Pesticides and pollinators in New York: Current research and recommendations for growers

How many species of bees in NY?
Bees of New York

Managed

3

Wild/Native

1

412

416 species!

Solitary ground nester

Halictus confuses

Colletes inaequalis
Solitary cavity nester

Wool carder bee

Snail shell nester

Osmia conjuncta
New York crops dependent on pollination

Values from: New York State Agricultural Overview. 2014, USDA

Pollination-dependent crops in NY

<table>
<thead>
<tr>
<th>Crop Type</th>
<th>Harvested Acres</th>
<th>Value of Production ($)</th>
</tr>
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<tbody>
<tr>
<td>Apples</td>
<td>40,000</td>
<td>240,355,000</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>290,000</td>
<td>144,207,000</td>
</tr>
<tr>
<td>Soybeans</td>
<td>327,000</td>
<td>52,137,000</td>
</tr>
<tr>
<td>Beans</td>
<td>9,800</td>
<td>31,371,000</td>
</tr>
<tr>
<td>Squash</td>
<td>4,300</td>
<td>20,493,000</td>
</tr>
<tr>
<td>Pumpkins</td>
<td>5,200</td>
<td>12,640,000</td>
</tr>
<tr>
<td>Peach</td>
<td>1,600</td>
<td>10,091,000</td>
</tr>
<tr>
<td>Cucumber</td>
<td>1,700</td>
<td>7,520,000</td>
</tr>
<tr>
<td>Strawberries</td>
<td>700</td>
<td>3,472,000</td>
</tr>
<tr>
<td>Pears</td>
<td>700</td>
<td>3,042,000</td>
</tr>
<tr>
<td>Cherries</td>
<td>700</td>
<td>1,091,000</td>
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<td>700</td>
<td>2,800,000</td>
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New York State Agricultural Overview. 2014, USDA
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Bees contribute ~$500M in pollination services annually - NYS Dept. Ag & Markets (2015)

### NYS Beekeeping

- ~3,000 NYS Beekeepers
- ~100,000 colonies
- ~4.0 million lbs honey annually (\$10 million)
33-45% colonies died in U.S. the past 6 years

Bees of New York

53/416 species (~13%) are in decline
Why are pollinators doing so poorly?
Why are pollinators doing so poorly?

- Agrochemicals
- Insecticides
- Fungicides
- Herbicides
- Pests & Pathogens

Especially novel pests and pathogens
Why are pollinators doing so poorly?

- Pests & Pathogens
- Climate Change
- Agrochemicals

- Phenological mismatch
- Droughts

Low diversity (or lack of) resources
Why are pollinators doing so poorly?

- Pests & Pathogens
- Climate Change
- Agrochemicals
- Habitat
- Management Practices
- Poor management

1/17/19
Outline

1. Pesticide risk to bees in New York
   a) Day-to-day normal conditions
   b) During pollination of apple
   c) Interactions between pesticides and disease

2. Recommendations for reducing risk

What’s normal day-to-day pesticide risk?

Emma Mullen  Paul Cappy
Travis Grout  Scott McArt

2016
NYS BEEKEEPER TECH TEAM REPORT

https://pollinator.cals.cornell.edu/resources/nys-beekeeper-tech-team
Sampling colonies from 198 NYS beekeepers

Measuring pesticide residues: Nico Baert
How common is pesticide exposure?

- Pesticides are ubiquitous
- At least 1 compound found in 197/198 colonies

What pesticides are in the wax?

13 most prevalent compounds:

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<th># Positive Detections</th>
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<td>Piperonyl butoxide</td>
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<td>196</td>
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<td>Fenpyroximate</td>
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Wheeler, Mullen, Cappy & McArt 2017
What’s the risk from exposure?

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163/198 (82%) colonies contained pesticide combinations known to be synergistic

Synergisms not accounted for in risk estimate

Wheeler, Mullen, Cappy & McArt 2017
How does a synergism work?

Toxins
Plant defenses
Pesticides

Less toxic compounds
Mono-oxygenase enzymes

Toxins
Plant defenses
Pesticides
How does a synergism work?

Ergosterol biosynthesis inhibiting fungicides

Toxins
Plant defenses
Pesticides

Inability to break down toxins
Up to 1000-fold increase in insecticide toxicity
What does a synergism look like?

Bifenthrin (insecticide) x Myclobutanil (fungicide)

Casey Hale

Aaron Iverson

*New* Pesticide decision-making guides

https://pollinator.cals.cornell.edu/resources/grower-resources/
Meant to complement CCE guides

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Pesticide risk to honey bees during NY apple pollination

120 experimental hives into 30 orchards
What pollen do bees collect?

- Apple pollen
  - Avg = 8.7%

- Buckthorn pollen
  - Avg = 38.6%

Ashley Fersch

McArt, Fersch, Milano, Truitt & Boroczky 2017 Scientific Reports
Pesticide risk: apple bloom period

- Generally high risk from pesticides

- Pollen from 22/30 orchards above regulatory agency level of concern

Pesticide risk not predicted by apple foraging

- Pollen from 22/30 orchards above regulatory agency level of concern

McArt, Fensch, Milano, Truitt & Boroczky 2017 Scientific Reports
Pesticide risk not predicted by apple foraging

How are bees being exposed?
1) Insecticide residues: none of the riskiest were sprayed during bloom

<table>
<thead>
<tr>
<th>Compound</th>
<th>Compound Type</th>
<th>Mean residue (ppb)</th>
<th>Positive detections</th>
<th>Hazard Quotient (Risk)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thiamethoxam</td>
<td>Neonicotinoid</td>
<td>21.5</td>
<td>5</td>
<td>21486.0</td>
</tr>
<tr>
<td>Cyfluthrin</td>
<td>Pyrethroid</td>
<td>93.3</td>
<td>6</td>
<td>10981.6</td>
</tr>
<tr>
<td>Carbaryl</td>
<td>Carbamate</td>
<td>69.9</td>
<td>11</td>
<td>5126.4</td>
</tr>
<tr>
<td>Indoxacarb</td>
<td>Oxadiazine</td>
<td>557.1</td>
<td>2</td>
<td>4285.4</td>
</tr>
</tbody>
</table>

.... but all were sprayed in the previous 2 yrs, and are known to be environmentally persistent
Pesticide risk in wildflowers

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**Wildflowers (0 m from orchard edge)**

- **Site Hazard quotient (% contact LD<sub>50</sub>):**
  - T
  - J
  - V
  - A
  - S
  - H
  - L
  - M
  - A
  - G
  - X
  - Y
  - B
  - P
  - N
  - K
  - C
  - F
  - I
  - Z
  - W
  - Q
  - D
  - U

---

**Pesticide risk in wildflowers**

- **Site (orchard):**
  - EFSA acute exposure level of concern
  - US EPA acute exposure level of concern
  - EFSA chronic exposure level of concern

---

**Chlorpyrifos**

**Indoxacarb**

**Imidacloprid**

**Cyprodinil**

**Phosmet**
**Outline**

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What predicts disease and range contractions in United States bumble bees?

- 284 sites
- >10,000 bees screened for Nosema disease

Best predictor of Nosema: Chlorothalonil usage

McArt, Urbanowicz, McCoshum, Irwin & Adler 2017 PRSB
**Chlorothalonil and *Nosema***

4 x more likely to become infected with *Nosema* at high fungicide levels

Pettis et al. *Plos One* 2013

---

**Chlorothalonil as a synergist**

Chlorothalonil causes fluvalinate to become 5 times more toxic

Mortality of developing honey bee larvae

Zhu et al. *Plos One* 2014
Bees actually prefer to drink nectar contaminated with chlorothalonil

How much chlorothalonil is used in the United States?

<table>
<thead>
<tr>
<th>Compound</th>
<th>Class</th>
<th>Chemical family</th>
<th>Total application in 2009 (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorothalonil</td>
<td>Fungicide</td>
<td>Aromatic</td>
<td>4,101,408</td>
</tr>
<tr>
<td>Mancozeb</td>
<td>Fungicide</td>
<td>Dithiocarbamate</td>
<td>2,720,704</td>
</tr>
<tr>
<td>Captan</td>
<td>Fungicide</td>
<td>Dicarboximide</td>
<td>1,577,117</td>
</tr>
<tr>
<td>Pyraclostrobin</td>
<td>Fungicide</td>
<td>Pyrazole</td>
<td>812,365</td>
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<tr>
<td>Maneb</td>
<td>Fungicide</td>
<td>Dithiocarbamate</td>
<td>575,011</td>
</tr>
<tr>
<td>Ziram</td>
<td>Fungicide</td>
<td>Zinc</td>
<td>533,063</td>
</tr>
<tr>
<td>Propiconazole</td>
<td>Fungicide</td>
<td>Conazole</td>
<td>512,490</td>
</tr>
<tr>
<td>Azoxystrobin</td>
<td>Fungicide</td>
<td>Strobilurin</td>
<td>479,867</td>
</tr>
<tr>
<td>Thiophanate-Methyl</td>
<td>Fungicide</td>
<td>Benzimidazole precursor</td>
<td>323,038</td>
</tr>
<tr>
<td>Metiram</td>
<td>Fungicide</td>
<td>Dithiocarbamate</td>
<td>309,132</td>
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https://water.usgs.gov/nawqa/pnsp/usage/
Best predictor of losses: total fungicide usage

McArt, Urbanowicz, McCoshum, Irwin & Adler 2017 PRSB

Fungicides, not insecticides, impact wild bees in NYS apple

Data from Bryan Danforth & Mia Park

Low intensity 2011 pesticide use index High intensity
Bees are exposed to a lot of fungicides

Fungicides: 94% of total residues in bee bread during apple bloom

So what can be done?

McArt, Fersch, Milano, Truitt & Boroczky 2017 Scientific Reports
Outline

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Develop an integrated pest management (IPM) plan that reduces pesticide usage

1. Incorporate habitat that encourages natural enemies (and pollinators!)
2. Plant disease- and pest-resistant crops
3. Crop rotations
4. Monitor pest levels to determine when you need to spray
5. Alternate pest control methods
   • pheromone lures, biological control, etc.

- Aphid midge is a predator to aphids
- GM cucumbers resistant to powdery mildew
- Rotating can reduce soil diseases and pests
Always follow label laws

The EPA is improving label laws to protect pollinators

8 page information leaflet

Part of new EPA label for some insecticides

http://pmep.cce.cornell.edu

When using pesticides...

1. Spray at night and when air is calm.
When using pesticides...

1. Spray at night and when air is calm.
2. Avoid spraying during bloom.

When using pesticides...

1. Spray at night and when air is calm.
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3. Choose a pesticide of lowest toxicity to bees that provides the needed pest control. If all available pesticides are highly toxic, choose the one with the shortest residual period.
When using pesticides...

1. Spray at night and when air is calm.
2. Avoid spraying during bloom.
3. Choose a pesticide of lowest toxicity to bees that provides the needed pest control. If all available pesticides are highly toxic, choose the one with the shortest residual period.

4. Reduce planting dust for treated seeds: use wax treated seeds, deflectors on machinery, be aware of dry/windy conditions.
If possible, alert beekeepers within a 3-mile radius 48 hrs prior to spraying

Consult your local beekeeping club to identify nearby beekeepers

Contacts for all NYS beekeeping clubs can be found at our Pollinator Network website:

http://pollinator.cals.cornell.edu/
Summary

1) Pesticide risk to bees can be high, especially during crop pollination

2) Reduce risk via IPM, choosing safest pesticides, and following labels

3) Keep fungicides on your radar – they’re not harmless (**booklet info next!**)

4) Communicate with beekeepers

Cornell Pollinator Webpage

http://pollinator.cals.cornell.edu/
Dyce Lab on Facebook for news and updates
https://www.facebook.com/DyceLab/

Thank you

Dyce Lab
Emma Mullen
Mary Kate Wheeler
Nicolas Baert
Pete Graystock
Aaron Iverson
Ashley Fersch
Paige Muniz
Laura Figueroa
Kass Urban-Mead
Kaitlin Deutsch
Timothy Salazar
Nelson Milano
Phoebe Koenig
Abby Davis
Blyss Bieber
Elena Suarez

http://blogs.cornell.edu/mcartlab/