. Foragers bring back pollen to the hive, which is fed to the bee brood. Insecticide residues have been detected in this pollen. The term 'insecticide' includes insect growth regulators, also known as IGRs.

Complete metamorphosis



Winston Fig. 4.1

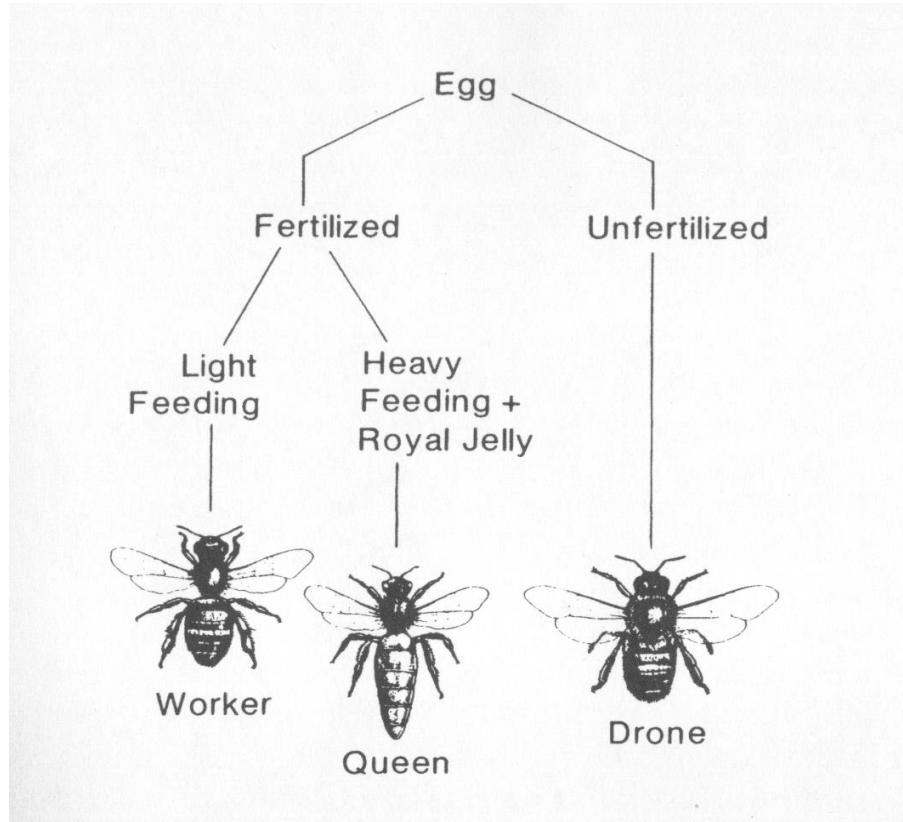
Honey bee

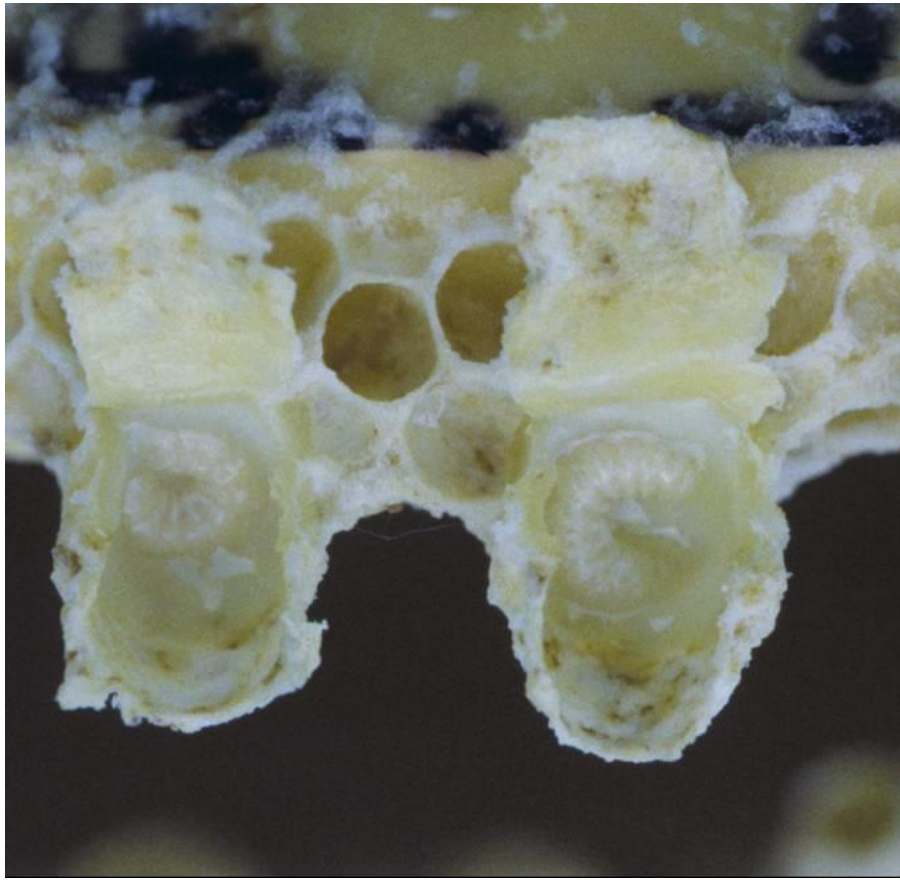


Swallowtail butterfly

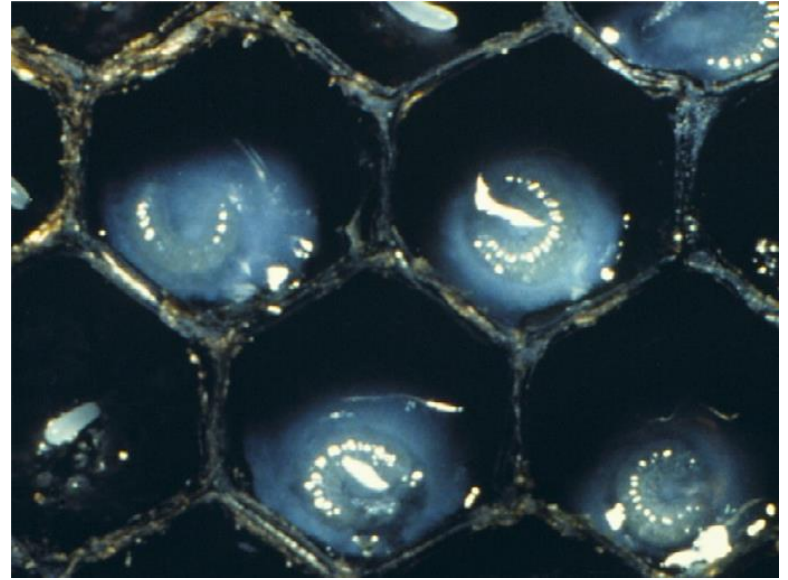
Three castes

“Biology of
the Honey
Bee” Fig. 4.6





Queens



Workers

Grafting Worker Larvae into Queen Cells



Photo: Zachary Huang

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
- Brood failure in weeks following almond bloom

1. Which pesticides and combinations are bees exposed to during almond bloom

2. Which pesticides and combinations could cause adult bees to die?

3. Which pesticides and combinations can cause developmental problems in workers and queens?

“Bee Safe” pesticides applied to almonds during bloom

- Fungicides, herbicides, a few insecticides
- Low acute toxicity to adult bees in laboratory testing
- Carry no cautionary language on label regarding bee exposure





[-> CalPIP Home](#)

[-> My Selections](#)

DATA SOURCE: ?

PUR ▼

[Pesticide Use Report](#)

SEARCH BY DATA

CATEGORY:

Date ?

[-> Year](#)

Location ?

[-> County](#)

[-> MTRS](#)

[-> Zip Code](#)

Site/Crop ?

[-> Name Search](#)

Product ?

[-> Name Search](#)

Chemical ?

[-> Name Search](#)

Other Criteria ?

[-> Ag/NonAg](#)

[-> Format Output](#)

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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.

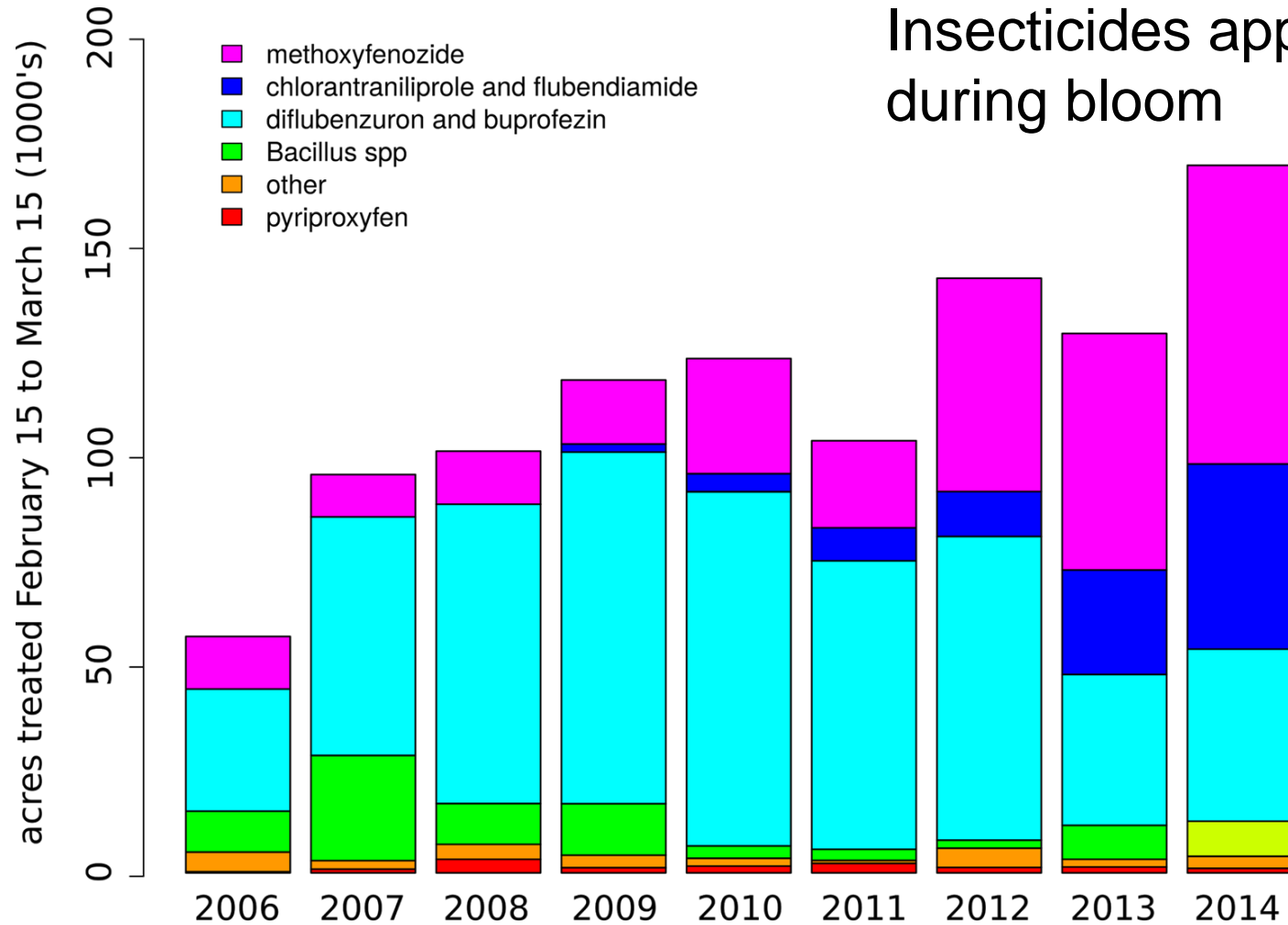
Notes on version updates, bug fixes and known issues. [more...](#)

First Time Users

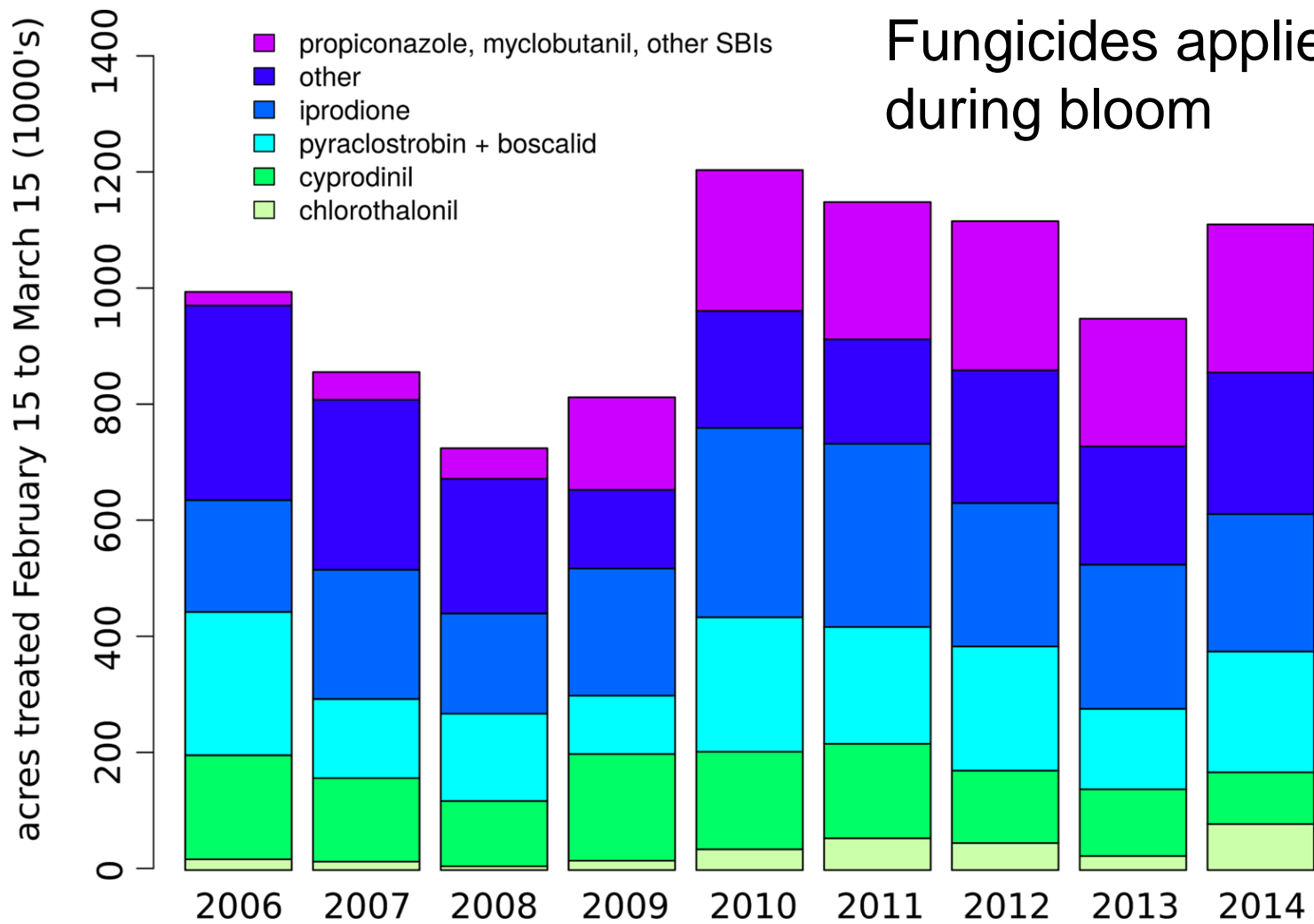
If this is your first visit to our site, you may want additional information to make your visit more successful. [more...](#)

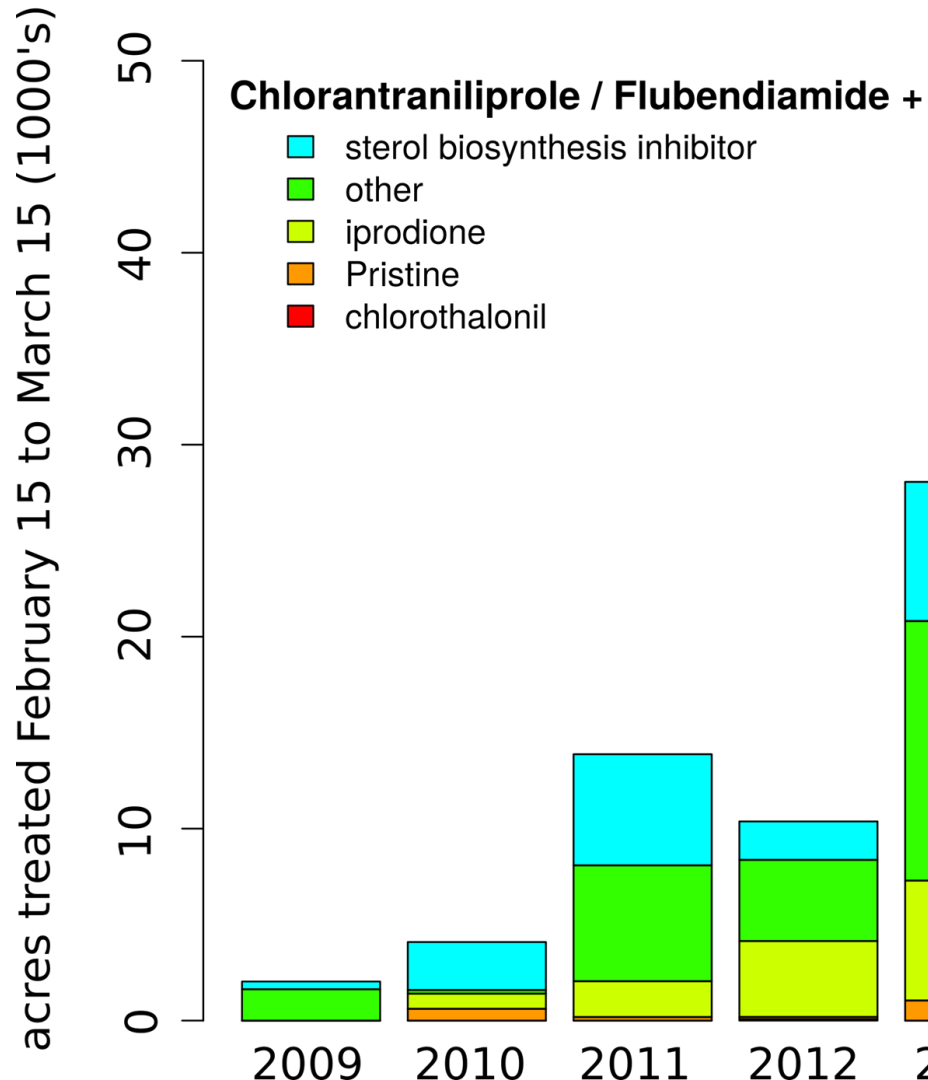
About the Data Sources

Insecticides applied during bloom



Fungicides applied during bloom





Nearly all
insecticides
applied
during
almond
bloom are
tank mixes
with
fungicides

Acute worker toxicity: Insecticides and combinations



GROUP 28 INSECTICIDE

ALTACOR® is a water dispersible granule.

Active Ingredient

Chlorantraniliprole
 3-Bromo-N-[4-chloro-2-methyl-6-[(methylamino)carbonyl]phenyl]-1-(3-chloro-2-pyridinyl)-1H-pyrazole-5-carboxamide

By Weight

35.0%

Other Ingredients

65.0%

TOTAL

100.0%

Crops	Insects	DuPont™ ALTACOR® Rate Per Acre	
		Lb A.I.	Ounces Product
Tree Nuts, (EPA Crop Group 14), Including: Almond; Beech nut; Brazil nut; Butternut;	Hickory shuckworm Pecan nut casebearer	0.044 – 0.099	2.0 – 4.5
	Codling moth Navel orange worm Light brown apple moth Oblique banded leafroller Oriental fruit moth Peach twig borer	0.066 – 0.099	3.0 – 4.5

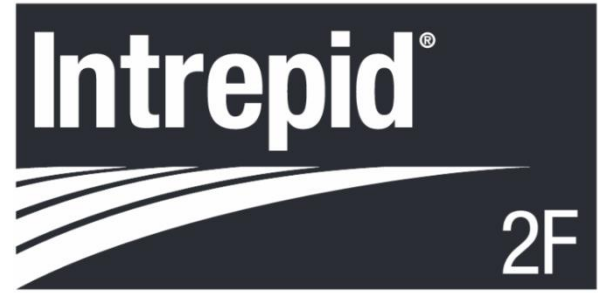
Acute worker toxicity: Insecticides and combinations



GROUP	28	INSECTICIDE
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ALTACOR® is a water dispersible granule.

<i>Active Ingredient</i>	<i>By Weight</i>
Chlorantraniliprole	
3-Bromo-N-[4-chloro-2-methyl-6-[(methylamino)carbonyl]phenyl]-1-(3-chloro-2-pyridinyl)-1H-pyrazole-5-carboxamide	35.0%
<i>Other Ingredients</i>	65.0%
TOTAL	100.0%



INSECTICIDE

®Trademark of The Dow Chemical Company ("Dow") or an affiliated company of Dow

Group	18	INSECTICIDE
-------	----	-------------

Active Ingredient:

methoxyfenozide: Benzoic acid, 3-methoxy-2-methyl-, 2-(3,5-dimethylbenzoyl)-2-(1,1-dimethylethyl) hydrazide	22.6%
Other Ingredients	77.4%
Total	100.0%

Contains 2 lb active ingredient per gallon

Acute worker toxicity: Insecticides and combinations



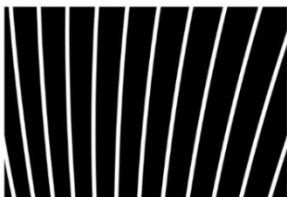
GROUP	28	INSECTICIDE
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ALTACOR® is a water dispersible granule.

Active Ingredient	By Weight
Chlorantraniliprole 3-Bromo-N-[4-chloro-2-methyl-6-[(methylamino)carbonyl]phenyl]-1-(3-chloro-2-pyridinyl)-1H-pyrazole-5-carboxamide	35.0%
Other Ingredients	65.0%
TOTAL	100.0%

GROUP	15	INSECTICIDE
-------	----	-------------

Dimilin® 2L

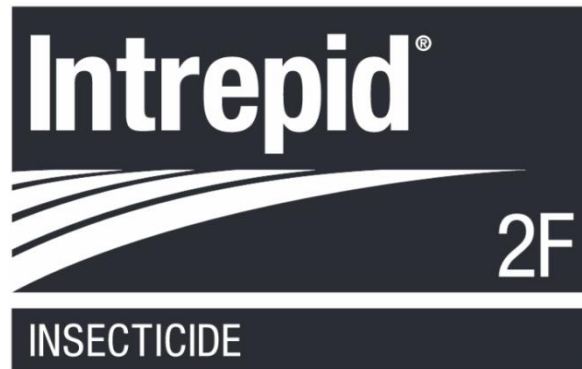


**Insect Growth Regulator
Aqueous Flowable**

For use on barley, oats, triticale, wheat, cotton, grassland and non-crop areas, leafy brassica and turnip greens, livestock/poultry premises, peanuts, pears, peppers, rice, soybeans, stonefruit (excluding cherries), tree nuts, and turfgrass

Not for Homeowner/Residential Use

**Net
Contents:
1
gallon**



®Trademark of The Dow Chemical Company ("Dow") or an affiliated company of Dow

Group	18	INSECTICIDE
-------	----	-------------

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Other Ingredients	77.4%
Total	100.0%

Contains 2 lb active ingredient per gallon

Acute worker toxicity: Insecticides and combinations



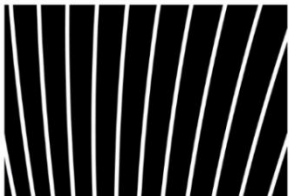
GROUP 28 INSECTICIDE

ALTACOR® is a water dispersible granule.

Active Ingredient	By Weight
Chlorantraniliprole 3-Bromo-N-[4-chloro-2-methyl-6-[(methylamino)carbonyl]phenyl]-1-(3-chloro-2-pyridinyl)-1H-pyrazole-5-carboxamide	35.0%
Other Ingredients	65.0%
TOTAL	100.0%

GROUP 15 INSECTICIDE

Dimilin® 2L

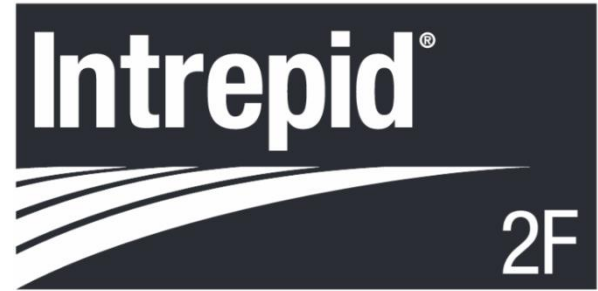


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Other Ingredients	77.4%
Total	100.0%

Contains 2 lb active ingredient per gallon

**Thiamethoxam
(positive control)**

Insecticide	max lb. a.i. per acre
chlorantraniliprole (Altacor)	0.099
methoxyfenozone (Intrepid)	0.25
diflubenzuron (Dimilin)	0.25



Tilt®

Fungicides

syngenta.

Fungicide

Broad spectrum fungicide for control of plant diseases

Active Ingredient:

Propiconazole*: 41.8%

Other Ingredients**: 58.2%

Total: 100.0%

Crop	Target Diseases	Use Rate fl oz product/A	Remarks
Almonds	Brown Rot Blossom Blight (<i>Monilinia laxa</i> , <i>M. fructicola</i>)	4-8	Apply Tilt at 5-10% bloom and 50-100% bloom. Under severe disease conditions, use the highest rate. Minimum retreatment interval is 7 days.
	Anthraco­nose (<i>Collectotrichum acutatum</i>)	8	Apply Tilt beginning at bud break on a 7-14 day interval.



Tilt®

syngenta®

Fungicide

Broad spectrum fungicide for control of plant diseases

Active Ingredient:

Propiconazole*: 41.8%

*Other Ingredients**:* 58.2%

Total: 100.0%

Fungicides



Fungicide

Broad spectrum fungicide for control of plant diseases

Active Ingredient:

Propiconazole* 41.8%

Other Ingredients** 58.2%

Total: 100.0%

Fungicides

4 Flowable Fungicide

EPA Reg. No. 279-9564

EPA Est. No.: 279-NY-1

ACTIVE INGREDIENT:

Iprodione: 3-(3,5-dichlorophenyl)-N-(1-methylethyl)-2,4-dioxo-1-imidazolidinecarboxamide* 41.6%

OTHER INGREDIENTS: 58.4%

TOTAL 100.0%

*Equivalent to 4 Lbs. Iprodione per gallon.

FIRST AID

IF ON SKIN OR CLOTHING

- Take off contaminated clothing.
- Rinse skin immediately with plenty of water for 15-20 minutes.
- Call a poison control center or doctor for treatment advice.

IF SWALLOWED

- Call a Poison Control Center or doctor immediately for treatment advice.
- Have person sip a glass of water if able to swallow.
- Do not induce vomiting unless told by a Poison Control Center or doctor.



Fungicide

Broad spectrum fungicide for control of plant diseases

Active Ingredient:

Propiconazole*: 41.8%

Other Ingredients**: 58.2%

Total: 100.0%

Pristine®

Fungicide

For use in disease control and plant health in the following crops: alfalfa; Belgium endive; berries; bulb vegetables; carrot; celery; citrus fruit; cucurbit vegetables; globe artichoke; grape; hops; pome fruit; radicchio; stone fruit; strawberry; and tree nut

Active Ingredients:

pyraclostrobin*: (carbamic acid, [2-[[[1-(4-chlorophenyl)-1H-pyrazol-3-yl]oxy]methyl]phenyl]methoxy-, methyl ester) 12.8%

boscalid***: 3-pyridinecarboxamide,2-chloro-N-(4'-chloro(1,1'-biphenyl)-2-yl)- ... 25.2%

Other Ingredients: 62.0%

Total: 100.0%

* 0.128 oz (0.008 lb) of pyraclostrobin in 1 oz of product

** 0.252 oz (0.0158 lb) of boscalid in 1 oz of product

EPA Reg No. 7969-199

EPA Est. No.

Fungicides

rovral®

brand

4 Flowable Fungicide

EPA Reg. No. 279-9564

EPA Est. No.: 279-NY-1

ACTIVE INGREDIENT:

Iprodione: 3-(3,5-dichlorophenyl)-N-(1-methylethyl)-2,4-dioxo-1-imidazolidinecarboxamide* 41.6%

OTHER INGREDIENTS: 58.4%

TOTAL 100.0%

*Equivalent to 4 Lbs. Iprodione per gallon.

FIRST AID

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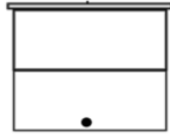
IF SWALLOWED

- Call a Poison Control Center or doctor immediately for treatment advice.
- Have person sip a glass of water if able to swallow
- Do not induce vomiting unless told by a Poison Control Center or doctor.

	Fungicide	boscalid + pyraclostrobin (Pristine)	iprodone (Rovral)	propiconazole (Tilt)
Insecticide	max lb. a.i. per acre	0.344	0.5	0.225
chlorantraniliprole (Altacor)	0.099			
methoxyfenozide (Intrepid)	0.25			
diflubenzuron (Dimilin)	0.25			

	Fungicide	boscalid + pyraclostrobin (Pristine)	iprodione (Rovral)	propiconazole (Tilt)
Insecticide	max lb. a.i. per acre	0.344	0.5	0.225
chlorantraniliprole (Altacor)	0.099	1 : 3.47	1 : 5.05	1 : 2.27
methoxyfenozide (Intrepid)	0.25	1 : 1.38	1 : 2	1: 0.90
diflubenzuron (Dimilin)	0.25	1 : 1.38	1 : 2	1: 0.90
		ratio of insecticide : fungicide		

Oral application



Collect frame of brood from colony

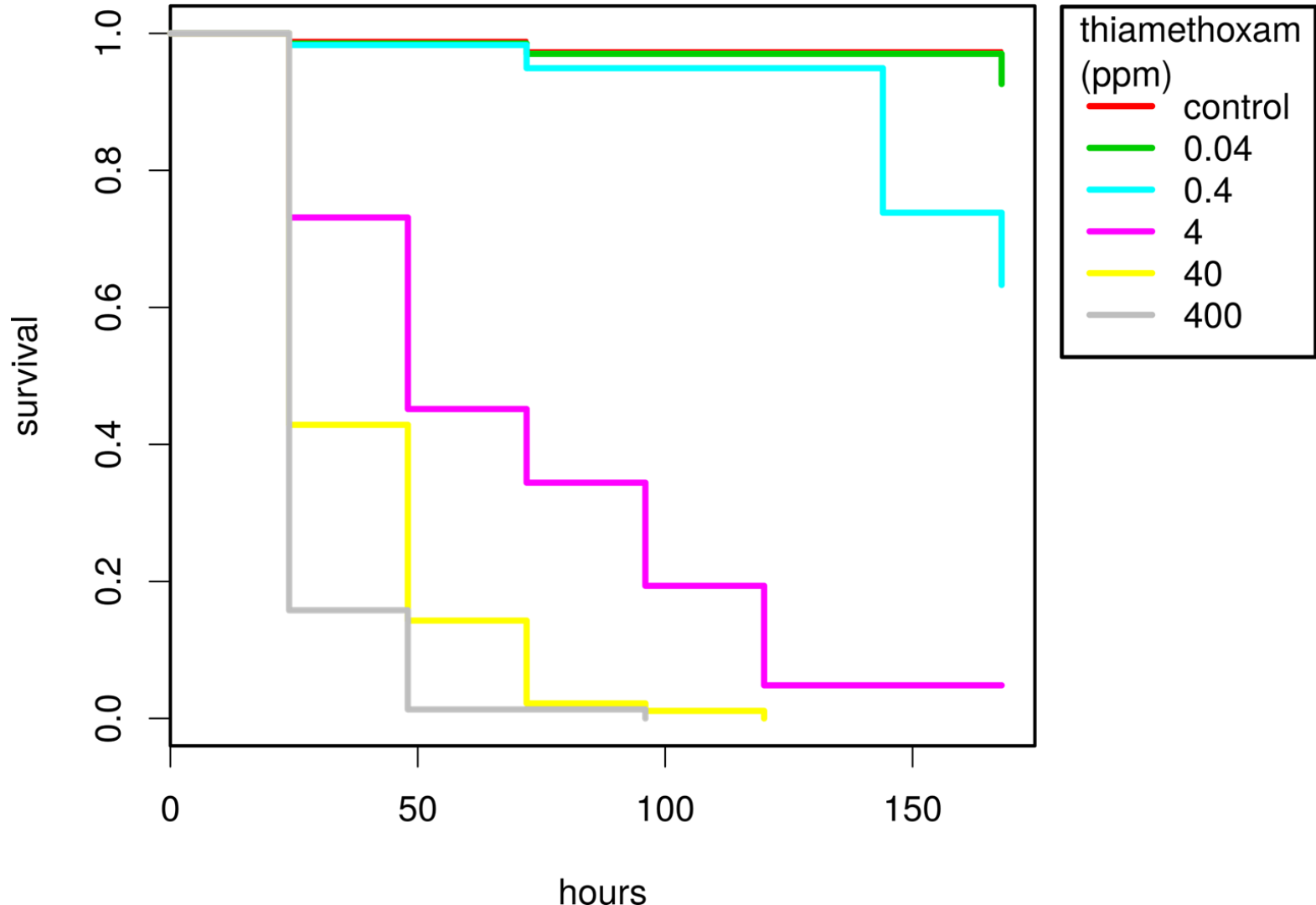
Uniformly aged cohort of young bees

Treat groups with varying doses of pesticides in pollen

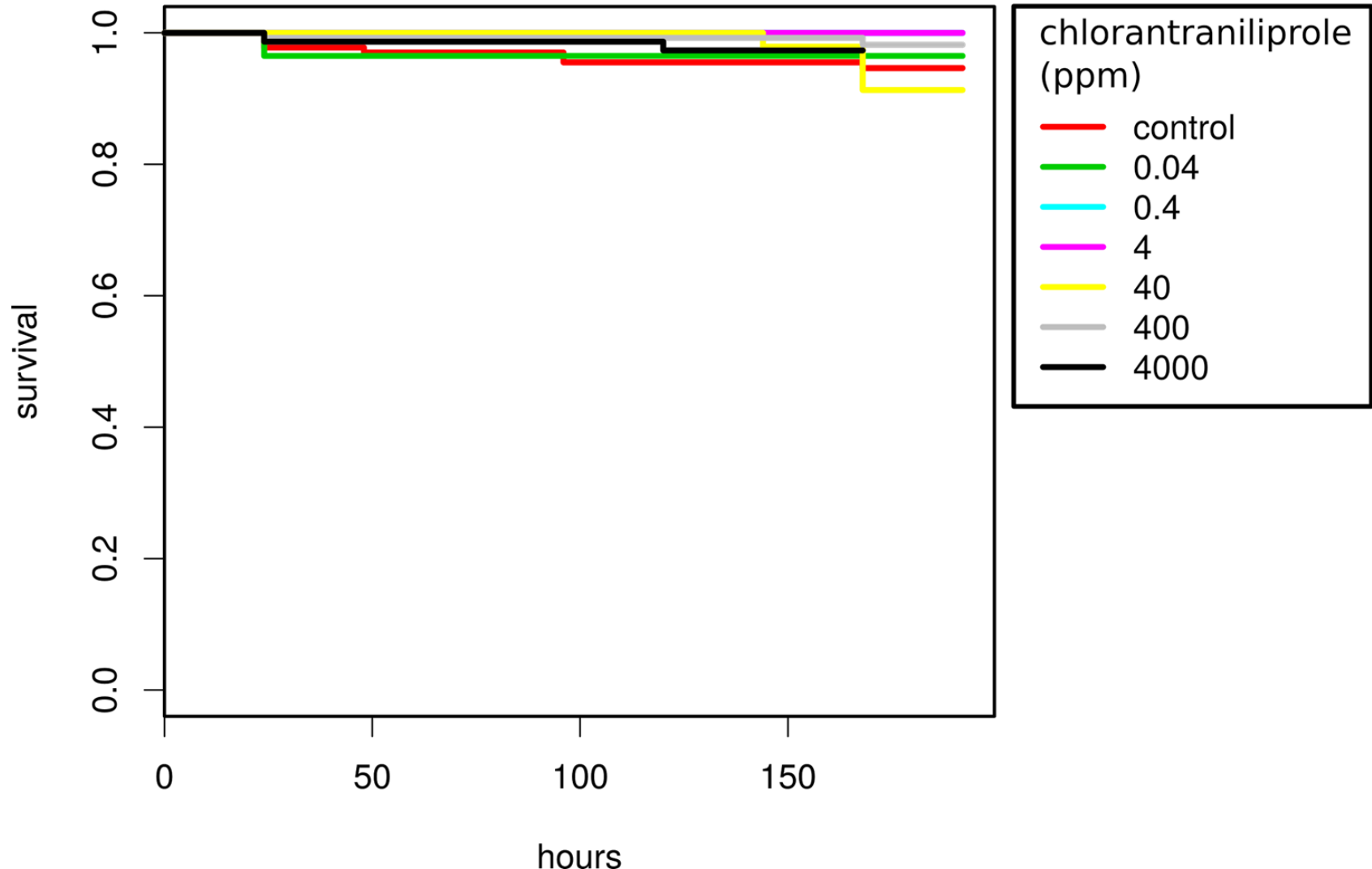
Count living and dead bees daily for 10 days

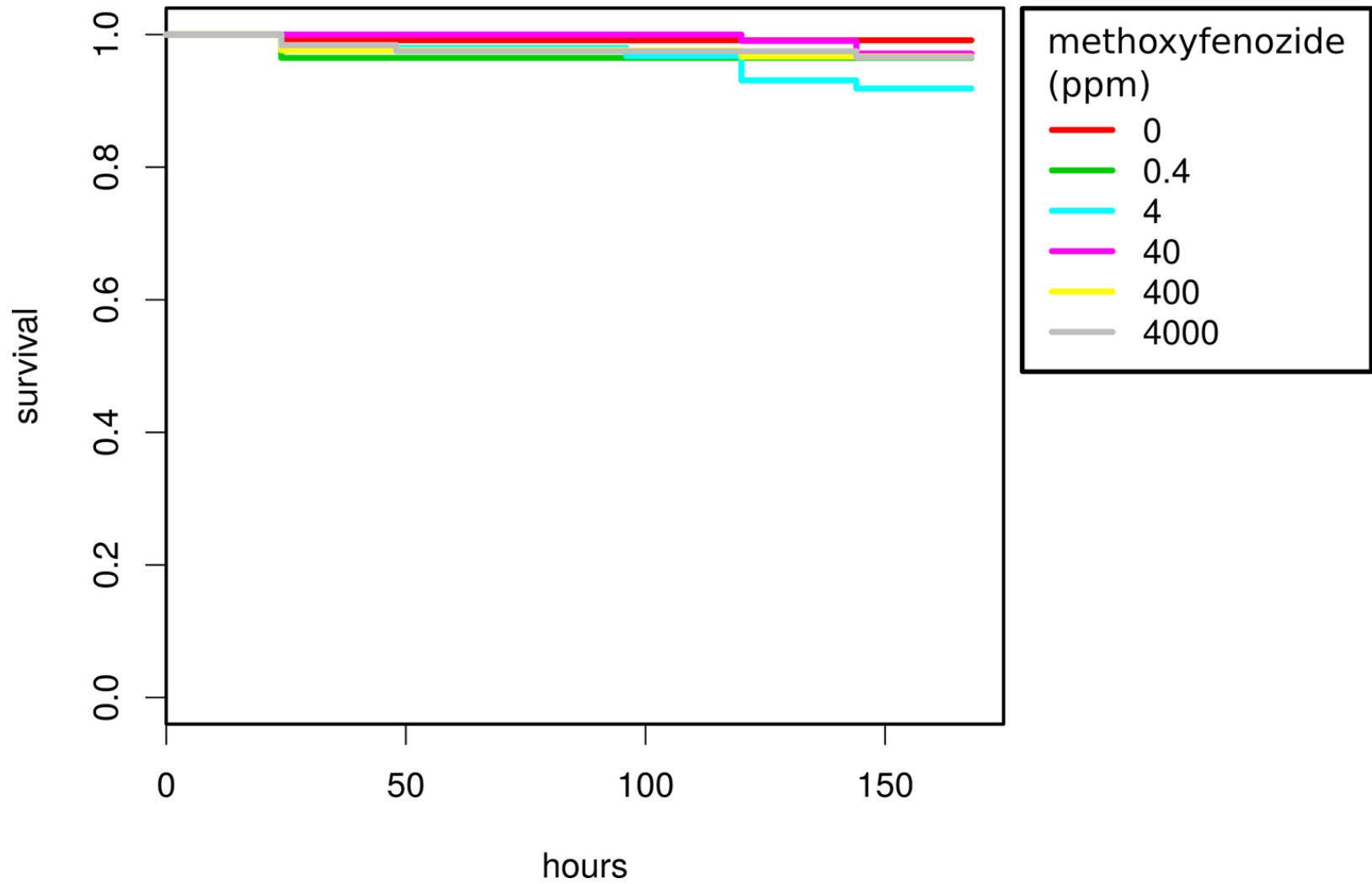


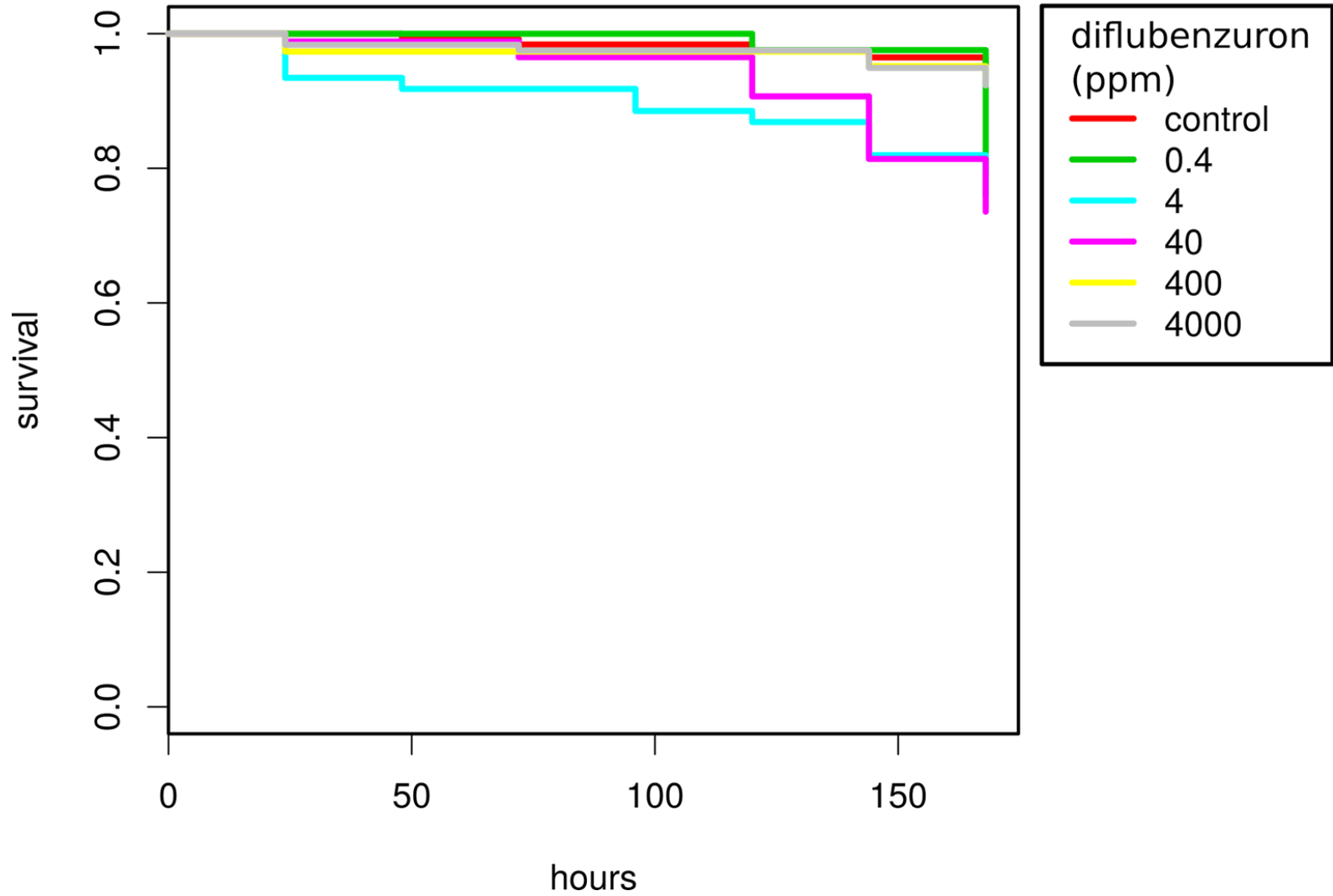
Positive
Control



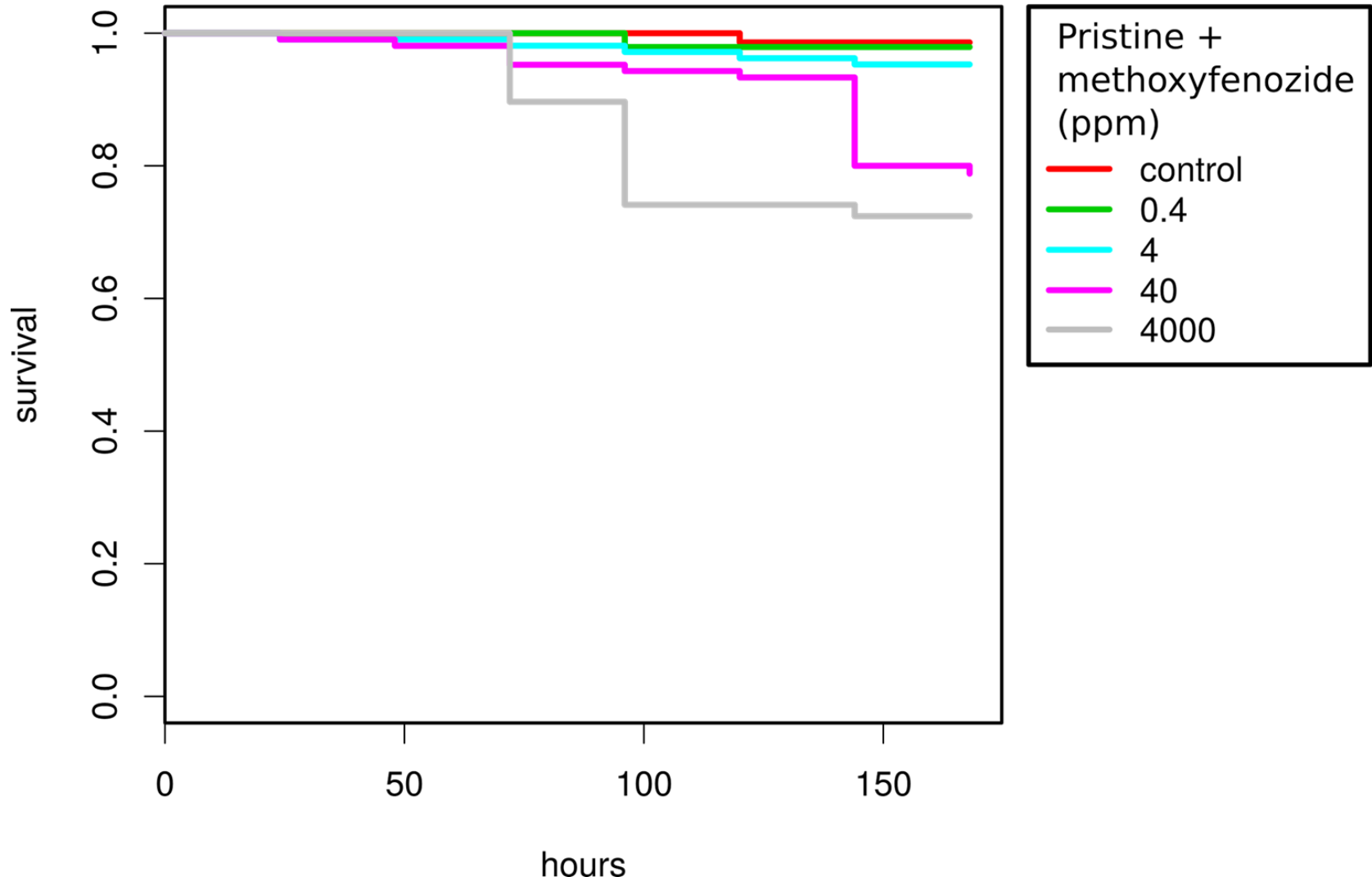
	Insecticide alone	boscalid + pyraclostrobin (Pristine)	iprodisone (Rovral)	propiconazole (Tilt)
chlorantraniliprole (Altacor)				
methoxyfenozide (Intrepid)				
diflubenzuron (Dimilin)				
thiamethoxam (positive control)	0.04 ppm			





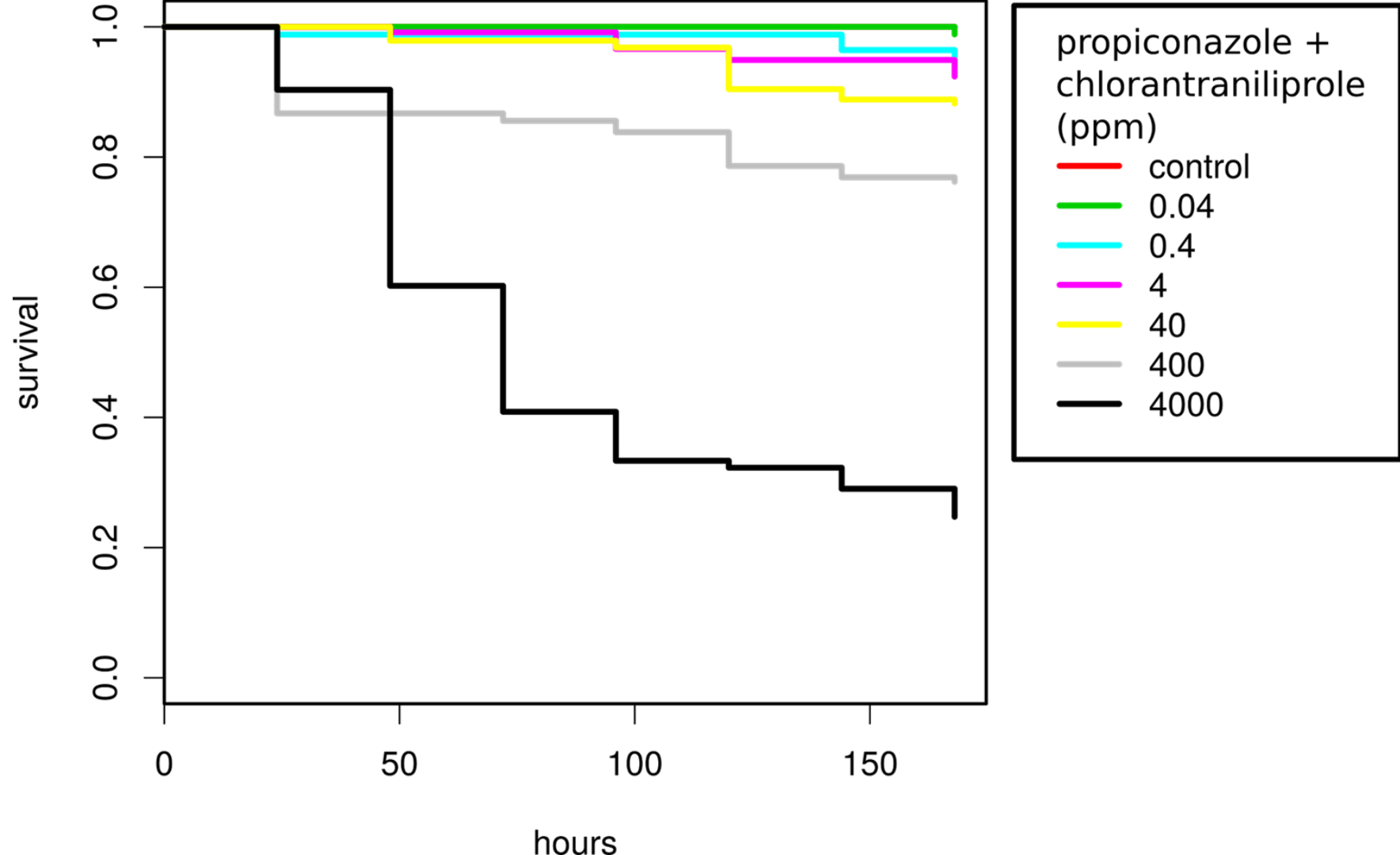


	Insecticide alone	boscalid + pyraclostrobin (Pristine)	iprodisone (Rovral)	propiconazole (Tilt)
chlorantraniliprole (Altacor)	> 4000 ppm			
methoxyfenozide (Intrepid)	> 4000 ppm			
diflubenzuron (Dimilin)	> 4000 ppm			
thiamethoxam (positive control)	0.04 ppm			



	Insecticide alone	boscalid + pyraclostrobin (Pristine)	iprodisone (Rovral)	propiconazole (Tilt)
chlorantraniliprole (Altacor)	> 4000 ppm	> 4000 ppm		
methoxyfenozide (Intrepid)	> 4000 ppm	40 ppm		
diflubenzuron (Dimilin)	> 4000 ppm	> 4000 ppm		
thiamethoxam (positive control)	0.04 ppm			

	Insecticide alone	boscalid + pyraclostrobin (Pristine)	iprodisone (Rovral)	propiconazole (Tilt)
chlorantraniliprole (Altacor)	> 4000 ppm	> 4000 ppm	4000 ppm	
methoxyfenozide (Intrepid)	> 4000 ppm	40 ppm	> 4000 ppm	
diflubenzuron (Dimilin)	> 4000 ppm	> 4000 ppm	4000 ppm	
thiamethoxam (positive control)	0.04 ppm			

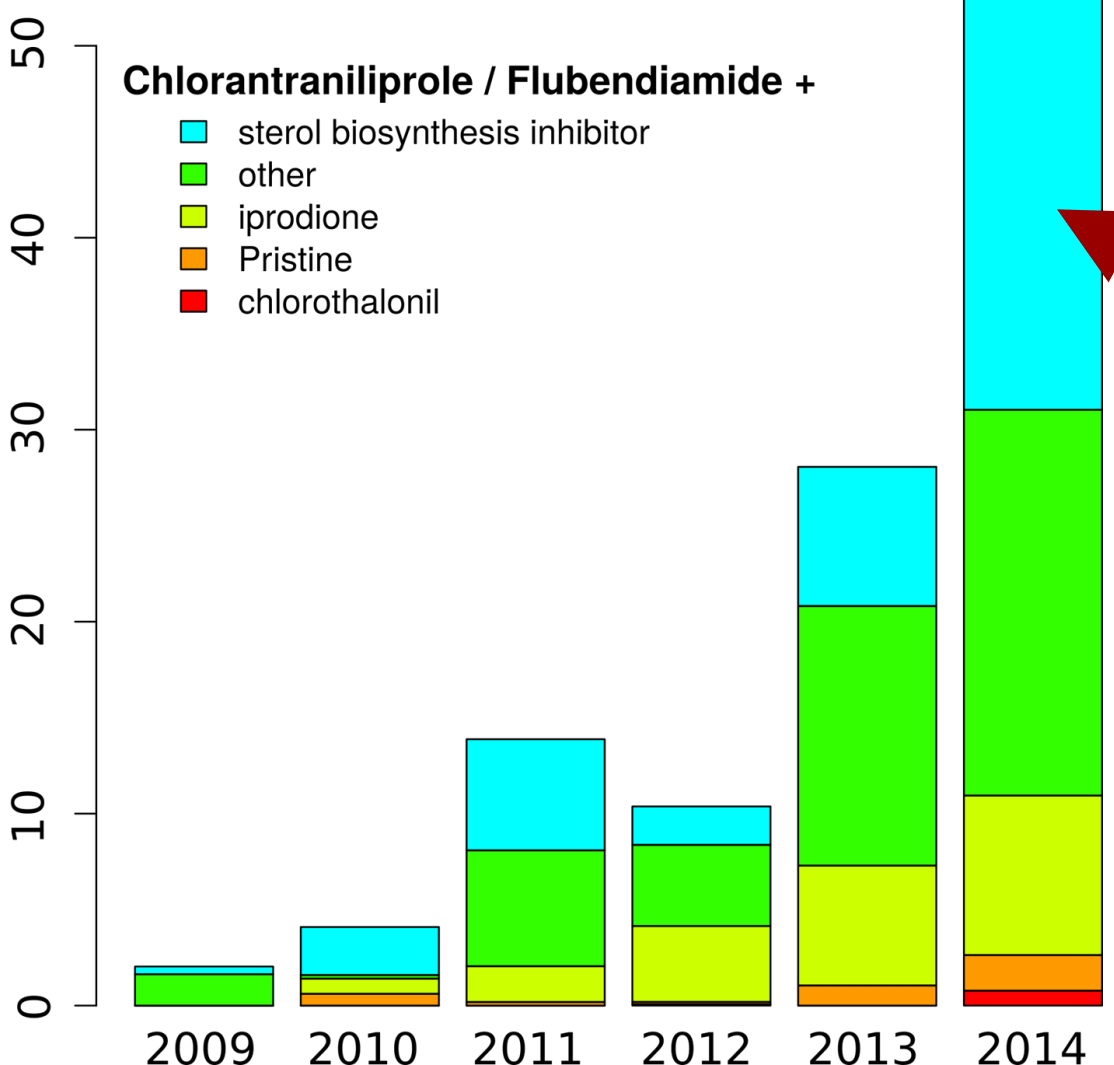


	Insecticide alone	boscalid + pyraclostrobin (Pristine)	iprodisone (Rovral)	propiconazole (Tilt)
chlorantraniliprole (Altacor)	> 4000 ppm	> 4000 ppm	4000 ppm	0.4 ppm
methoxyfenozone (Intrepid)	> 4000 ppm	40 ppm	> 4000 ppm	400 ppm
diflubenzuron (Dimilin)	> 4000 ppm	> 4000 ppm	4000 ppm	40 ppm
thiamethoxam (positive control)	0.04 ppm			

acres treated February 15 to March 15 (1000's)

Chlorantraniliprole / Flubendiamide +

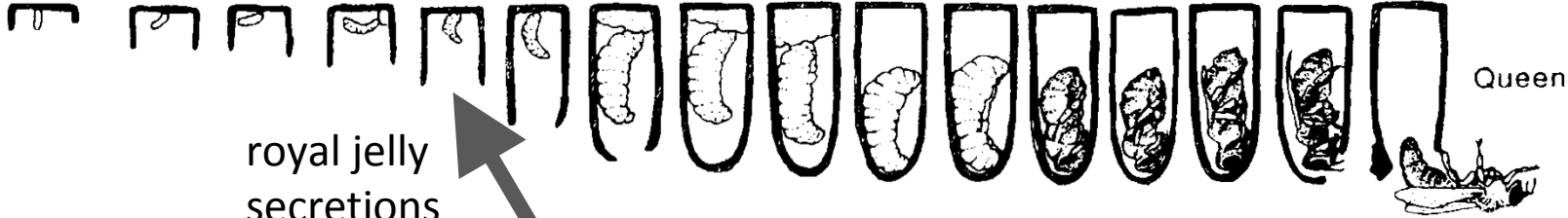
- sterol biosynthesis inhibitor
- other
- iprodione
- Pristine
- chlorothalonil



A bee kill may have occurred on these 20,000 acres

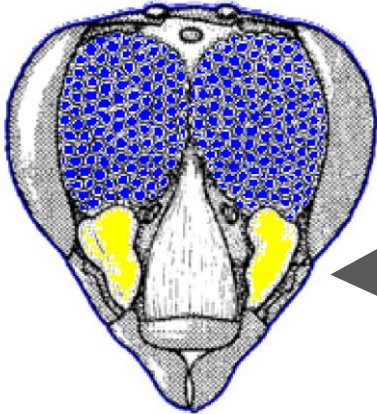
Developmental effects: Queen development

Winston, "Biology of the Honey Bee"



hypopharangeal glands

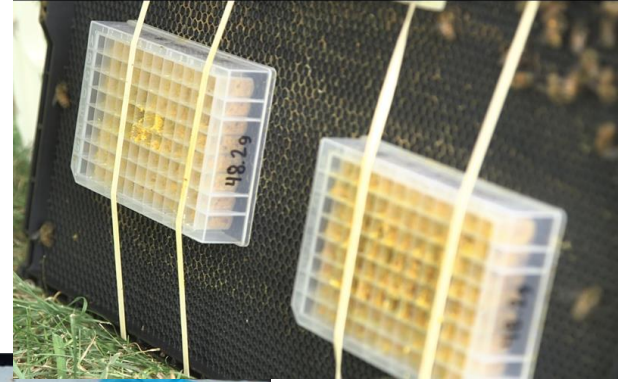
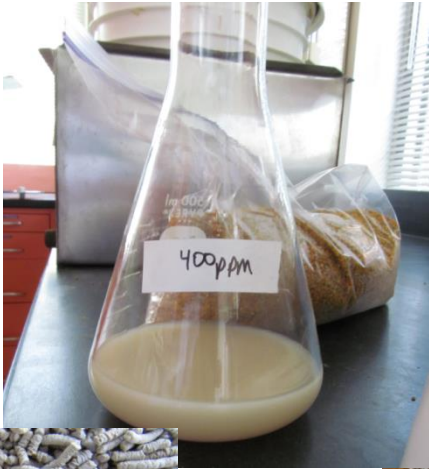
mandibular glands



nurse worker bee consumes pollen + pesticides



Pollen with Pesticides



Grafting queen cells

Young larvae (24 - 48 hrs),
produced by the same
queen, are grafted into JZ-
BZ queen cell cups

30-60 cups per treatment



Image source: beeinformed.org

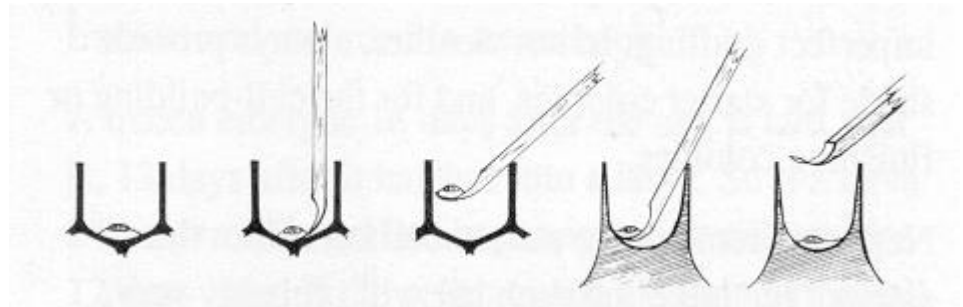


Image source: agriculture.vic.gov.au/

5-frame swarm box as queen cell starter



Swarm box setup (5 frames)

3 lb. of nurse bees in box

Dummy frame (foundation) →

pollen (treatment) →

Grafted queen cups →

Empty comb →

Sugar syrup →



Boxes are closed then moved to a dark, temperature controlled (70 - 76 F) room for 4 days



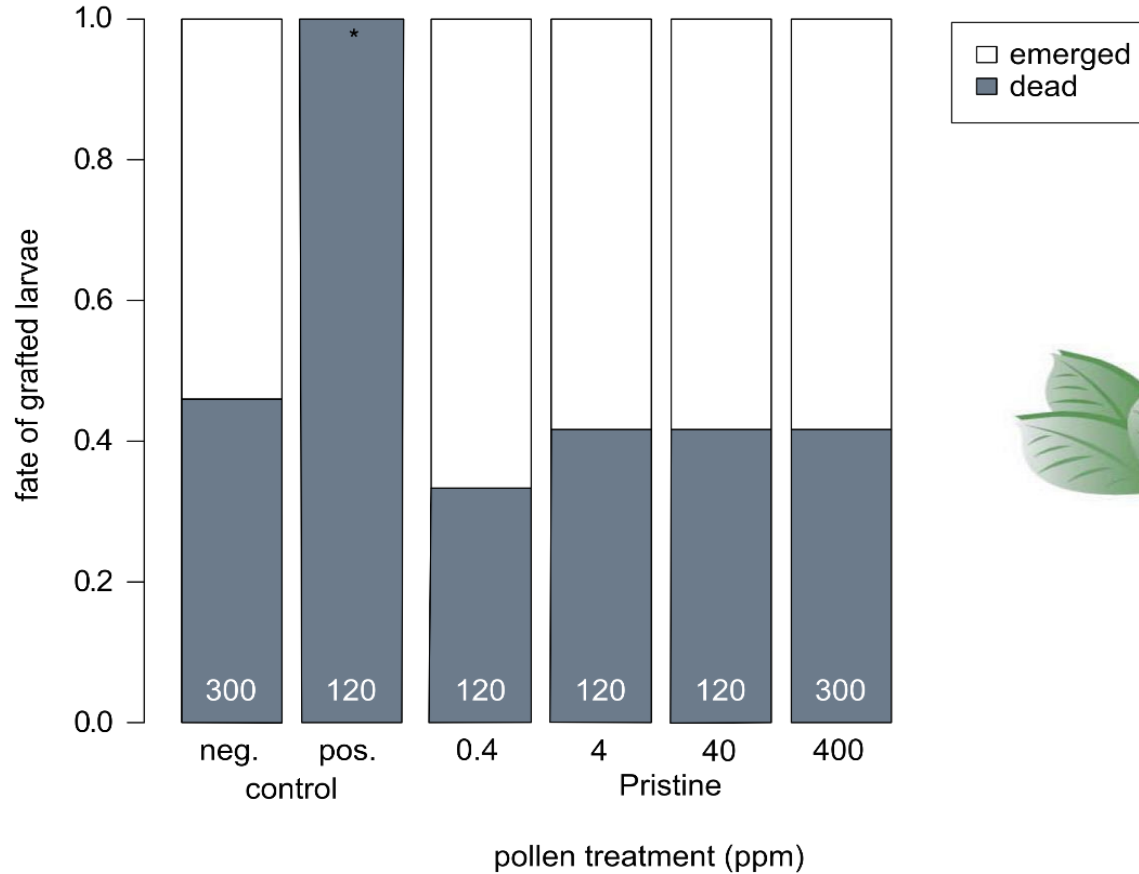
Day 8: place capped queen cells in cages, then back to the incubating colony for emergence

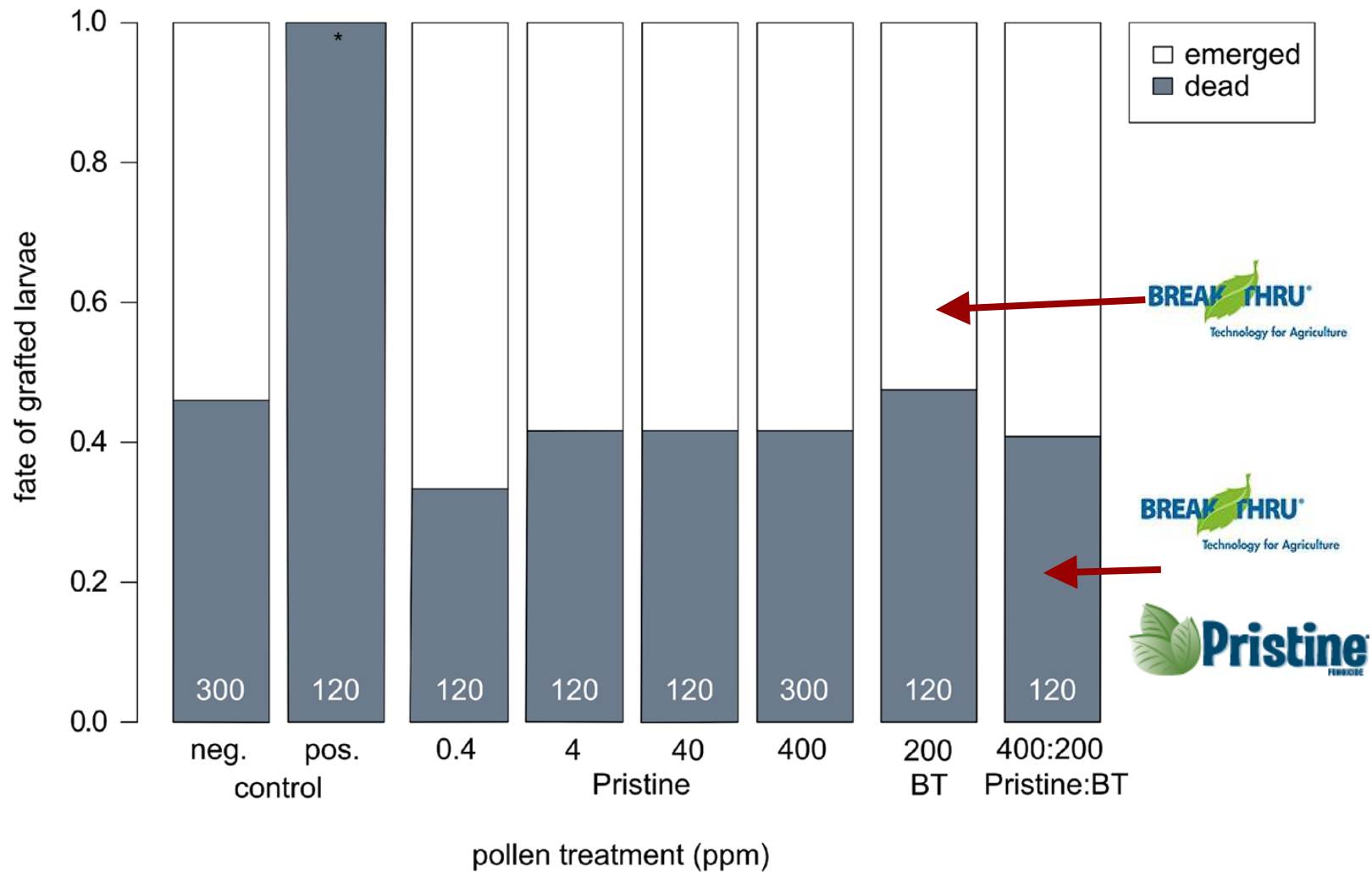
Day 10: remove 5 queen cells per treatment for establishing mating nucs. Leave the remaining cells to emerge in the incubating colony

Day 11 - 17: record emerged queens and mortality every 2 - 3 days.

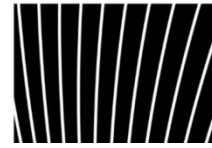
Collect queens on day 17.







Dimilin® 2L

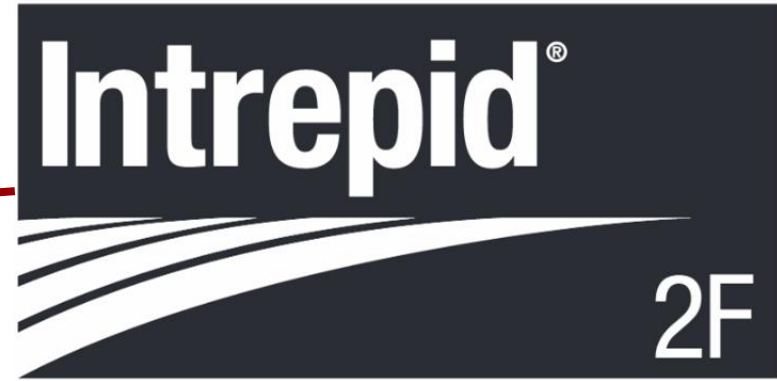
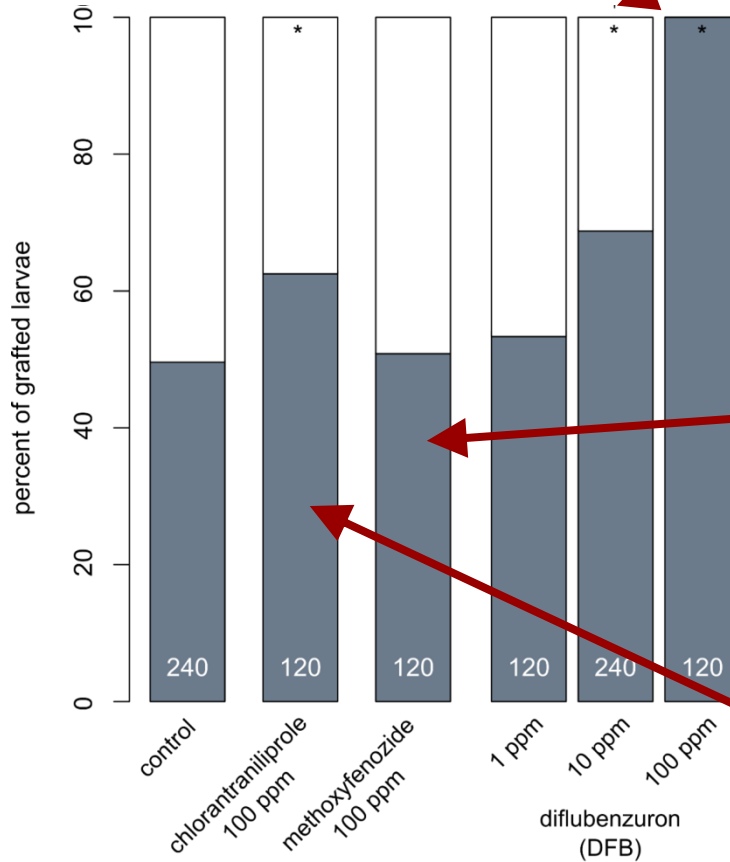


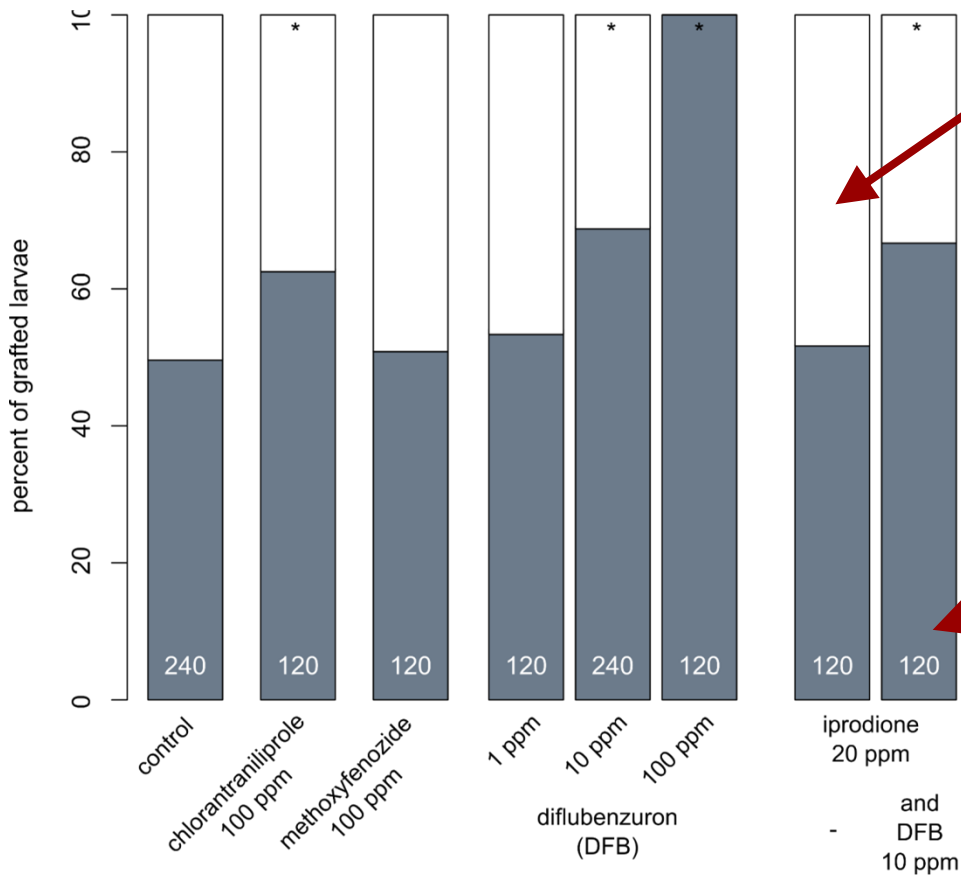
**Insect Growth Regulator
Aqueous Flowable**

For use on barley, oats, triticale, wheat, cotton, grassland and non-crop areas, leafy brassica and turnip greens, livestock/poultry premises, peanuts, pears, peppers, rice, soybeans, stonefruit (excluding cherries), tree nuts, and turfgrass

Not for Homeowner/Residential Use

Net
Contents:
1
gallon





rovral[®] brand
4 Flowable Fungicide

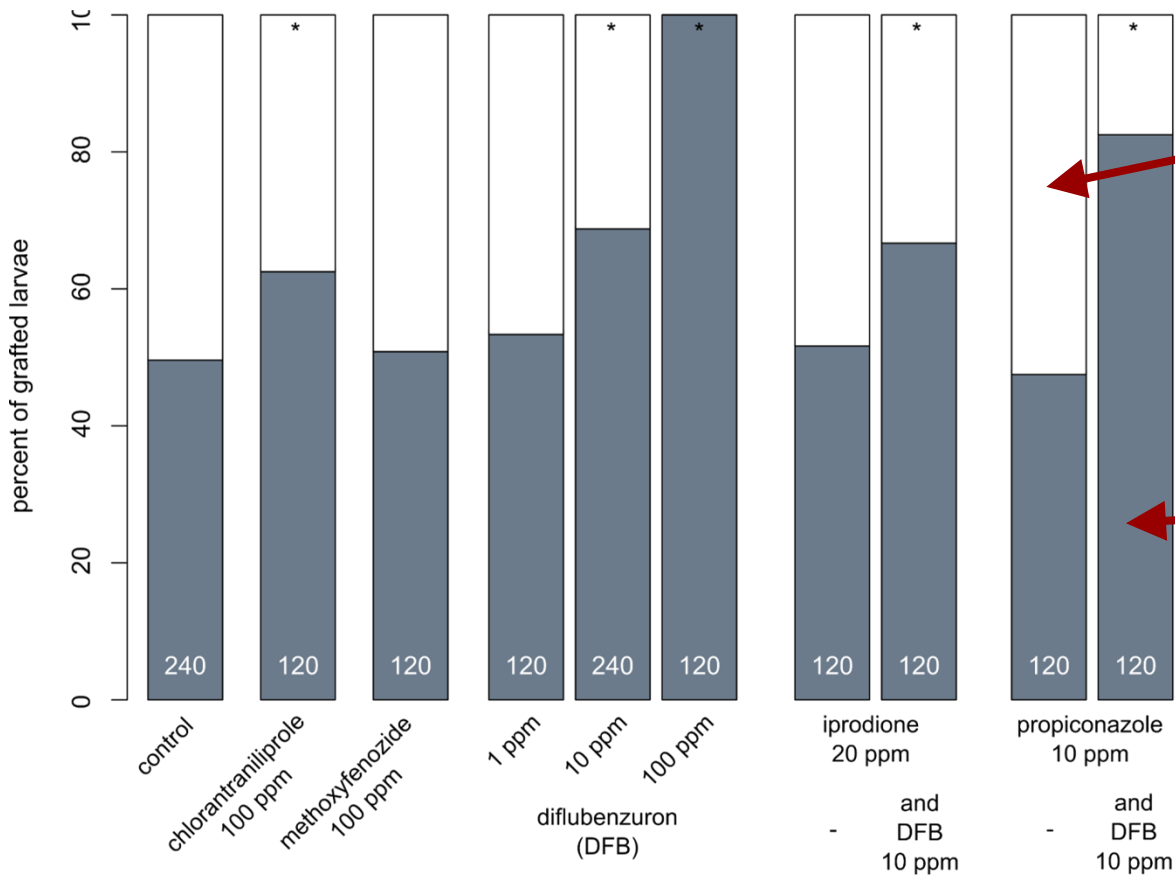
rovral[®] brand
4 Flowable Fungicide

Dimilin[®] 2L
Insect Growth Regulator
Aqueous Flowable

For use on barley, oats, triticale, wheat, cotton, grassland and non-crop areas, leafy brassica and turnip greens, livestock/poultry premises, peanuts, pears, peppers, rice, soybeans, stonefruit (excluding cherries), tree nuts, and turfgrass

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1 gallon

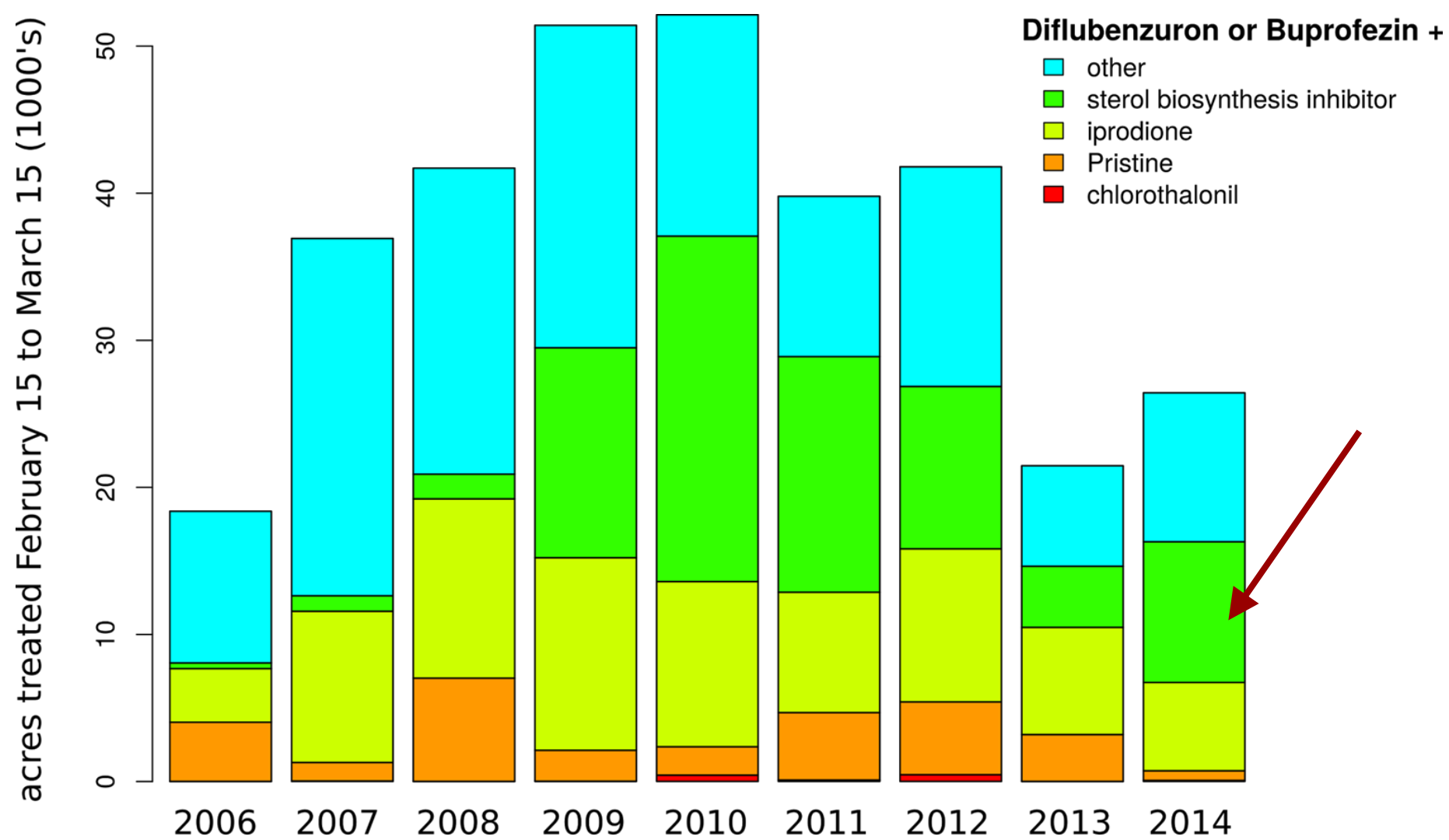


GROUP 3 FUNGICIDE PULL HERE TO OPEN ▶

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Dimilin® 2L
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 For use on barley, oats, triticale, wheat, cotton, grassland and non-crop areas, leafy brassicas and turnip greens, livestock/poultry premises, peanuts, pears, peppers, rice, soybeans, stonefruit (excluding cherries), tree nuts, and turfgrass
 Not for Homeowner/Residential Use

Net Contents: 1 gallon



Conclusions

1. Insecticides are applied in tank-mixes during bloom (rarely alone)
2. Some tank-mixes of insecticides and fungicides can kill adult bees directly
3. Others tank-mixes kill developing bees

HONEY BEE BEST MANAGEMENT PRACTICES FOR CALIFORNIA ALMONDS



HONEY BEES AND INSECTICIDES

All parties involved in almond pollination and/or applying pesticides should follow the precaution of not applying insecticides during bloom. Bee losses appear to have occurred in almonds as a result of tank-mixing insecticides with bloom-time fungicides. While the losses could have other causes, there is a scientific basis for concern; this is based on field experience that is being substantiated with controlled studies.^{6,7} Currently, most bee label warnings are only based on adult acute toxicity studies; however, recent information indicates some may be harmful to young developing bees in the hive (bee brood). Until recently, the U.S. EPA has not required data for possible effects on bee brood. Foragers bring back pollen to the hive, which is fed to the bee brood. Insecticide residues have been detected in this pollen. The term 'insecticide' includes insect growth regulators, also known as IGRs.

Jody Johnson, Cullaborate





Can Application Time Limit Fungicide Exposure to Honey Bees in Almonds?

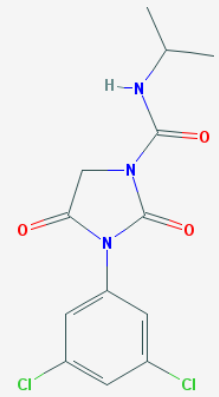
J Johnson, Cullaborate, LLC, Baltimore MD, J.Pettis, Honey Bee Inst.,
Univ. of Bern, Switzerland, G. Wardell, Wonderful Orchards, Lost Hills, CA,
D. Lopez USDA Bee Res. Lab, Beltsville MD



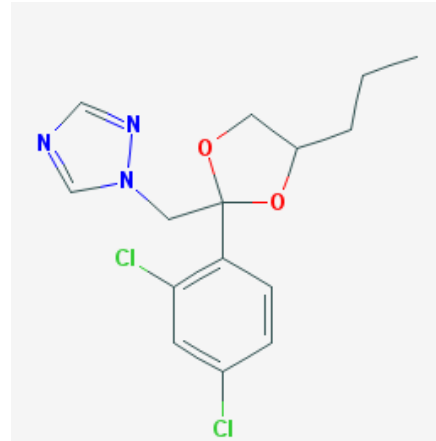
Why do we worry about fungicides around bees when honey bees (HB) are animals and not the targeted fungi?

We worry because :

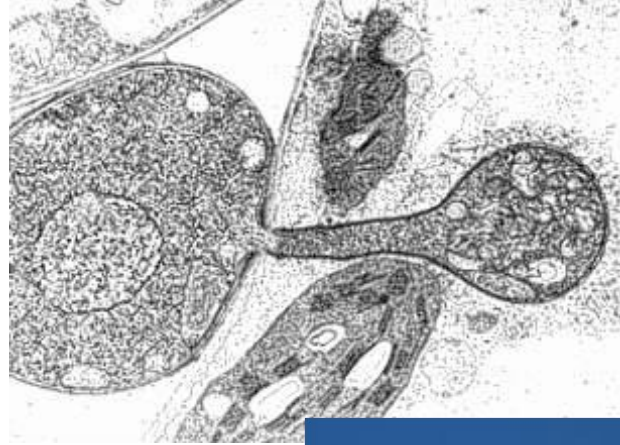
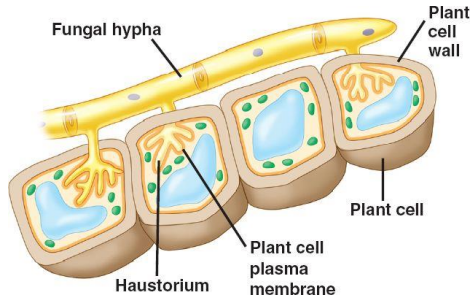
- 1) There are reported effects in HBs (Johnson et al.2013, Pettis et al 2013, Brattsten et al.1994)
- 2) The fungicide's mode of action may share common biochemistry with the animal kingdom. (Radice et al.1998)
- 3) The fungicide may interfere in an unanticipated way with the animal's biochemistry (Iwasa et al.2004 , Brattsten et al.1994)
- 4) Beneficial fungi utilized by HB to make bee bread may be negatively impacted (Yoder et al. 2013)



Iprodione(Rovral)↑
Propiconazole (Tilt) ↓



Propiconazole demethylation inhibitor

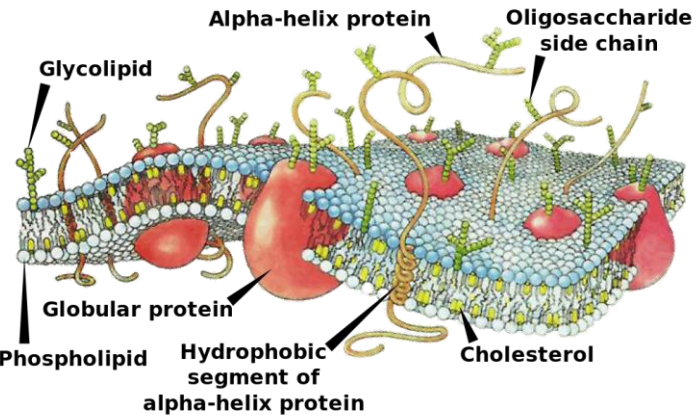


Puccinia graminis (stem rust) haustorium penetrating wheat cell

Brown rot on almond



UC Statewide IPM Project
© 2000 Regents, University of California



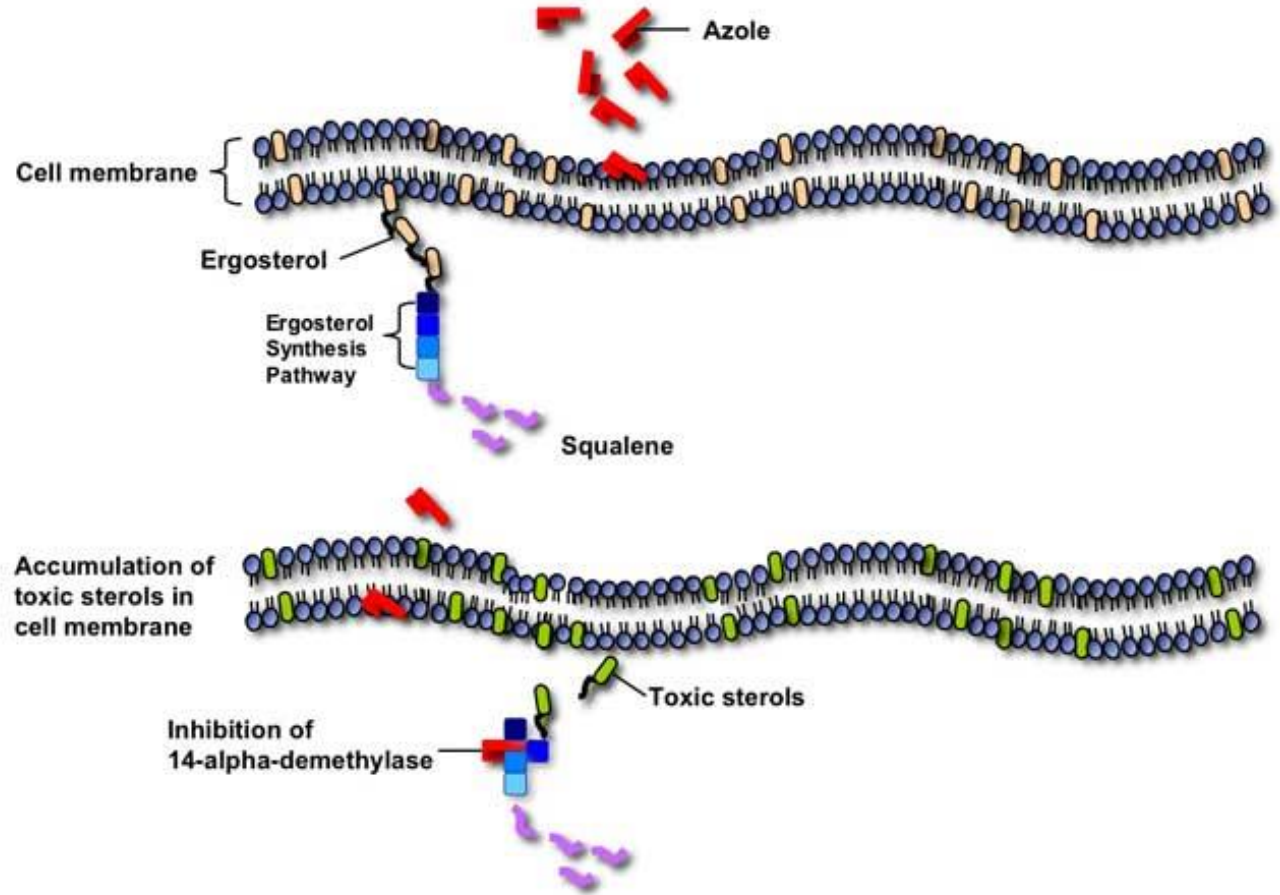
Propiconazole Demethylation

Demethylation required
for ergosterol synthesis
and functional fit in
membrane.

(Fungistatic vs fungicidal)

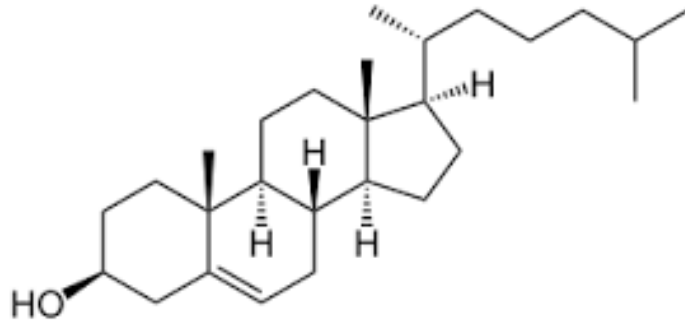
Cholesterol found in
animal cell, ergosterol
found in fungal cells

Membranes = physical
barrier, regulate
material exchange

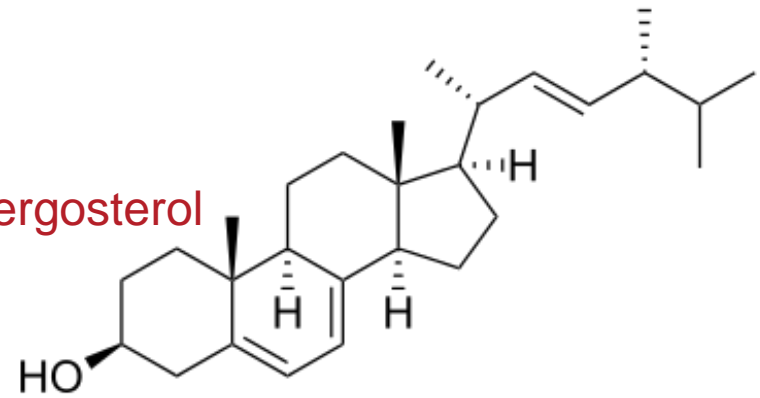


Propiconazole

Cholesterol



ergosterol



During the biosynthesis of cholesterol, three demethylations occur, one on the C14 named 14 α -demethylation and two on the C4 named 4 α -demethylations (Cabrera-Vivas et al 2003)

P450's

Propiconazole inhibits microsomal cytochrome P450s from midguts of *Spodoptera eridania* sixth-instar caterpillars. (Brattsen et al. 1994).

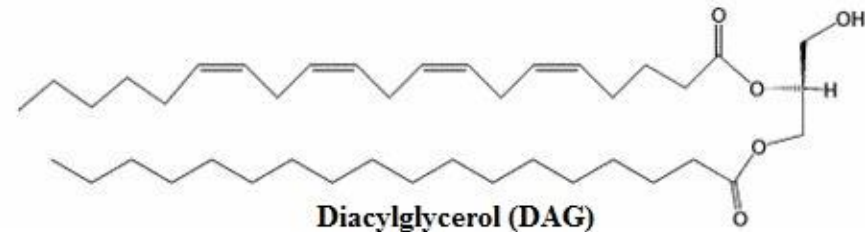
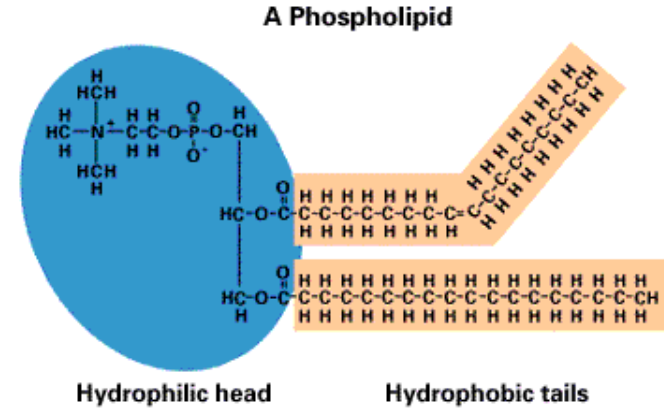
Iprodione affects lipid metabolism in grey mold (Griffiths et al. 1998)

Iprodione affected lipid metabolism of *B.cinerea* by decreasing phospholipids and increasing concentrations of diacylglycerols (precursors of phospholipids).

Concentrations inhibitory to growth.

Most effective concentrations were 1-10pM (10^{-12} M)

Results suggests that iprodione is inhibiting reactions utilizing diacylglycerols



Iprodione blocks cytochrome c reductase and might be endocrine active

Iprodione induces lipid peroxidation by means of oxygen activation in fungi. The oxidative damage through production of free oxygen radicals (ROS) is due to interaction with the flavin enzyme NADPH cytochrome c reductase. Normal electron flow from NADPH to cytochrome c is blocked (Radice et al 1998, 2001). Because lipid (and membrane) synthesis is prevented, mycelium growth is arrested.

Galli et al 2014 observed that iprodione and its metabolites bound to androgen receptor → endocrine active. Iprodione bound similar to endogenous hormones in humans and zebrafish but less so in rat.

de Loof 2006 Ecdysteroids- vertebrate vs invertebrate sex hormones

To capture potential HB exposure to fungicide,

we measured 4 metrics before and after AM and PM fungicide application:

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

Fungicide levels in: (a) pollen sampled directly from anthers and
(b) pollen collected in traps at the hive.



2015 study with iprodione

- Iprodione (Rovral 4F) was sprayed according to label at a uniform rate using an air blast ground rig either at 6pm on Day 1 in Zone 1, or at 11am on Day 3 in Zone 2. Day 1 yielded pre treatment data, Day 2 post-PM treatment, and Day 3, post-AM treatment. Pollen was trapped from 5pm to 5pm of the following day. Foragers were counted for 3 min in flowers (1m² area) and at hive entrances. Bloom density was measured by bloom count within the meter².

Orchard maps for 2015 and 2017

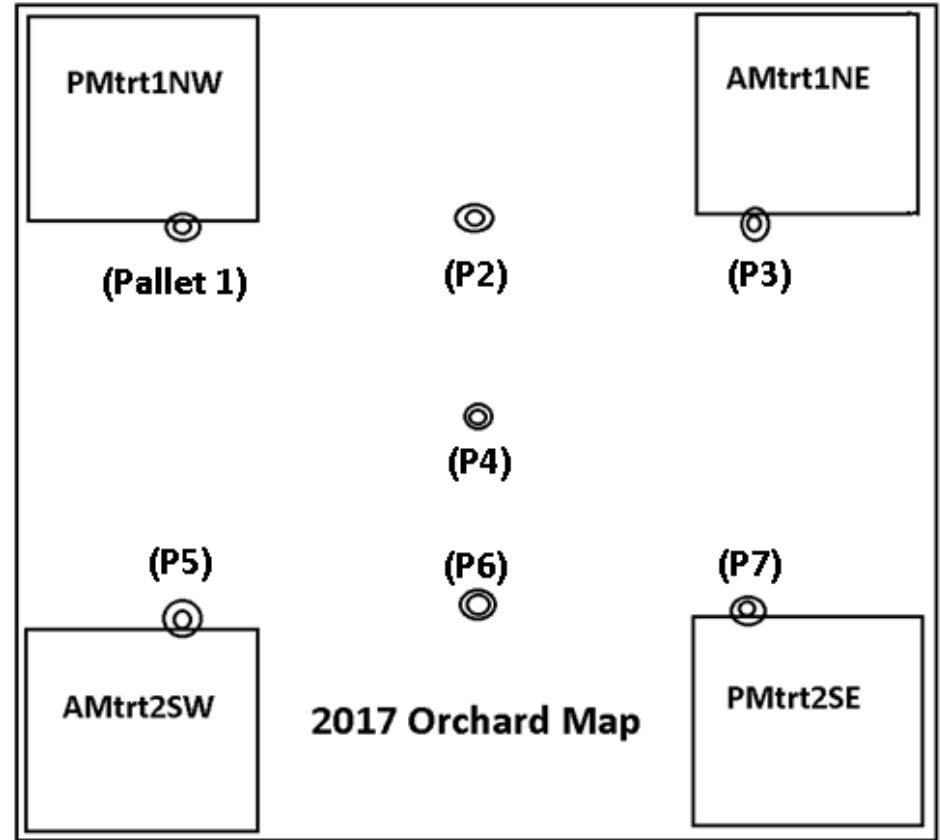
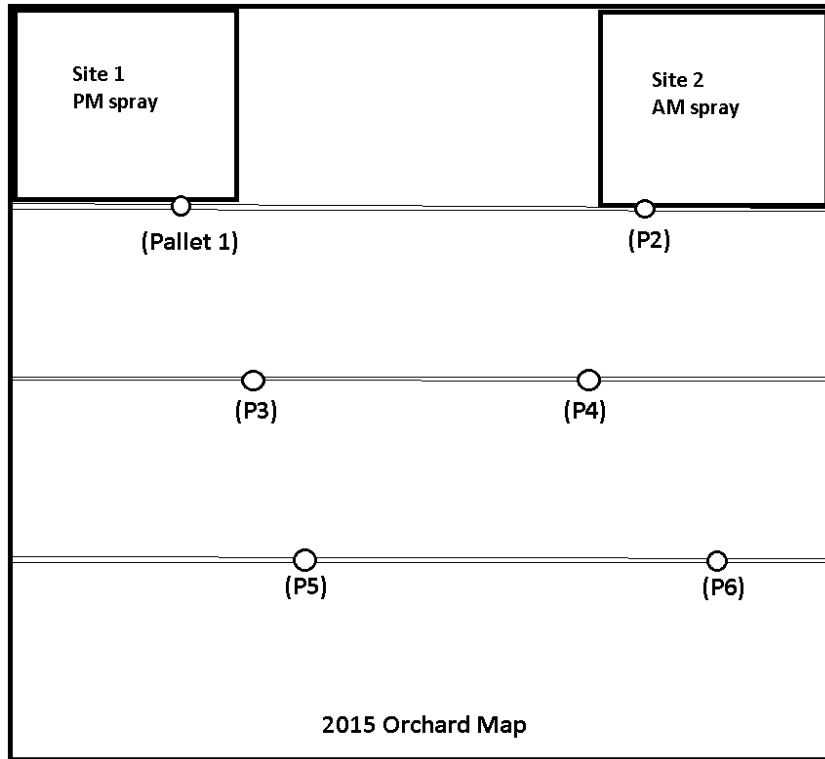


Figure 1: Iprodione Loads in Pollen

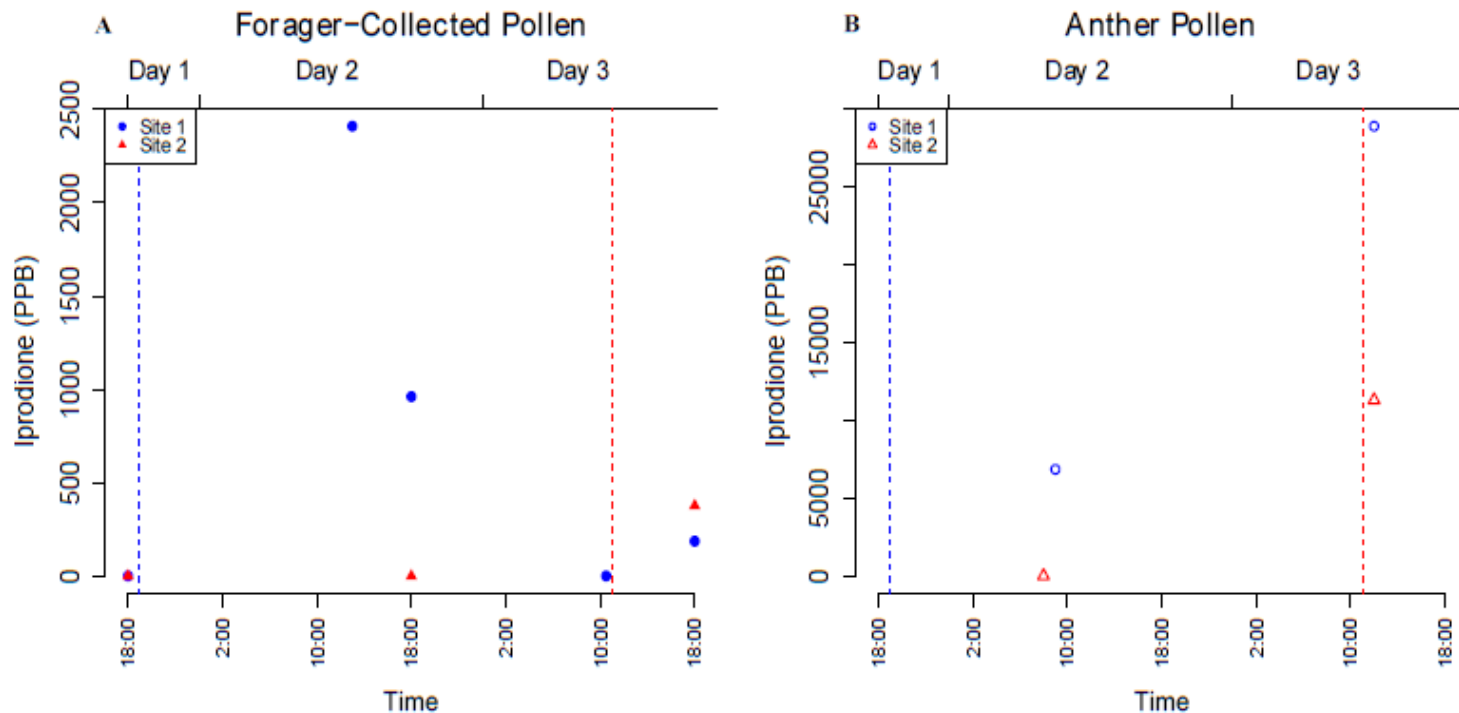


Figure 1: Iprodione loads (ppb) detected in (A) Forager-collected pollen and (B) Anther pollen from Site 1 (blue circles) and Site 2 (red triangles) across the three days of study.

Results from 2015 study

Anther pollen after AM spray had highest concentrations of iprodione despite detectable spray drift.

Anther pollen collected immediately after AM spray had contaminant levels significantly higher than anther pollen collected the morning after PM spray, (no detectable spray drift)- expected result

Contaminant concentration in forager-collected pollen was significantly higher following PM spray than following AM spray.-unexpected result

The simultaneously high loads of iprodione in anther pollen and the low loads in bee-collected pollen following AM spray may reflect declining forager activity within contaminated sites rather than a difference in iprodione in available forage.

Foraging activity decreased from Day 1 to Day 3-- expected result because almond bloom period was waning.

In 2017, a period of more consistent bloom will be targeted because we suspect that diminishing bloom affected our results.

Intent of 2017 study

Investigate two fungicides – iprodione (Rovral) and propiconazole (Tilt)

- Repeat AM and PM sprays
- Repeat pollen collection at anthers and hive
- Repeat counting of bee presence among almond blooms.
- Repeat counts of foragers returning to hive
- Note prevailing wind directions each day
- Target the study to take place at peak bloom.

Special Thanks to the California
Almond Board of California,
Wonderful Orchards, USDA –
BRL, and Dr. Jeff Pettis



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**Emily Symmes,
UCCE IPM Advisor**



Honey Bee BMPs

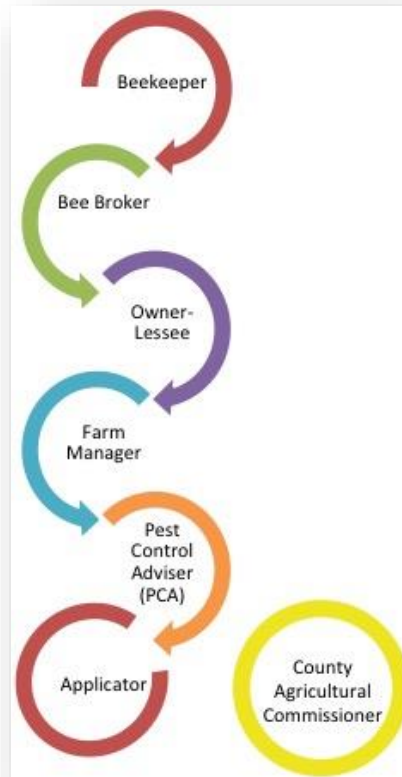
Emily J. Symmes, PhD

University of California Area IPM Advisor,
Sacramento Valley



Communication is the key

- **Communication Chain**



Communication is the key

- **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**
- **If treatment is deemed necessary, growers/PCAs/applicators should contact County Ag Commissioners so that beekeepers with nearby managed hives are notified 48 hours in advance**
- **Beekeepers should register hives and request optional notification from Ag Commissioners**
- **Report suspected pesticide related incidences to County Ag Commissioners. Bee health concerns cannot be addressed without data from potential incidents**
- **Maintain communication with neighbors after hive removal**



General Guidelines

- Provide adequate clean water for bees
- Never spray hives directly
- Turn off spray rig nozzles near hives
- Avoid hitting flying bees with any application
- Avoid application or drift onto blooming weeds in or adjacent to orchard
- Avoid applying systemic pesticides or those with residual toxicities prior to bloom



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- Turn off spray rig nozzles near hives
- Avoid hitting flying bees with any application
- Avoid application or drift onto blooming weeds in or adjacent to orchard
- Avoid applying systemic pesticides or those with residual toxicities prior to bloom
- Agree on proper hive removal timing
- Continue communicating with neighbors that may still have bees foraging nearby



If treatments are necessary during bloom

- **Explore alternate timing options**
 - Dormant
 - Delayed-dormant
 - Post-bloom
- **Be aware of presence of bees in the areas outside of your orchard**
- **Use IPM – only apply as needed based on sound monitoring, thresholds, decision support guidelines**

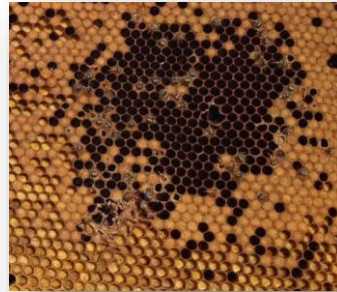


Insecticide Guidelines

- Do not spray insecticides at bloom
- One exception – *Bacillus thuringiensis* (Bt)
- Remember that most labels only note honey bee cautionary statements based on acute toxicity to adult bees, not impacts on developing brood



Newly emerged,
wingless bees pulled
from the combs by
other bees



Empty cells of brood that
failed in their attempts to
emerge as adults

Fungicide Guidelines

- Disease protection during bloom is critical
- Fungicide applications need to be made at certain times
 - Late afternoon, evening
 - Bees & pollen not present
 - Ensure adequate drying time before bees begin foraging the following day



Fungicide Guidelines

- Addition of adjuvants may be detrimental – proceed with caution until more is known
- Avoid tank mixes – synergistic impacts not well understood



Bee kill resulting from spraying a tank mix of an herbicide, spray oil, and foliar nutrient

Signs of Bee Injury

- Excessive numbers of dead or dying adult honey bees in front of hives
- Dead newly-emerged workers or brood at the hive entrance
- Lack of foraging bees on a normally attractive blooming crop
- Adult bees exhibiting stupefaction; paralysis; jerky, wobbly, or rapid movements; spinning on the back
- Disorientation and reduced efficiency of foraging bees
- Immobile or lethargic bees unable to leave flowers
- Bees unable to fly and crawling slowly as if chilled
- Queenless hives

More Information & Additional Resources

- Honey Bee Best Management Practices for Almonds (Almond Board of California)
 - [Almonds.com/BeeBMPs](https://almonds.com/BeeBMPs)
 - Supplemental quick guide – general
 - Supplemental quick guide – applicator/driver
 - English and Spanish
- almonds.com/growers/pollination#honey-bee-protection
- catalog.extension.oregonstate.edu/pnw591



Bee precaution pesticide ratings

Guidance on how to reduce bee poisoning, based on reported pesticide effects on adults and brood of honey bees and other bee species. Ratings are for the pesticide active ingredient, the common name.*

- I Do not apply or allow to drift to plants that are flowering.
- II Do not apply or allow to drift to plants that are flowering, except when the application is made between sunset and midnight if allowed by the pesticide label and regulations.
- III No bee precaution, except when required by the pesticide label or regulations.

Note: These are not the pollinator protection statements on the pesticide labels. Some of the listed pesticides are not registered, or approved, for use. Make sure the pesticide use is legal and appropriate before making any application. Always read the label before making any pesticide application.

Common name → →

Trade name

<input checked="" type="checkbox"/>	↕ Common name (Example trade name)	Type	Mode of action	↕ Rating	Other effects on bees	Toxic to honey bee brood	Toxic to other bee species
Please select a common name or trade name from the list above.							

ipm.ucanr.edu/beeprecaution

A close-up photograph of a glass jar filled with almonds. In the foreground, a small white dish contains a dollop of almond butter. The background is a warm, golden-yellow color.

Questions?