# What the science says on the impact of neonicotinoids on our pollinators

Erfan Vafaie Extension Program Specialist, IPM erfan.vafaie@ag.tamu.edu sixleggedaggie.com



**Overton Field Day** 

June 25, 2015

# Pollinators

#### Not Just Honey

Many valuable agricultural products are dependent on honeybee pollination.

Crop value in billions- 2006	% Pollinated
	by honeybees

Soybeans \$19.7	50%
Alfalfa 7.5	б0
Cotton 5.2	80
Almonds 2.2	100
Apples 2.1	90
Oranges1.8	90
Peaches0.5	80
Cherries, sweet 0.5	90
Grapefruit 0.4	90
Tangerines 0.1	90

SOURCE: U.S. Dept of Agriculture; AP Roger A. Morse and Nicholas W. Calderone, Cornell University



### Pollinators







- "A serious problem threatening the health of honey bees and the economic stability of commercial beekeeping and pollination operations in the United States." - <u>USDA</u>
- October 2006: some beekeepers reported 30 90% hive loss
- Abandoned hives:
  - adults missing
  - capped brood
  - presence of food stores
  - presence of queen bee





Figure 4: US honey-producing colonies



Data source: U.S. Department of Agriculture's (USDA) National Agricultural Statistics Service (NASS) NB: Data collected for producers with 5 or more colonies. Honey producing colonies are the maximum number of colonies from which honey was taken during the year. It is possible to take honey from colonies which did not survive the entire year.

ATEXAS A&M GRILIFE EXTENSION



- Causes?
  - Pathogens
  - Parasites
  - Management stressors
  - Environmental stressors
  - Pesticides



Photo: Wikipedia User Pollinator



- Causes?
  - Pathogens
  - Parasites
  - Management stressors
  - Environmental stressors
  - Pesticides



#### Photo: Wikipedia User Brian9018



- Causes?
  - Pathogens
  - Parasites
  - Management stressors
  - Environmental stressors
  - Pesticides



#### Photo: DCHoneybees



- Causes?
  - Pathogens
  - Parasites
  - Management stressors
  - Environmental stressors
  - Pesticides





Similar to Nicotine (Acetylcholine agonist)



Similar to Nicotine (Acetylcholine agonist)

Acetamiprid, **clothianidin**, **imidacloprid**, nitenpyram, nithiazine, thiacloprid, **thiamethoxam**, dinotefuran



Similar to Nicotine (Acetylcholine agonist)

Acetamiprid, clothianidin, imidacloprid, nitenpyram, nithiazine, thiacloprid, thiamethoxam, dinotefuran

Imidacloprid - most widely used insecticide in the world



Similar to Nicotine (Acetylcholine agonist) Imidacloprid (Merit, Marathon, Premise, Advantage) Dinotefuran (Safari, Transect, Zylam) Acetamiprid (Transport, Tristar) Thiacloprid (not yet registered for non-ag use) Clothianidin (Arena, Aloft) Thiamethoxam (Flagship, Meridian, Optigard)



Similar to Nicotine (Acetylcholine agonist)

Acetamiprid, **clothianidin**, **imidacloprid**, nitenpyram, nithiazine, thiacloprid, **thiamethoxam**, dinotefuran





Similar to Nicotine (Acetylcholine agonist)

# Acetamiprid, **clothianidin**, **imidacloprid**, nitenpyram, nithiazine, thiacloprid, **thiamethoxam**, dinotefuran



#### **Agonists and Antagonists**



XTENSION

### Systemic



Illustration: eXtension.org



#### A petition from the campaign to Ban the use of neonicotinoid pesticides before they devastate bee populations in the USA

SIGN THE PETITION TO

#### Environmental Protection Agency

We urge the EPA to ban the use of neonicotinoid pesticides from being used on crops and in household products to protect nature's hardest workers, bees. Europe just banned these pesticides for two years and there is still time to save bees in the USA if you take action now.

Neonicotinoid, known as "neonics" for short, is a farm pesticide produced primarily by the German chemical giant Bayer, widely used in the U.S. to coat a massive 142 million acres of corn, wheat, soy and cotton seeds. They are also common ingredients in many home gardening products. However, 152,655 people have helped this campaign

#### Progress 152,669 7,331 signed more needed Share this on f in in

#### 6 UPDATES >

#### Garden Plants Are Treated with Bee-Killing Pesticides!

\* A first-of-its-kind pilot study reveals that more than half of garden plants attractive to bees sold at Home Depot and Lowe's have been pre-treated with pesticides that could in fact be lethal to the bees \* 50,000 EXTENSION

### Neonics CREDO MOBILIZE Search

# BAN NEONICOTINOID PESTICIDES IN OREGON.

#### TO: KATY COBA, DIRECTOR OREGON DEPARTMENT OF AGRICULTURE







We urge the Oregon Department of Agriculture (ODA) to declare an immediate ban on all neonicotinoid insecticides: imidacloprid, clothianidin, thiamethoxam, dinetofuran and acetamiprid. The negative environmental and economic impacts of outdoor uses of the neonicotinoid insecticides may be lasting and devastating to Oregon's agricultural businesses, from fruit trees to honey production.

Oregonians demand that the future of Oregon's agricultural sector be protected by a ban before bee populations decline any further.

#### Why is this important?

In mid-June, an estimated 50,000 bumblebees were killed in a shopping mall parking lot in Wilsonville, Oregon. The ODA confirmed that the massive bee die-off was caused by a neonicotinoid pesticide, dinotefuran, on nearby trees. Then, only days later, hundreds of bees were found dead after a similar

SIG	ίN		
First Name *			_
Last Name *			
Email *			
Address *			
Zip Code *			
	SIG	u	
	3161	N	

LOG IN

START A CAMPAIGN

You'll receive periodic updates on offers and activism opportunities from CREDO.

Sum

Fighting for people over profits



#### Stop selling the bee-poisoning neonics

Goal: 750,000

#### 744,417

Bees are dying off around the world in record numbers -- but big retailers are still selling the poison that is killing them.

Last season, 37 million bees (!) died on a single North American farm. Scientists now know why – study after study shows that deadly pesticides called "neonics",

#### Sign the petition to Home Depot, Lowe's and other retailers

#### Petition Text:

Stop selling bee-poisoning neonicotinoids."

#### FULL NAME

#### EMAIL ADDRESS

COUNTRY United States of America POSTAL / ZIP CODE

#### I'm a beekeeper.

Submit



#### **BAN THE PESTICIDES THAT ARE KILLING BEES**

#### ADD YOUR NAME BELOW TO DEMAND THE GOVERNMENT PROTECT OUR BEES

Email Address:\*

First Name:\*

Surname:\*

Postcode:\*

Add your comment here (optional)





#### 331980 SIGNATURES AND COUNTING!

Can you help us reach 350000 signatures today?



#### THE PETITION TEXT:

Dear Owen Paterson, Environment Secretary

It's time to take action to protect our dying bees!

Immediately halt the use of Nerve-agent pesticides (neonicotinoids) which are being blamed around the world for the sharp decline in bee numbers.

Take measures to reduce the use of all pesticides on bee pollinated crops.

denotes required field

Cum

change.org

D Search

Petitioning Premier Kathleen Wynne Y

# Save Ontario's bees: ban the use of neonicotinoid pesticides

Petition by The Ontario Beekeepers' Association

	19,375 NEEDED
First Name	
Last Name	
Email	
Street Address	
City	
State ᅌ	Outside U.S.?
Zip Code	
Why is this important t (Optional)	o you?

Display my signature on Change.org

#### Cum



لعربية DEUTSCH PYCCKИЙ FRANÇAIS ESPAÑOL PORTUGUÊS 한국어 简体中文 繁體中文 日本語 NEDERLANDS ITALIANO עברית TÜRKÇE POLSKI ROMÂNĂ EAAHNIKA

START A

#### 3 million to Save the Bees



Save the Bees from Avaazorg on Flickr



3,400,900

3,400,900 have signed the petition. Now let's get to 3,500,000

#### Posted: 7 May 2013

Quietly, globally, billions of bees are dying, threatening our crops and food. Massive public pressure has helped convince the European Union to ban these poisonous pesticides, but we can't stop there – these killers are used all over the world, and bees are in serious trouble.

#### SIGN THE PETITION

#### To World Leaders and Agriculture Ministers:

We call on you to immediately ban the use of neonicotinoid pesticides. The catastrophic demise of bee colonies could put our whole food chain in danger. If you act urgently with precaution now, we could save bees from extinction.

#### Already an Avaaz member?

Enter your email address and hit "Send".



SEND 🔺

#### First time here? Please fill out the form below.

Name		
Email		
Country	0	Postal code
Cell/Phone		
	····	



FRANCAIS ESPAÑOL PORTUGUÊS 繁體中文 简体中文 ROMÂNĂ EAAHNIKA NEDERLANDS ITALIANO TÜRKCE POLSKI עברית

# Donate

Join Shop

#### DAILY NEWS BLOG

#### Blog Home

#### ARCHIVES

Home

Select Month

#### CATEGORIES

- ➤ Agriculture (354)
- Alternatives/Organics (473)
- Announcements (164)
- Antibacterial (100)
- Aquaculture (10)
- Biofuels (5)
- Biological Control (1)
- Biomonitoring (14)
- Chemicals (1965) a 2,4-D (69) +4-aminopyridine (1) Abamectin (3) is Acephate (3)

« New Report Showcases Atrazine Manufacturer's Efforts to Discredit Critics Chinese Herbs Found To Be Tainted With Pesticides » 50,000 Bumblebees Dead After Neonicotinoid Pesticide Use in Oregon



(Beyond Pesticides, June 24, 2013) Just as Pollinator Week began last week, an estimated 50,000 bumblebees, likely representing over 300 colonies, were found dead or dving in a shopping mall parking lot in Wilsonville, Oregon. Authorities confirmed Friday that the massive bee die-off was caused by the use of a neonicotinoid pesticide, dinotefuran, on nearby trees. Then on Saturday, it was reported by The Oregonian that what could be hundreds of bees were found dead after a similar pesticide use in the neighboring town of Hillsboro.

According to the Xerces Society, this is the largest known incident of bumblebee deaths ever recorded in the country. Bumblebees, which are crucial to pollination of multiple berry and seed crops grown in the Willamette valley, have recently experienced dramatic population declines, a fate that is similar to other pollinators. Dan Hilburn, Director of plant programs at the Oregon Department of Agriculture (ODA), told Oregon Live that he's "never encountered anything guite like it in 30 years in the business." The incident highlights the difficulty of permitting in commerce such a highly toxic material that indiscriminately kills beneficial insects.



#### USING THE BLOG

- About the Daily News Blog
- How to comment
- Submit a story or topic

#### RECENT COMMENTS

- Liam on Ordinance to Outlaw County-wide Landscape Pesticide Use Introduced in Maryland
- > OrganicTwinkie on Oregon Legislators Working to Introduce Herbicide Spray Policy
- > Javi on Groups Call for Labeling of 300 Inerts Ingredients as EPA Delists 72 Already Discontinued



START A

PETITION



DIRECTION It is a violati this product inconsistent For best rest	DNS FOR USE on of Federal law to use t in a manner t with its labeling. ults, read and follow all label directions.
BEFORE YOU USE Read and follow these directions when using:	<ul> <li>Do not apply near lakes, streams, rivers, or ponds.</li> <li>Do not apply to soils which are water-logged or saturated.</li> <li>Bucket or measuring utensils should not be used for any food or drinking water purposes after use with this product.</li> </ul>
HOW TO USE	Determine the amount to use by measuring the distance around the tree trunk or height of the shrub. Pour the required amount into a bucket of water and empty the bucket around the base of the tree/shrub.
FOR USE ON	Outdoor trees and shrubs including listed fruit and nut trees: Apple Mayhaw Pecan Crabapple Oriental Pear Quince Loquat Pear
CONTROL	S







#### ENVIRONMENTAL HAZARDS

This product is highly toxic to aquatic invertebrates. Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwaters. Apply this product only as specified on this label. Extreme care must be taken to avoid runoff. Apply only to soil or other fill substrate that will accept the solutions at the specified rate. Do not treat soil that is water-saturated or frozen, or in any conditions where run-off or movement from the treated area (site) is likely to occur.

This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area. This chemical demonstrates the properties and characteristics associated with chemicals detected in groundwater. The use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in groundwater contamination.

Do not formulate this product into other end-use products.



#### 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.

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

- Ingestion of residues in nectar and pollen when the pesticide is applied as a seed treatment,
- soil, tree injection, as well as foliar applications. 0

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.aapco.org. Pesticide incidents can also be reported to the National Pesticide Information Center at: <u>www.npic.orst.edu</u> or directly to EPA at: <u>beekill@epa.gov</u>

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

# **Strategy Overarching Goals**

- Reduce honey bee overwintering losses to no more than 15% within 10 years
  - Compared to current 5-yr average rate of approximately 30%
- Restore monarch butterfly populations to 225 million butterflies by 2020
  - Their historical average population size
- Restore/enhance 7 million acres of land for pollinators over the next 5 years
  - Federal action and public/private partnerships

#### Current research

#### **Neonics and Pollinators**





Air seeder and Quadric Direct seeding, Cross Slot TM



# Nectar and Pollen



Source: OPERA Bee health in Europe, 2013



### Dusts



Sites with seed treatments (Elado: clothianidin + b-cyfluthrin) vs. no seed treatment

- Reduced wild bee density
- Reduced solitary bee nesting
- Reduced bumblebee colony growth
- Reduced reproduction of bumblebees
- No significant impact on honeybee health

Rundlof et al. (2015) Nature





**Figure 2.** Low-vacuum SEM image of a seed-coating particle (Poncho 2009) that, partially modified by the air humidity, adheres to the **GRILIFE** abdomen tegument of a bee exposed to the drilling machine emissions.



# Seed coating

Table 3 Content of neonicotinoids in honeybee samples collected at different times from the starting of sowing, after their flight near the drilling machine

No – date of trial	Insecticide	Collecting site	Sampling time*	No. of bees analysed	Quantity of insecticide in ng/bee
1 - 14/07/09	Clothianidin – 2009	Dispenser Hive	30 min <sup>†</sup> 3 h <sup>‡</sup> Day after <sup>‡</sup>	7 7 7	674 161 118
3 - 15/10/09	Imidacloprid – 2009	Dispenser Dispenser Hive	30 min <sup>\$</sup> 45 min <sup>†</sup> 3 h <sup>‡</sup>	7 4 8 8	3661 442 500
		Hive Non-woven net	4 h <sup>‡</sup> Day after	8 4	53 29

\*Time from start of sowing.

<sup>†</sup>Bees captured at the dispenser and dead in laboratory in high humidity.

<sup>‡</sup>Bees found dead on the ground in front of the apiary.

<sup>5</sup>Bees found dead on the ground near the dispenser.

#### Girolami et al. (2012) Journal of Applied Entomology



# Seed coating

eonicotinoids in honeybee samples collected at different times from the starting of sowing, after their flight near the dri

Insecticide	Collecting site	Sampling time*	No. of bees analysed	Quantity of insecticide in ng
Clothianidin – 2009	Dispenser	30 min <sup>†</sup>	7	674
	Hive	3 h‡	7	161
	Hive	Day after <sup>‡</sup>	7	118
Imidacloprid – 2009	Dispenser	30 min <sup>§</sup>	4	3661
	Dispenser	45 min <sup>†</sup>	8	442
	Hive	3 h <sup>‡</sup>	8	500
	Hive	4 h <sup>‡</sup>	8	53
	Non-woven net	Day after	4	29

wing.

dispenser and dead in laboratory in high humidity.

he ground in front of the apiary.

he ground near the dispenser.

Girolami et al. (2012) Journal of Applied Entomology



# Seed coating



### Soil Persistence

Lowest

Highest



Goulson (2013) Journal of Applied Ecology

### Field-realistic exposure

**Fig. 2.** The number of new queens produced by the control colonies was greater than the number produced in both low- and high-treatment colonies. Bars represent the mean number of queens and their standard errors. Asterisks indicate significant differences.





# Field-realistic exposure

In a meta-analysis of fourteen published studies of the effects of imidacloprid on honeybees under laboratory and semi-field conditions that comprised measurements on 7073 adult individuals and 36 colonies, fitted dose-response relationships estimate that trace dietary imidacloprid at field-realistic levels in nectar will have no lethal effects, but will reduce expected performance in honey bees by between 6 and 20%.

Cresswell, J. (2011). A meta-analysis of experiments testing the effects of a neonicotinoid insecticide (imidacloprid) on honey bees. *Ecotoxicology*, 20, 149-157.



# Nectar and Pollen

#### Nectar and Pollen

#### Sunflower & Maize

#### 10 ug/kg in flowers Few micrograms/kg in pollen Lethal oral dosage: ~102 ng/bee

#### 10 ug = 0.000 01 102 ng = 0.000 000 102

Bonmatin et al. (2003) Analytical Chemistry

### **Current bans/restrictions**



You are here: Home / News / Neonicotinoid pesticides are a huge risk - so ban is welcome, says EEA

#### Neonicotinoid pesticides are a huge risk - so ban is welcome, says EEA

👯 Change language

Topics: Chemicals Biodiversity Agriculture

The European Commission has decided to ban three neonicotinoid insecticides. These chemicals can harm honeybees, according to a large body of scientific evidence, so the European Environment Agency (EEA) commends the precautionary decision to ban them.





#### Featured article





Environmental spatial data: what is happening where?

When taken as a single variable, population density, transport infrastructure, soil types, land use and terrain characteristics, might tell only a part of the story. What links them together and ...



### **Current bans/restrictions**

European Environment Agency		Q. Search Europe's environment Advanced search	Search A-Z Glossary		
Topics	Data and maps	Indicators	Publications	Media	About EEA

be seen as only a starting point on the discourse over the use of this class of pesticides. It only applies to three of m seven neonicotinoids and only for use with "crops attractive to bees", so it does not take into account the impacts of neonicotinoids on aquatic invertebrate species, birds or other insects which are also major areas of concern. Neither does the ban cover new neonicotinoid insecticide Sulfoxaflor which may come onto the market soon." - EEA



characteristics, might tell only a part of the story. What links them together and ...



#### However

Things are never that simple...



### Australia

No sign of CCD in Australia

"Very few submitted reports of adverse effects of pesticides on bees and other pollinators in Australia"

 Neonicotinoids and the Health of Honey Bees in Australia, Australian Pesticides and Veterinary Medicines Authority (pg. 62)



#### Mites

Figure 4: US honey-producing colonies

Number of honey producing bee colonies

(x 1 000 000)



Data source: U.S. Department of Agriculture's (USDA) National Agricultural Statistics Service (NASS) NB: Data collected for producers with 5 or more colonies. Honey producing colonies are the maximum number of colonies from which honey was taken during the year. It is possible to take honey from colonies which did not survive the entire year.

### Canada

Table 1: Summary of number of beekeepers reporting for 2012 and 2013

	2012		2013 (as of Sept 20, 2013)		
	Ontario	Québec	Ontario	Québec	Manitoba
Beekeepers	42	1	74	4	4
Bee yards	242	8	319	5	9
Affected Hives	>4550 to 5890	788	>3789 to 6639	201	275
Crop link	corn, soy	corn	corn, soy	corn	corn
Sites	Corn growing	regions	Same general location	tion as 2012	

#### Notes:

unknown for 34 bee yards from 5 beekeepers

stimate if all hives in yards were affected

<sup>\*\*</sup> unknown for 114 bee yards from 35 beekeepers, 3789 is the # of hives known to be affected as of Sept 20, 2013; the upper estimate calculated based on 25 hives per bee yard (3789 + 114 yard x 25) = 6639

Source: <u>Health Canada</u>

EVIENDIA

# Canada



#### Bees are not affected by treated canola seed

There has been no evidence that planting canola seed treated with an insecticide places pollinators at risk. Seed treatments used for canola remain on the seed and are not released as dust into the air, and field studies show no chronic or acute poisonings from seed treatments when analyzed at field scale rates.

Canola Council of Canada



# Canada

# Alberta beekeepers oppose Ontario neonic lawsuit

Beekeepers here are speaking out against lawsuit, saying it's better to work with chemical companies







### Alternatives to neonics?

- Older chemistries:
  - Organophosphates
  - Carbamates
  - Organochlorines



# Thank you

**Erfan Vafaie** Extension Program Specialist, IPM

erfan.vafaie@ag.tamu.edu (O) 903-834-6191 sixleggedaggie.com

