



Photo: E. Y. Long

Minimizing risks to pollinators in specialty crops

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Topics

- The *buzz* about bees
- Pollinators in OH specialty crops
 - Bee biology 101
- Risks to pollinators in cropping systems
 - Which pesticides are most harmful?
 - How are bees exposed?
- What can you do to minimize risks & harm?



Why all the buzz?



- Wild & domesticated bees pollinate wildflowers and cultivated crops worldwide.



- The value of insect pollination:

\$15+ billion

(directly dependent crops alone!)

\$11.68 billion (by honey bees)

\$3.44 billion (by non-*Apis*)



Ohio specialty crops



Insect pollinated crops

Crop	Commercial product	Pollinator	Pollinator impact
Cantaloupe	fruit	Honey bees, Squash bees, Bumblebees, & Solitary bees	4- essential
Gourd	fruit		
Pumpkin	fruit		
Squash	fruit		
Watermelon	fruit		
Zucchini	fruit		

Insect pollinated crops

Crop	Commercial product	Pollinator	Pollinator impact
Apple	fruit	Honey bees, Bumblebees, Solitary bees, Leafcutter bees*, & Flies	3-great
Blackberry	fruit		
Blueberry*	fruit		
Cucumber	fruit		
Fennel	seed		
Sweet cherry	fruit		
Sour cherry	fruit		
Nectarine	fruit		
Peach	fruit		
Pear	fruit		
Plum	fruit		
Raspberry	fruit		

Meet the pollinators

- **Bees**
 - Honeybees
 - Bumblebees
 - Solitary bees
 - Mason bees
 - Leafcutter bees
 - Squash bees
- **Butterflies**
- **Flies**
- **Beetles too!**



E. Y. Long

Meet the pollinators

Honeybees



Mason bees



Squash bees



Bumblebees



Leafcutter bees



Hover flies



Bee biology 101

Key differences

- “Social” versus solitary bees:
 - Reproductive division of labor
 - Cooperative brood care
 - Overlapping of generations
- Colony size
- Foraging habits
- Habitat (nest sites)

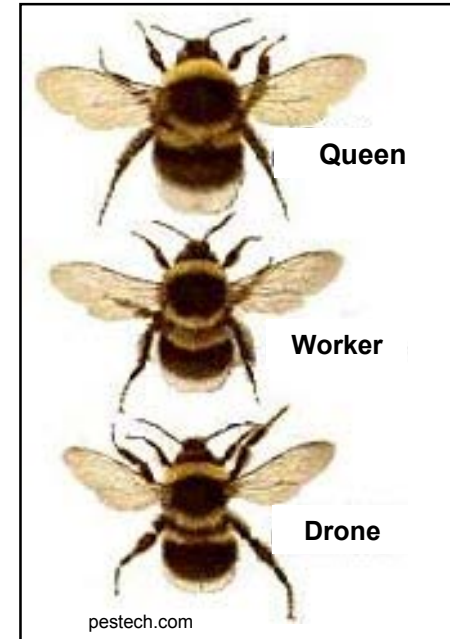
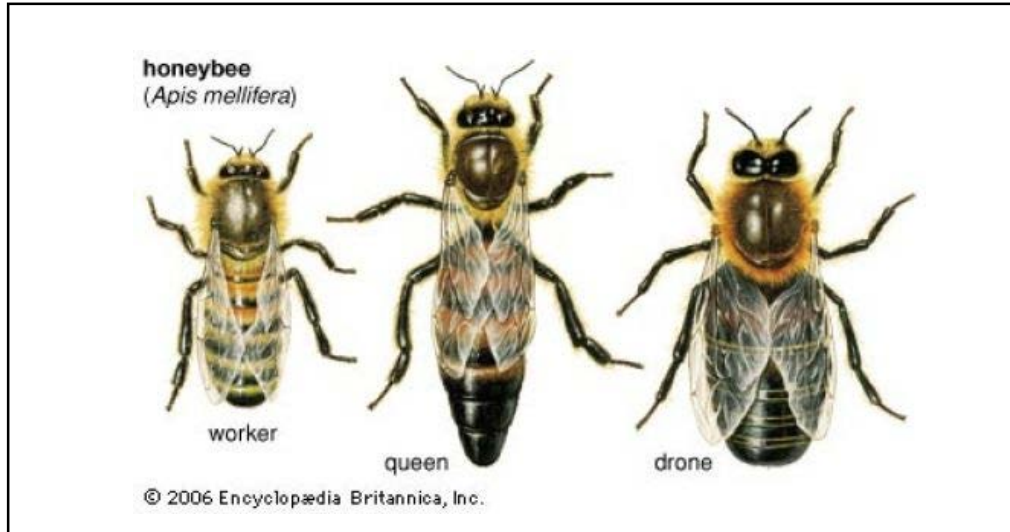
Shared qualities

- All the workers are female
- Ovipositor = the stinger
 - egg-layer & weapon in one!
- Use pheromones to communicate



Honey bees & Bumblebees

The “social” bees

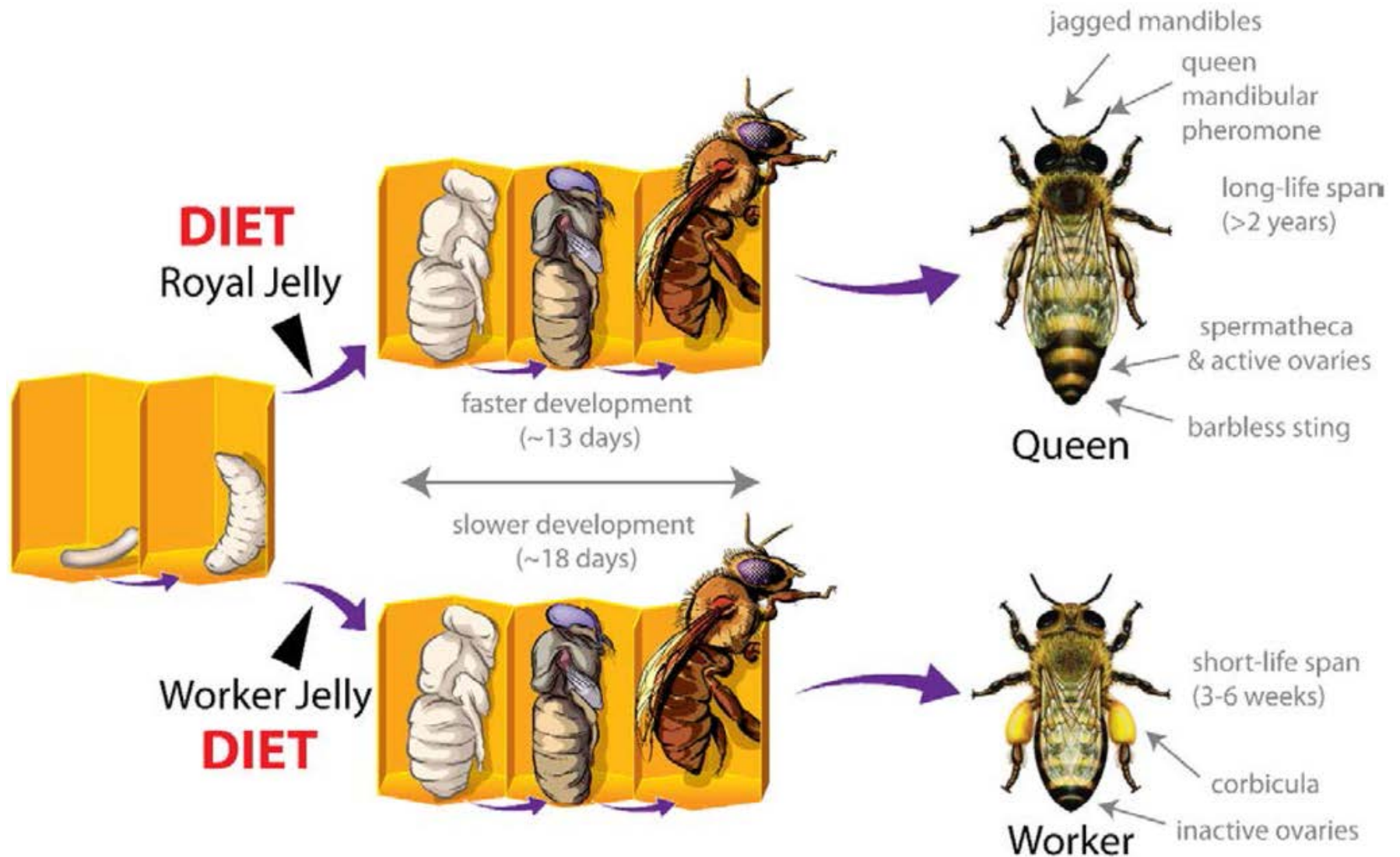


Caste	Honeybee ¹	Bumblebee ²
Queen	1	1
Workers	10,000 - 50,000	up to 400
Drones	100 - 500	0 - 50

¹Queen stings repeatedly, workers only once, drones not at all.

²Queen & workers can sting repeatedly, drones not at all.

FOOD! drives caste formation



Solitary bees

- No division of labor.
- Nest sites often in stems or the ground.
- Colonies are small.
- Rarely sting!



Bee populations are declining. . .



Estimated declines: ~33% each year from 2007-2010

Suspects in the decline of bees



Parasites & Pathogens



Management practices



Habitat simplification



Pesticides

Pesticides & Bees

Toxicity

Herbicides < Fungicides < Insecticides



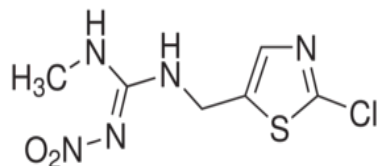
- Insecticides
 - Contact + fast action vs. **ingestion + residual activity**
 - Neonicotinoids** (“**Neonics**”)
- Also, synergistic (potent) mixtures between fungicides + insecticides.
- Adjuvants can be toxic too!

Unintended impacts beyond the field

- **Systemic pesticides used in agriculture can pose environmental risks to non-target areas and organisms¹⁻³.**



Neonicotinoids



Clothianidin

Contact LD₅₀:
2.2 x 10⁻⁸ grams!

- **Synthetic derivatives of nicotine; potent neurotoxins that act on the central nervous system of insects¹.**
- **Effective against a broad range of pests, especially sucking insects and soil pests¹.**
- **Widely adopted based on:**
 - **Low vertebrate toxicity**
 - **Persistence (EPA documents half-life between 148- 1,155 days for clothianidin).**
 - **High water solubility = allowing systemic action in plant tissues (present in *all* plant parts).**

Unexpected exposure to neonics

- Death of bees occurring with planting of neonicotinoid-treated maize seeds.



J. Obermeyer



J. Obermeyer

Indiana, USA
Spring 2010/2011

Impacts on bees



- ***Lethal effects*** (happen immediately)
 - Acute poisoning & death
- ***Sublethal effects*** (happen over time)
 - Impaired ability to fly & return “home”
 - Impaired learning ability
 - Increased foraging time
 - Increased susceptibility to pathogens
 - Reduced lifespan
 - Reduced egg-laying
 - Reduced queen production

Intersections with pesticides

- **Directly (body contact)**
 - **Body hairs trap particles**

Bees are 'charged'
in flight!



- **Indirectly (secondary contact)**
 - **Pollen, nectar, water, & “plant” water (guttation).**
 - **Contact with contaminated surfaces (flowers, leaves, or soil).**



Growing concerns about bees

OPEN ACCESS Freely available online



High Levels of Miticides and Agrochemicals in North American Apiaries: Implications for Honey Bee Health

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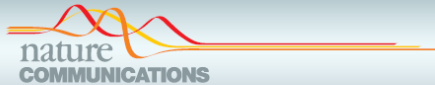
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Multiple Routes of Pesticide Exposure for Honey Bees Living Near Agricultural Fields

Christian H. Krupke^{1*}, Greg J. Hunt¹, Brian D. Eitzer², Gladys Andino¹, Krispn Given¹

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OPEN

Non-cultivated plants present a season-long route of pesticide exposure for honey bees

Elizabeth Y. Long¹ & Christian H. Krupke²



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journal homepage: www.elsevier.com/locate/envpol



Quantifying exposure of wild bumblebees to mixtures of agrochemicals in agricultural and urban landscapes^{*}

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Science



Neonicotinoid Pesticide Reduces Bumble Bee Colony Growth and Queen Production

Penelope R. Whitehorn *et al.*

Science **336**, 351 (2012);

DOI: 10.1126/science.1215025

OPEN ACCESS Freely available online



Pesticide Residues and Bees – A Risk Assessment

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What is the risk?

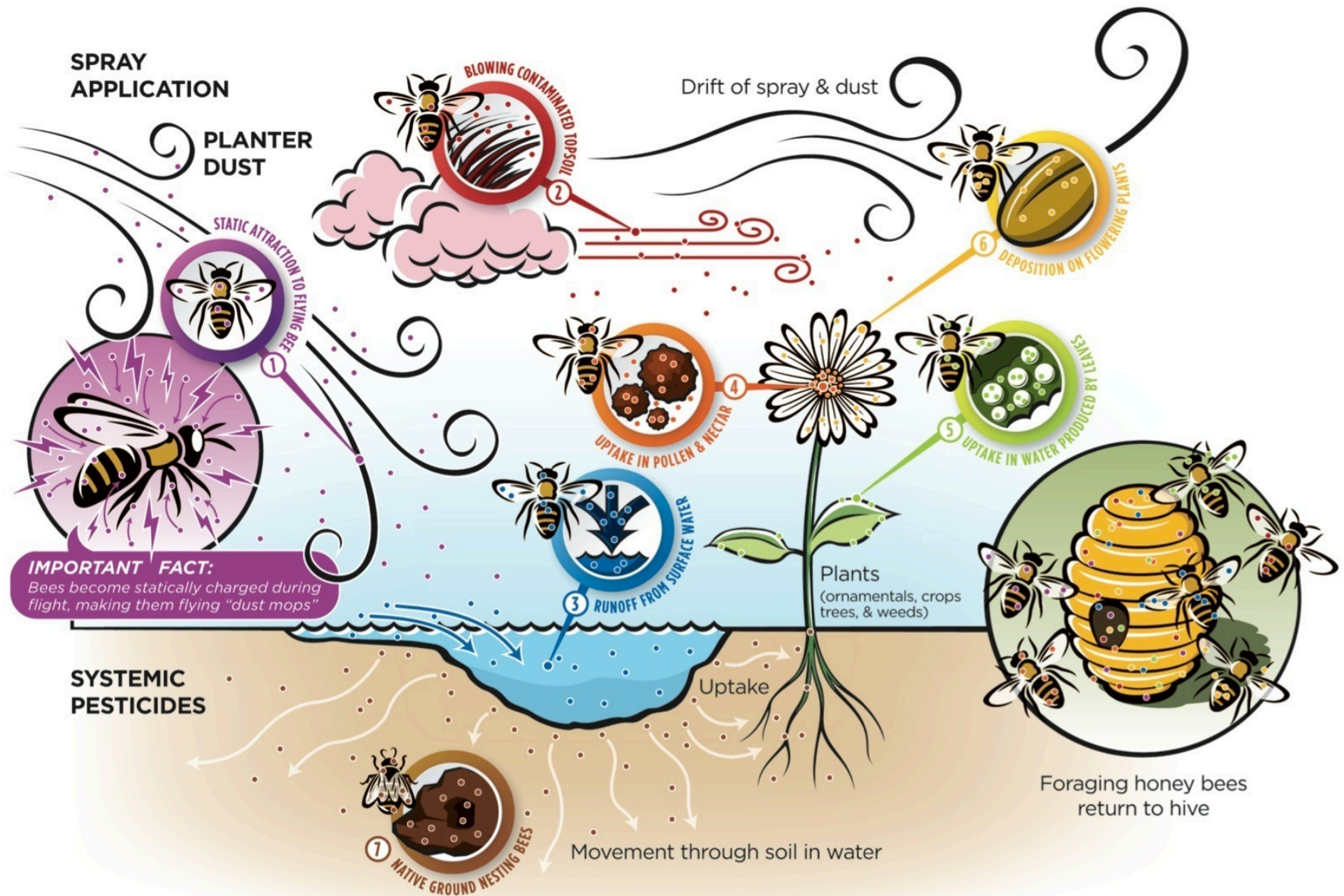


$$\text{Risk} = \frac{\text{Frequency (\%)} \times \text{residue dose}}{\text{Toxicity (LD}_{50}\text{)}}$$

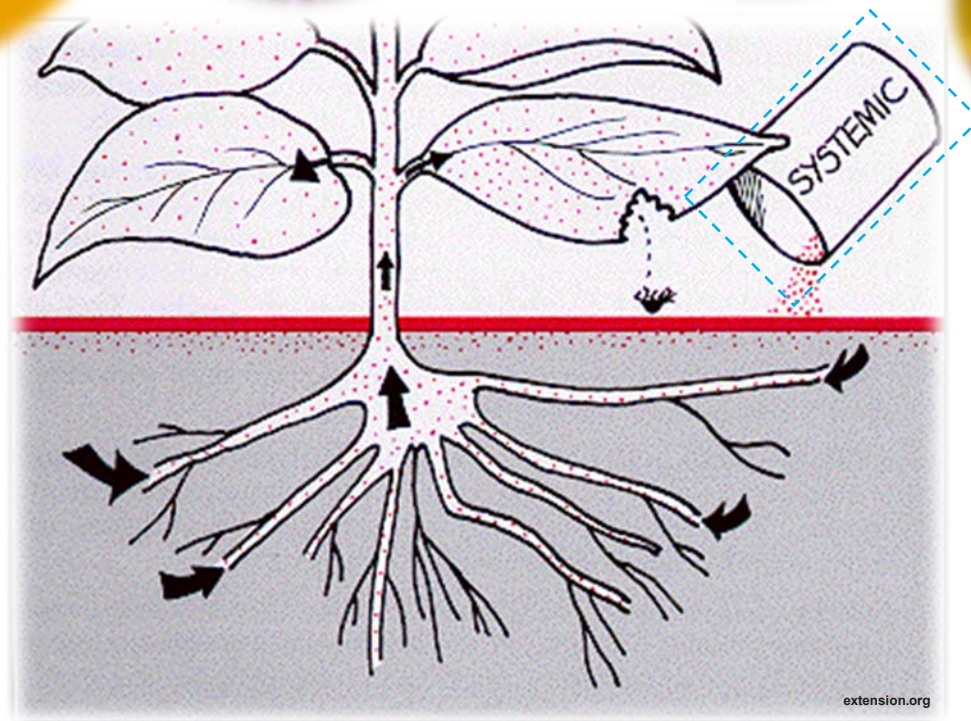
Dose that kills 50% of a test population

- How **likely** are pollinators to come into contact with pesticide residues?
- **How contaminated** are pollinator resources?
- How **toxic** are the contaminants to bees?
 - So, something less toxic can still be harmful if it's present a lot

Major Routes of Pesticide Exposure for Foraging Honey Bees and Their Transmission to the Hive



Residues in plants pose threats too



Residues detected in plant products

Range of concentrations of various
neonicotinoid insecticides in:



Pollen:

1.1 - 134 ppb



Guttations:

11,900 - 47,000 ppb (field)

82,800 - 110,000 ppb (lab)

Cascading effects of pesticide exposure on bee health

- Honeybee hives located in seed-treated corn areas have *greater “stress” gene activity, and higher pathogen and Varroa mite loads.*

Field study, Alburaki et al. 2015

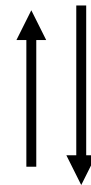
- Higher exposure to insecticides (imidacloprid & clothianidin) associated *with reduced winter survival, higher Varroa mite loads, and symptoms of colony collapse.*

Semi-field studies, Dively et al. 2015 & Lu et al. 2014

- Bees with increasing amounts of clothianidin *have less glycogen, fat, & protein.*

Field study, Lundgren 2016

Pesticides



Parasites & Pathogens

Are pollen resources contaminated?



Non-agricultural area



Untreated corn field



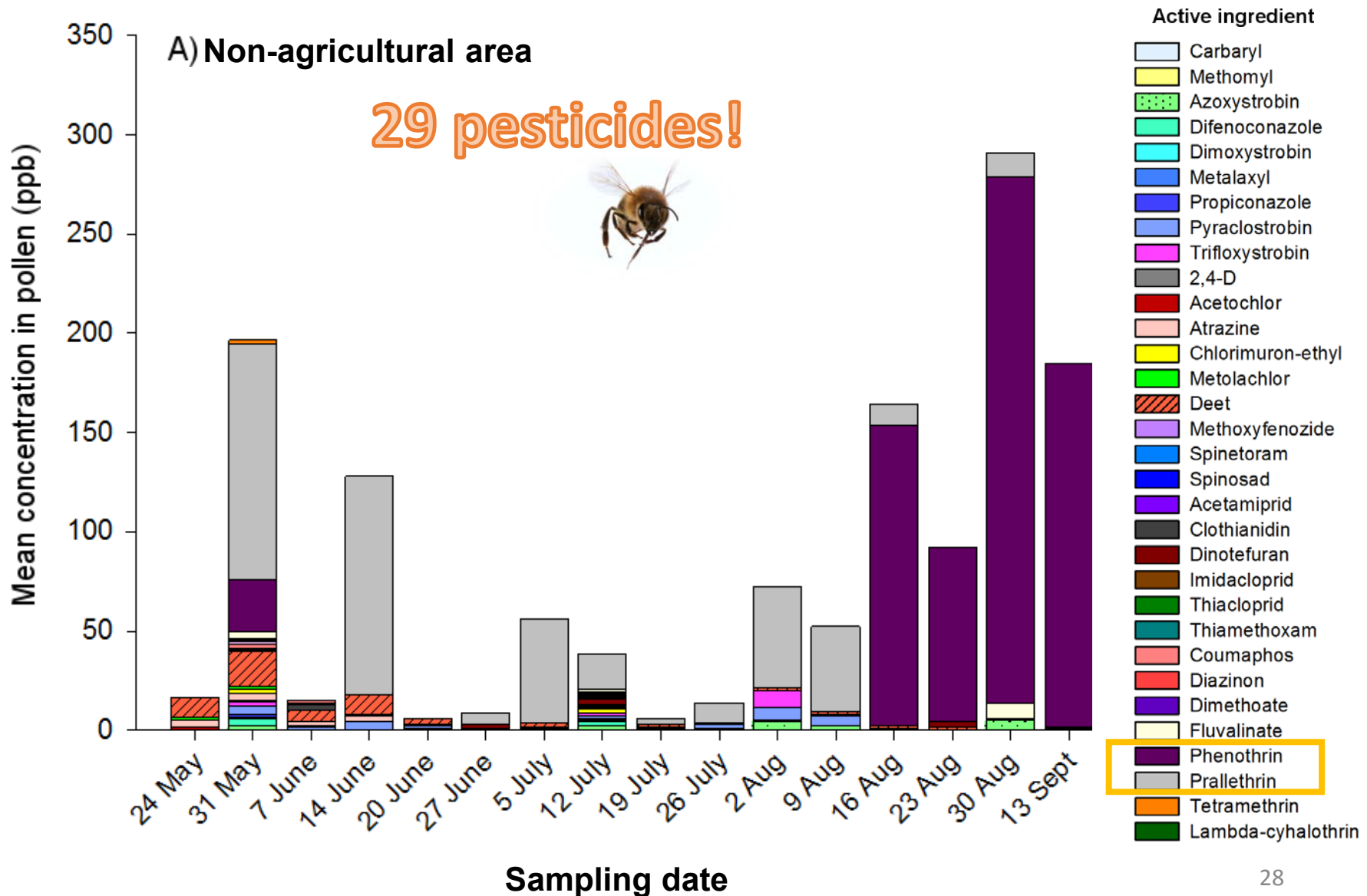
Seed-treated corn field



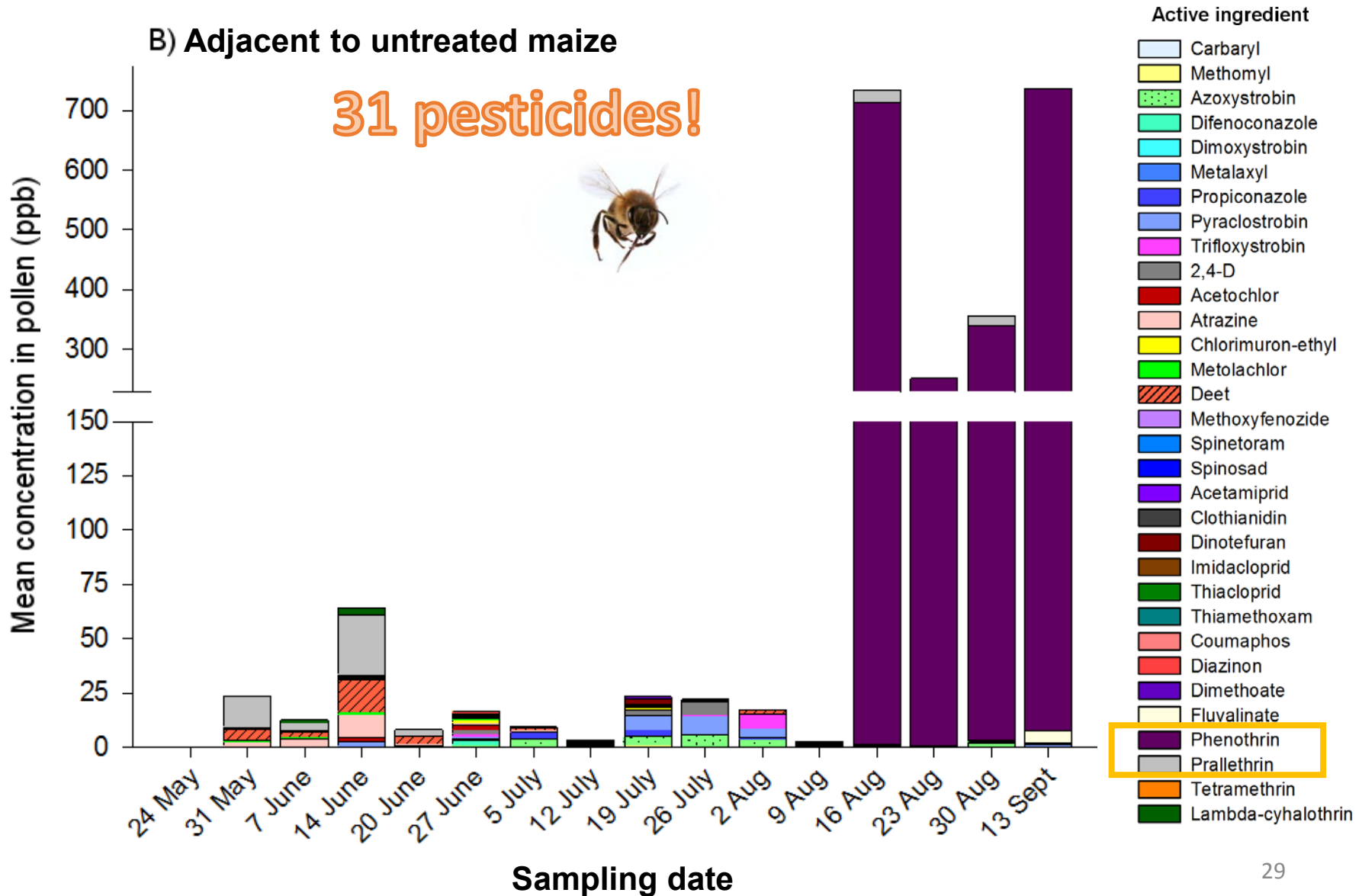
- **Sampled bee-collected pollen for 16 weeks (May-Sept).**
- **Screened pollen for 67 pesticides.**
- **Identified pollen collected by honey bees.**



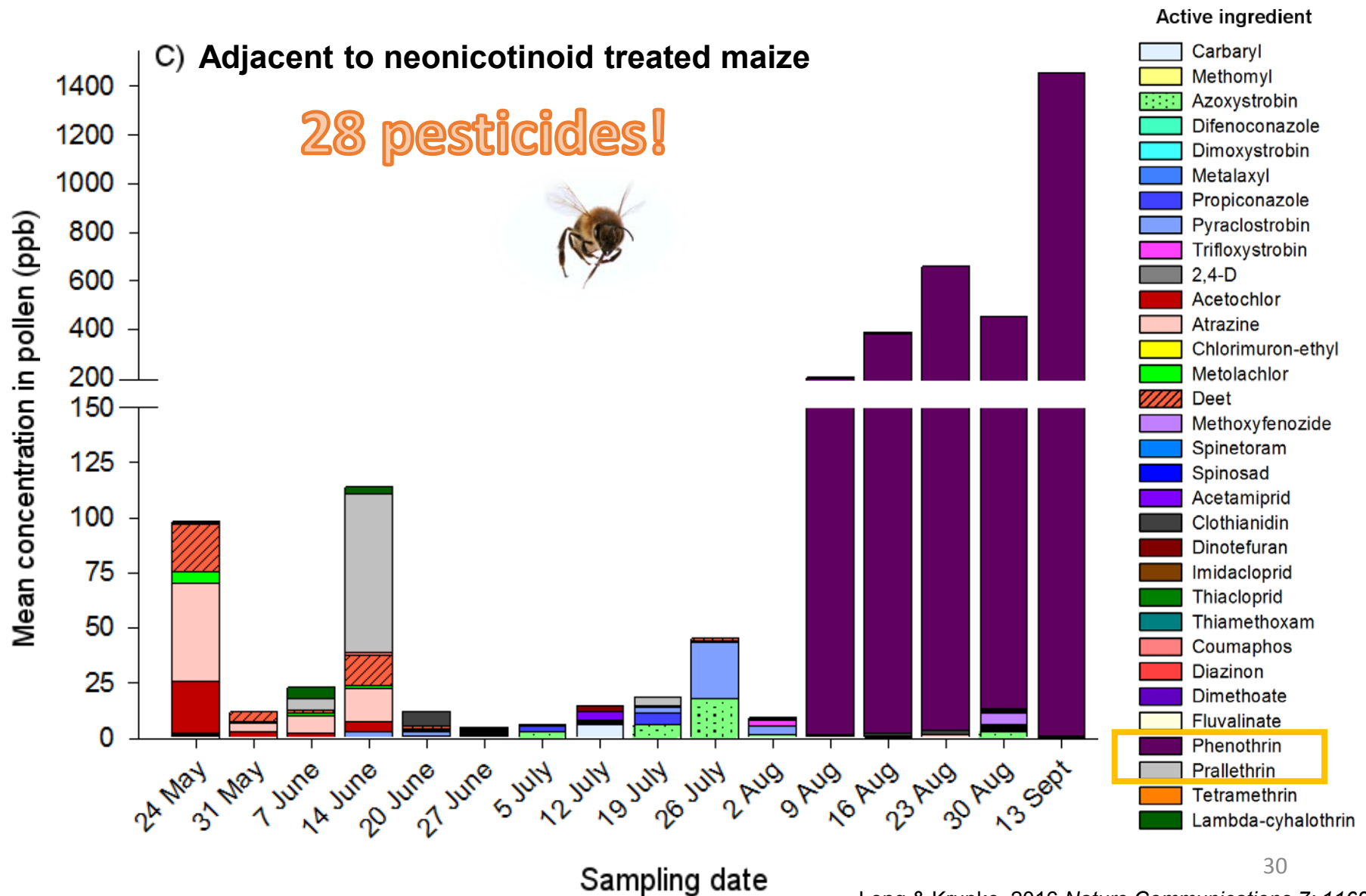
Pesticides detected in pollen



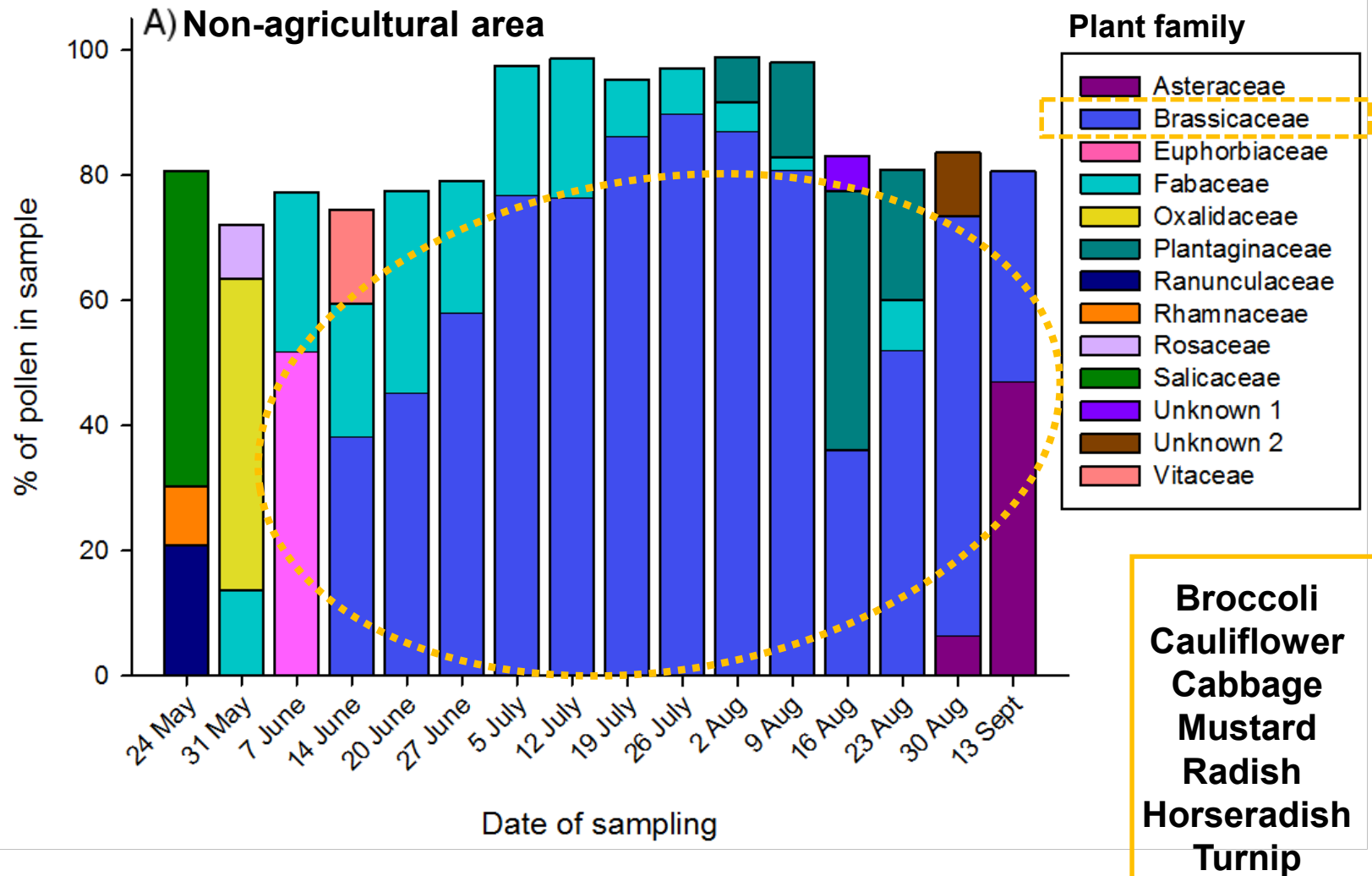
Pesticides detected in pollen



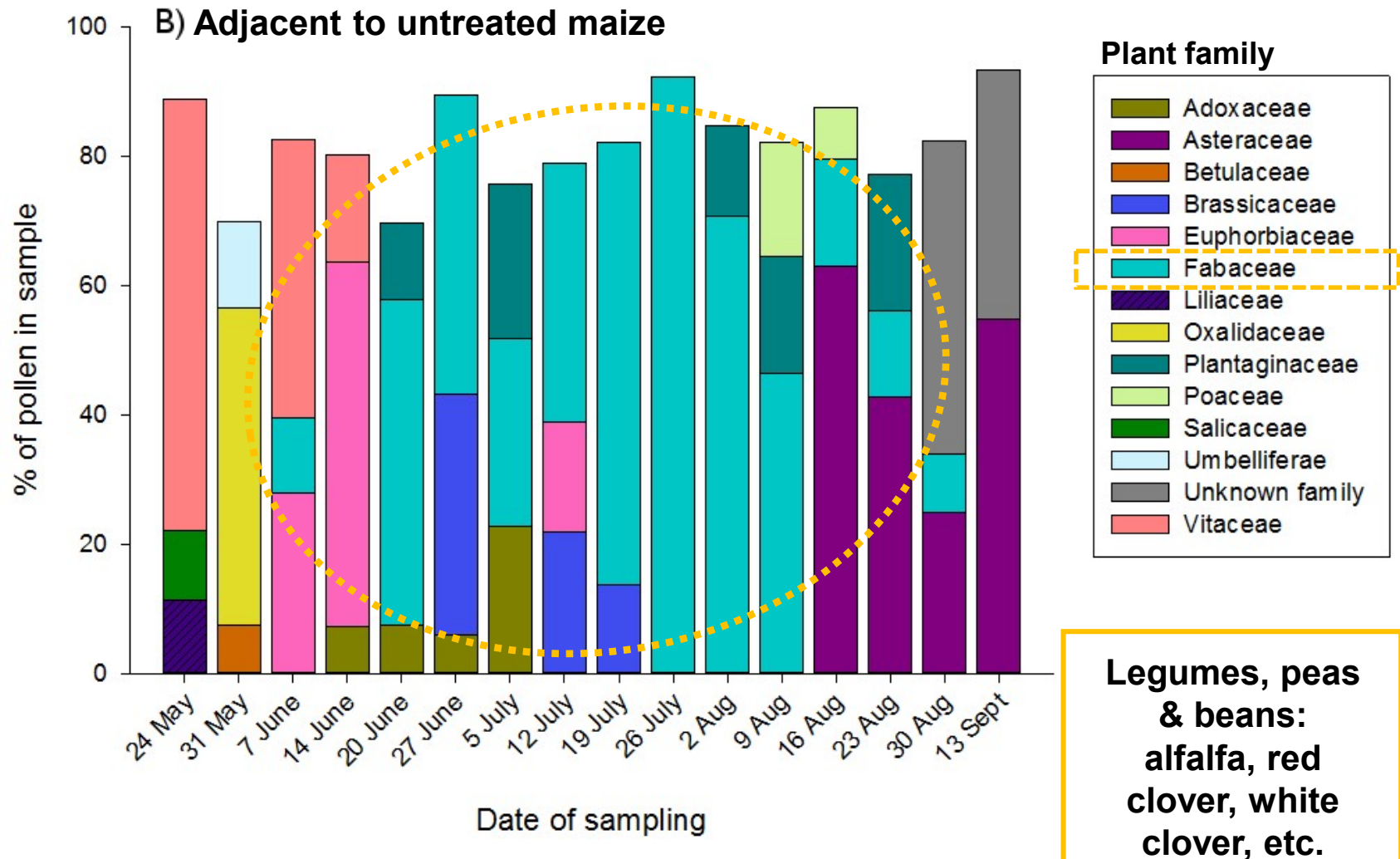
Pesticides detected in pollen



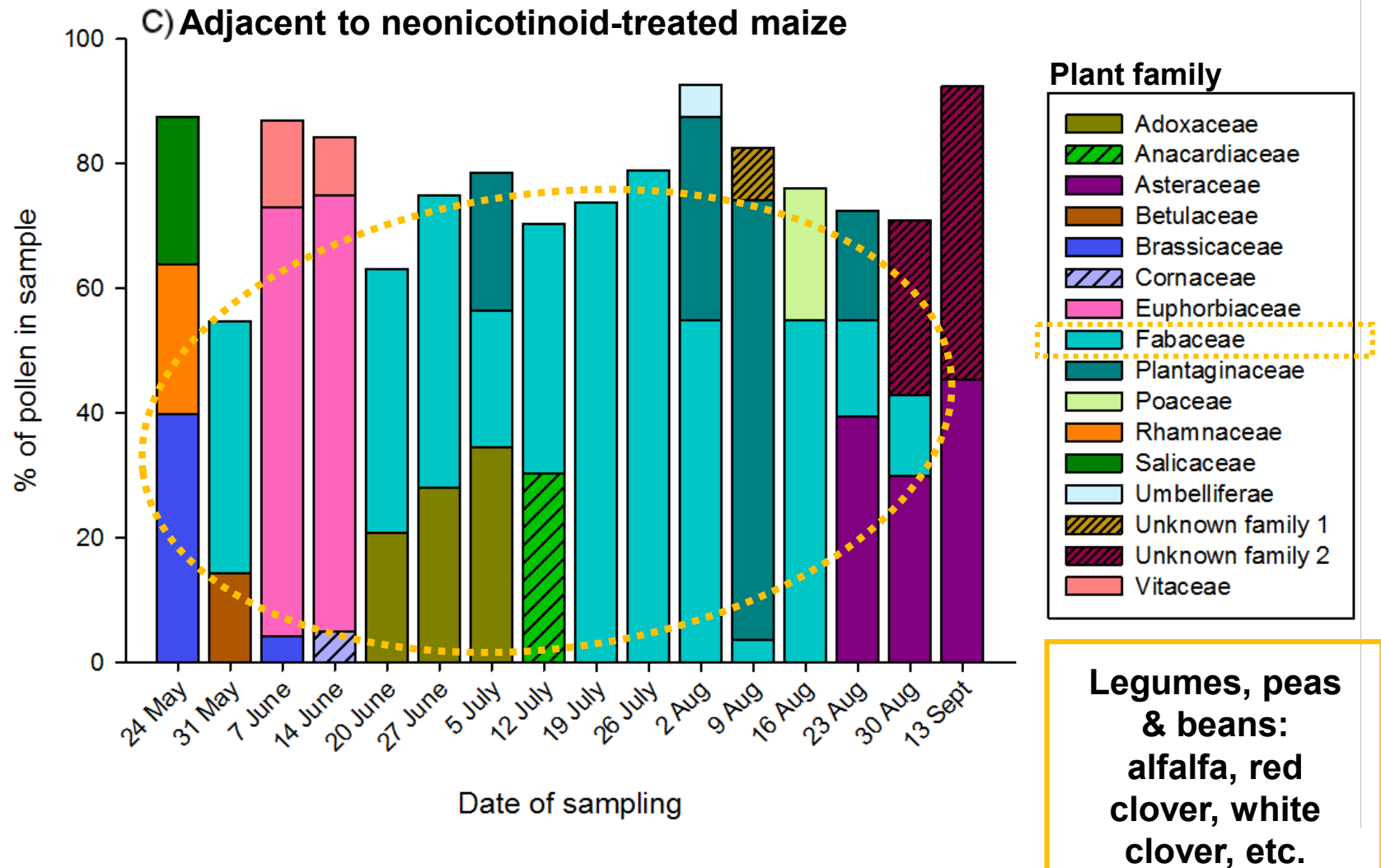
What pollen sources do honey bees use?



What pollen sources do honey bees use?



What pollen sources do honey bees use?



OH specialty

Residues in pumpkin pollen



Neonicotinoid	Application method	Level in pollen (~6 wks post transplant)
Imidacloprid (Admire Pro, high rate)	Transplant water	60.9 ppb
Imidacloprid (Admire Pro, low rate)	Transplant water	36.7 ppb
Imidacloprid (Admire Pro, high rate)	$\frac{1}{2}$ rate at transplant + $\frac{1}{2}$ rate drip irrigation (3 wks post transplant)	80.2 ppb
Thiamethoxam (Platinum)	$\frac{1}{2}$ rate at transplant + $\frac{1}{2}$ rate drip irrigation (3 wks post transplant)	68 ppb
Thiamethoxam (Actara)	Foliar spray (x 2) (4 & 6 wks post transplant)	95.2 ppb
Thiamethoxam (FarMore)	Seed treatment	Not detected

What can you do?



- **Spray only when you need to!**
- **Don't spray when pollinators are active.**
 - Apply pesticides in the late evening, night, or early morning.
- **Don't spray when the crop, or nearby plants (including weeds), are in bloom.**
- **Be mindful of pesticide drift:**
 - Don't spray when winds favor drift.
 - Use ground applications instead of air when possible.

What can you do?




- If drenching/irrigating with systemic products, do so as early as possible before flowering.
- Let neighboring beekeepers know when you plan to spray.

Look for new bee advisory box!


THE NEW EPA BEE ADVISORY BOX

On EPA's new and strengthened pesticide label to protect pollinators

PROTECTION OF POLLINATORS



APPLICATION RESTRICTIONS EXIST FOR THIS PRODUCT BECAUSE OF RISK TO BEES AND OTHER INSECT POLLINATORS. FOLLOW APPLICATION RESTRICTIONS FOUND IN THE DIRECTIONS FOR USE TO PROTECT POLLINATORS.



Look for the bee hazard icon in the Directions for Use for each application site for specific use restrictions and instructions to protect bees and other insect pollinators.

This product can kill bees and other insect pollinators. Bees and other insect pollinators will forage on plants when they flower, shed pollen, or produce nectar.

Bees and other insect pollinators can be exposed to this pesticide from:

- Direct contact during foliar applications, or contact with residues on plant surfaces after foliar applications
- Ingestion of residues in nectar and pollen when the pesticide is applied as a seed treatment, soil, tree injection, as well as foliar applications.


When Using This Product Take Steps To:

- Minimize exposure of this product to bees and other insect pollinators when they are foraging on pollinator attractive plants around the application site.
- Minimize drift of this product on to beehives or to off-site pollinator attractive habitat. Drift of this product onto beehives can result in bee kills.

Information on protecting bees and other insect pollinators may be found at the Pesticide Environmental Stewardship website at:
<http://pesticidestewardship.org/pollinatorprotection/Pages/default.aspx>

Pesticide incidents (for example, bee kills) should immediately be reported to the state/tribal lead agency. For contact information for your state/tribe, go to: www.aapno.org. Pesticide incidents can also be reported to the National Pesticide Information Center at: www.npic.orst.edu or directly to EPA at: beekills@epa.gov

Alerts users to separate restrictions on the label. These prohibit certain pesticide use when bees are present.



The new bee icon helps signal the pesticide's potential hazard to bees.


Makes clear that pesticide products can kill bees and pollinators.

Bees are often present and foraging when plants and trees flower. EPA's new label makes it clear that pesticides cannot be applied until all petals have fallen.

Warns users that direct contact and ingestion could harm pollinators. EPA is working with beekeepers, growers, pesticide companies, and others to advance pesticide management practices.

Highlights the importance of avoiding drift. Sometimes, wind can cause pesticides to drift to new areas and can cause bee kills.

The science says that there are many causes for a decline in pollinator health, including pesticide exposure. EPA's new label will help protect pollinators.



Read EPA's new and strengthened label requirements: <http://go.usa.gov/jHH4>



Summary



- Pollinators are valuable members of our specialty cropping systems.
- Pollinator 'lifestyle' can influence how they are impacted by pesticides.
- Pollinators are exposed to *multiple* pesticides *throughout* the season.
- Judicious use of pesticides & knowledge of pollinators in your system are key ways you can help safeguard these insects. 😊

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Questions?

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