UNIVERSITY OF ILLINOIS EXTENSION

PREPARING A NEW GENERATION
OF ILLINOIS FRUIT AND VEGETABLE FARMERS

POLLINATION, POLLINATORS, AND CHALLENGES

Rick Weinzierl

Illinois Migrant Council

new ILLINOIS fruit & vegetable FARMERS

Definitions, courtesy of Wikipedia
(with a few edits)

- **Pollination:** Pollination is the process by which pollen is transferred from the anther (male part) to the stigma (female part) of flowers, thereby enabling fertilization and reproduction.
- In spite of a common perception that pollen grains are gametes, like the sperm cells of animals, this is incorrect; pollination is an event in the alternation of generations. Each pollen grain is a male haploid gametophyte, adapted to being transported to the female gametophyte, where it can effect fertilization by producing the male gamete (or gametes), in the process of double fertilization).
- A successful angiosperm pollen grain (gametophyte) containing the male gametes gets transported to the stigma, where it germinates and its pollen tube grows down the style to the ovary. Its two gametes travel down the tube to where the gametophyte(s) containing the female gametes are held within the carpel. One nucleus fuses with the polar bodies to produce the endosperm tissues, and the other with the ovule to produce the embryo. Hence the term: "double fertilization".
- In gymnosperms (including conifers) the ovule is not contained in a carpel, but exposed on the surface of a dedicated support organ such as the scale of a cone, so that the penetration of carpel tissue is unnecessary. Details of the process vary according to the division of gymnosperms in question.
- Pollination, aided by wind, insects, or other animals, allows flowering plants to produce seeds and fruits.

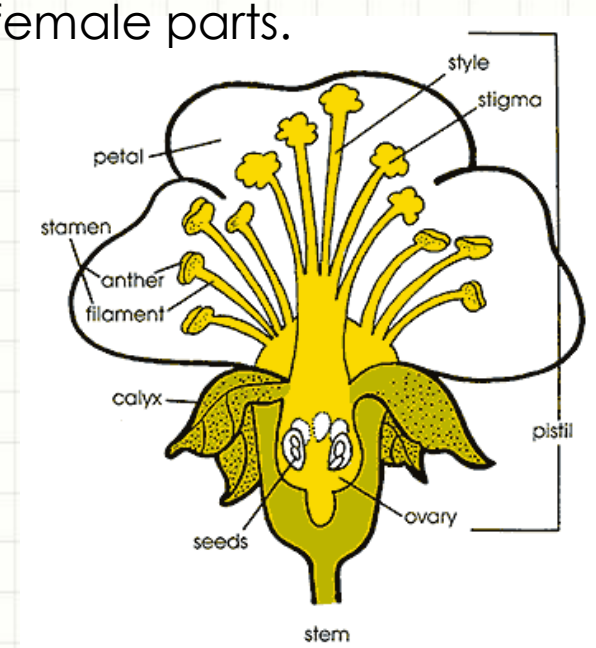
and more from Wikipedia (also with minor edits) …

- **Pollinators** are the organisms that carry pollen from the stamen to the stigma … they may be insects, birds, bats, or occasionally other animals.
- **Pollenizers** are plants that serve as the source of pollen for successful pollination and fertilization. While some plants are capable of self pollenization, the term is more often used in pollination management to refer to a plant that provides abundant, compatible, and viable pollen at the same flowering time as the pollenized plant. For example, most crabapple varieties are good pollenizers for any apple variety that blooms at the same time, and are often used in apple orchards for that purpose. Some apple cultivars produce very little pollen; some produce pollen that is sterile or incompatible with other apple varieties. These are poor pollenizers. A pollenizer can also be the male plant in dioecious species (where entire plants are of a single sex), such as with kiwifruit or holly.

OK, so flowers …

- may each include male and female organs that are self fertile ... and may or may not benefit from pollen transfer from male to female flower parts by insects or other pollinators
  - Pollen transfer may be physical, by wind or gravity (think corn, beans, peaches)
- may each include male and female organs, but pollen from another cultivar or variety may be needed for successful fertilization
  - Nearly all apples and most sweet cherries, for example
- may occur separately as male and female flowers on the same plant
  - Cucurbits
- may be on separate male and female plants
  - Asparagus, kiwi, holly, and gingko (and detassled corn grown for seed production)

Apple flowers have male and female parts.

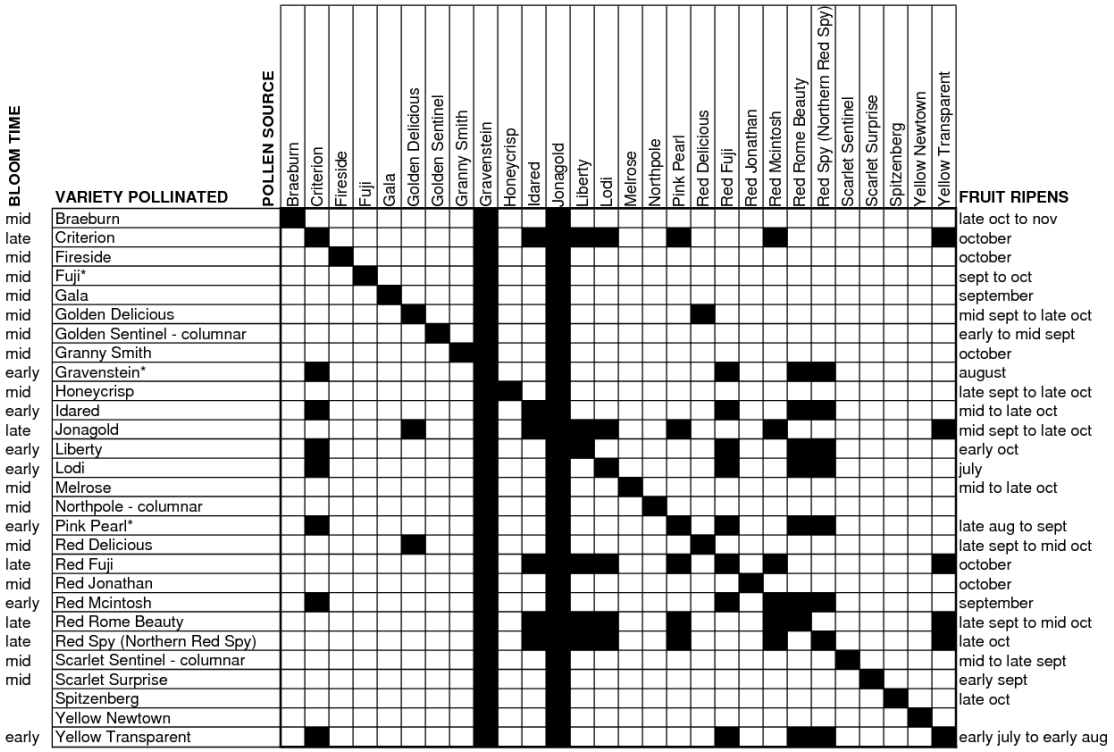


Male (left) and female (right) flowers occur on the same squash plant.

Pollenizers

APPLE POLLINATION CHART

Most apples are partially self fertile, and will set a fair crop in the absence of a pollenizer. If another variety is nearby, you will get a much better crop. A few cultivars, such as Gravenstein are poor pollen producers (indicated with an asterisk), and require a pollenizer to set fruit . Snowdrift Crabapple is an excellent and attractive pollenizer for mid and late season bloomers.



* = this variety requires a pollenizer to set fruit

HOW TO USE THE POLLINATION CHART-

1. Select the variety to produce fruit from the **left** side of the chart.
2. Potential pollen parents are listed across the **top** of the chart.
3. If the **intersecting** square is **white**, the variety **will be** pollinized.
4. If the **intersecting** square is **shaded**, the variety **won't** be pollinized.

Insect-aided pollination …

- may occur without management
  - If the result of wild honey bees, it's not really "natural" … honey bees are not native to North American but instead imported by European immigrants
  - Insect pollinators include bees, wasps, butterflies, moths, flies, beetles, and other insects that visit flowers for pollen or nectar
- may be managed
  - Honey bees
  - Bumble bees, orchard mason bees (blue orchard bee, hornfaced bees), and leafcutter bees … are sometimes cultured
  - Squash bees, digger bees, and carpenter bees may be conserved

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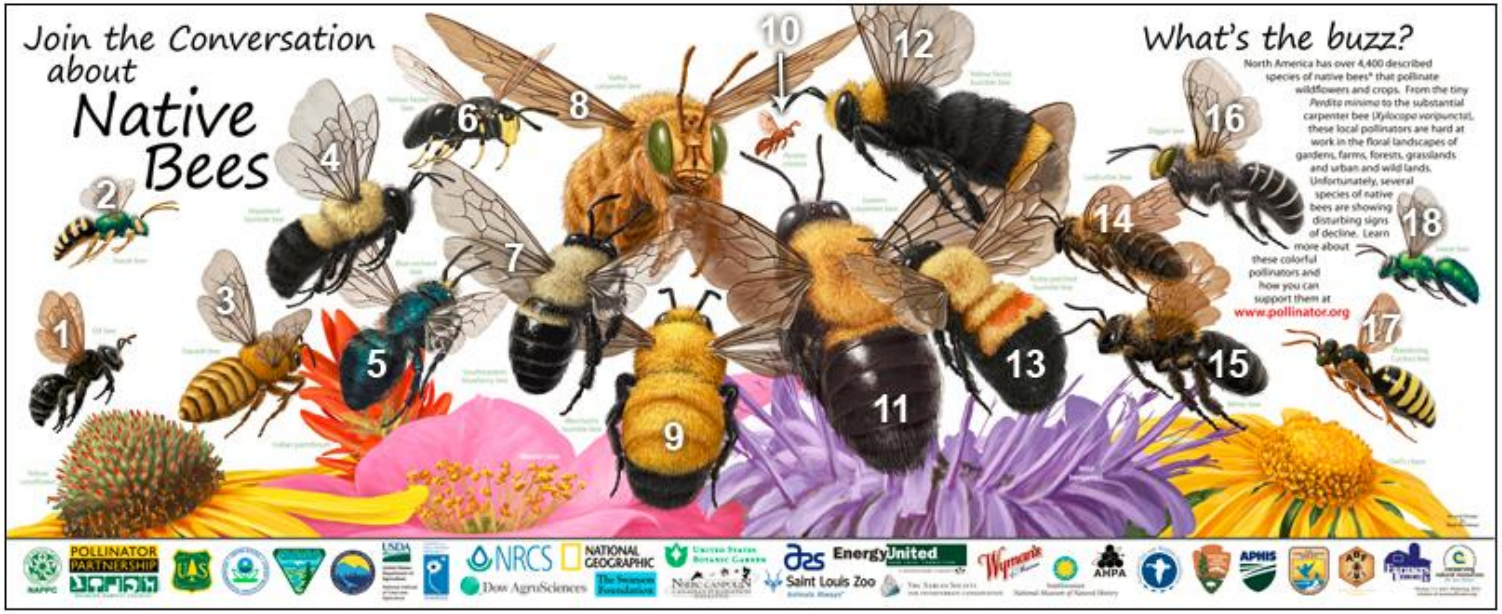

1. ***Macropis nuda***.
2. ***Agapostemon texanus***. US sweat bee
3. ***Peponapis pruinosa***. Squash and gourd bees
4. ***Bombus impatiens***. The Impatient Bumble Bee
5. ***Osmia lignaria***. The Blue Orchard Bee
6. ***Hylaeus sp***.
7. ***Habropoda laboriosa***. The Southeastern Blueberry Bee
8. ***Xylocopa varipuncta***. The Valley Carpenter Bee
9. ***Bombus morrisoni***. Morisson's bumble bee
10. ***Perdita minima***.
11. ***Xylocopa virginica***. Eastern Carpenter Bee
12. ***Bombus vosnessenskii***.
13. ***Bombus affinis***.
14. ***Megachile sp***. Leafcutter bees
15. ***Andrena cornelli***. Miner bees
16. ***Anthophora centriformis***. Digger bees, or anthophorids
17. ***Nomada sp***. The Wandering Cuckoo Bee
18. ***Augochorella pomoniella***. Sweat bees

http://www.pollinator.org/NativeBees.htm

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Bumble bees … wild and managed pollinators.

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Orchard Bees.com

Small Backyard
20 cocoons or 3 tubes

BUY NOW BUY NOW

Backyard
40 cocoons or 6 tubes

BUY NOW BUY NOW

Backyard Orchard
100 cocoons or 18 tubes

BUY NOW BUY NOW

Orchard (1+ acres)
1000 cocoons or 168 tubes

BUY NOW BUY NOW

Mason Bee Houses

BUY NOW

Nesting Tubes

Orchard mason bees are indigenous to North America, and their role as pollinators is crucial to our indigenous plant life. Keeping mason bees is a low cost way to improve our natural environment. They are easy to maintain, and delightful to watch.

While the importance of honeybees to our food supply has been well publicized by the media, the role of native pollinators such as the orchard mason bee and the bumble bee to our ecology is less widely recognized. We are dedicated to increasing the cultural and environmental awareness of orchard mason bees (Osmia lignaria), bumble bees (Bombus), and our many other native bee pollinators.

We have been doing business in Portland, Oregon area for 114 years. We have a large store where you can see all our bee products, and bee educational material. Our online store provides everything you could want to cultivate healthy and productive orchard bees.

Our store hours are: 9:00 am to 6:00 pm, Monday through Friday, and

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Leafcutter bees

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Squash bees … nest in ground. They look similar to honey bees but with fuzzier legs that lift dry pollen from squash blossoms, and male bees have a yellow spot on their face that resembles a nose.

They begin foraging (visiting cucurbit flowers) at or before dawn. Male and unfertilized female squash bees spend the night in flowers that have wilted during the day. In the morning, they chew their way out and start foraging and mating. Because they nest 5 to 20 inches below the soil surface, conservation tillage and no-till practices allow their survival.

Honey bees

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Using bees for pollination

	Honey bee hives/A	Alternatives
Apples	1.2	250 orchard mason bees/A
Blueberries (bees augment yield and size)	4	1-4 bumble bees or southeastern blueberry bees / bush
Muskmelon	2-3	Conserve squash bees
Cucumber	2-3	
Pumpkin	1	
Squash	1	
Watermelon	1-5	

Distributors of bumble bee colonies provide recommendations for outdoor and high tunnel / greenhouse uses.

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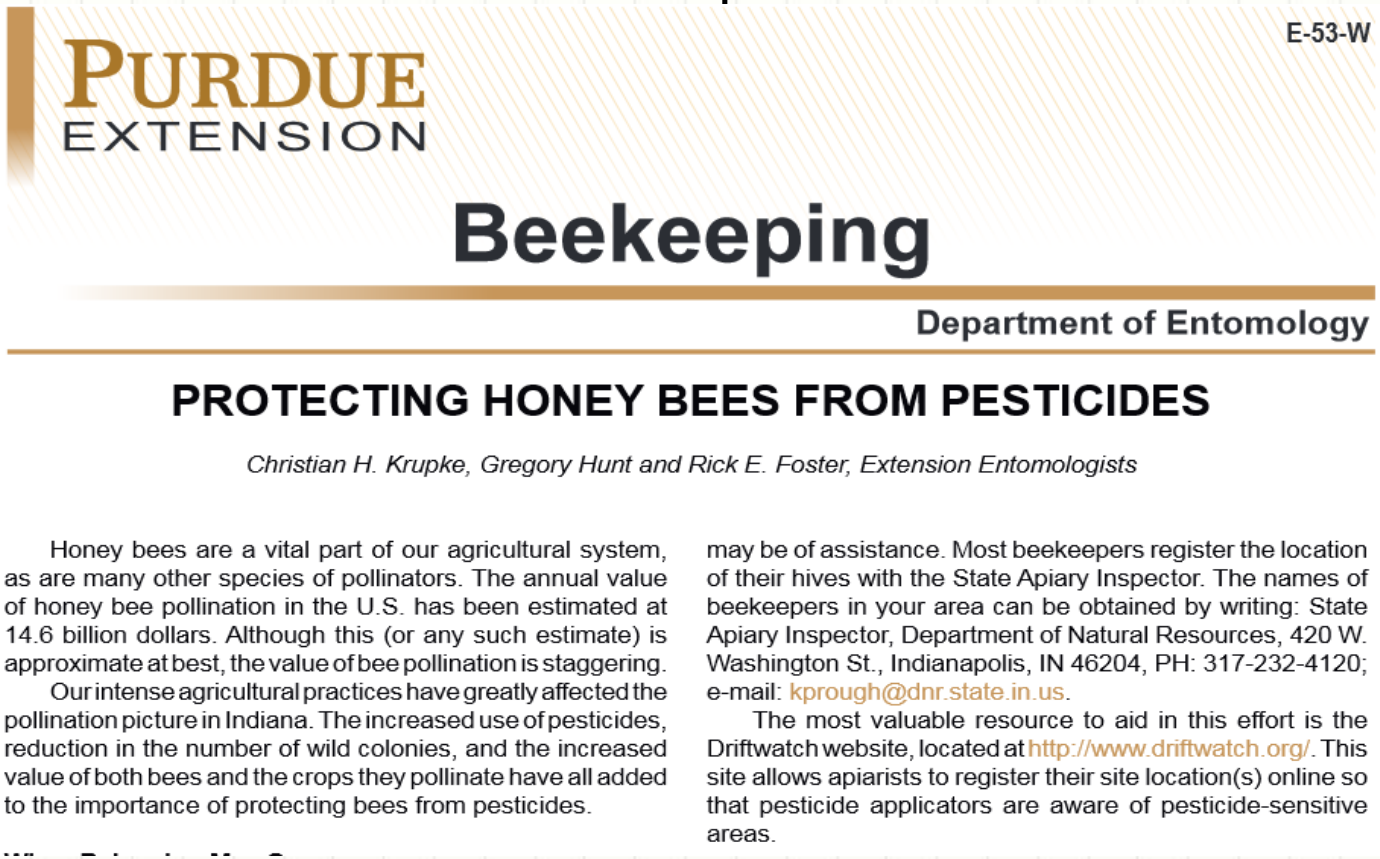
Challenges … threats to pollinators, beekeepers, and specialty crop production

- Host plant / habitat loss
- Climate and weather
- Insecticides
  - Overall use
  - Neonicotinoids
- Parasites and pathogens
  - Varroa and tracheal mite
  - Bacteria and viruses
    - Migratory beekeeping
- Colony collapse disorder

Insecticide management

- Fruit and vegetable growers can promote or hurt the survival of pollinators



PURDUE EXTENSION

E-53-W

Beekeeping

Department of Entomology

PROTECTING HONEY BEES FROM PESTICIDES

Christian H. Krupke, Gregory Hunt and Rick E. Foster, Extension Entomologists

Honey bees are a vital part of our agricultural system, as are many other species of pollinators. The annual value of honey bee pollination in the U.S. has been estimated at 14.6 billion dollars. Although this (or any such estimate) is approximate at best, the value of bee pollination is staggering.

Our intense agricultural practices have greatly affected the pollination picture in Indiana. The increased use of pesticides, reduction in the number of wild colonies, and the increased value of both bees and the crops they pollinate have all added to the importance of protecting bees from pesticides.

may be of assistance. Most beekeepers register the location of their hives with the State Apiary Inspector. The names of beekeepers in your area can be obtained by writing: State Apiary Inspector, Department of Natural Resources, 420 W. Washington St., Indianapolis, IN 46204, PH: 317-232-4120; e-mail: kprough@dnr.state.in.us.

The most valuable resource to aid in this effort is the Driftwatch website, located at http://www.driftwatch.org/. This site allows apiarists to register their site location(s) online so that pesticide applicators are aware of pesticide-sensitive areas.

http://extension.entm.purdue.edu/publications/E-53.pdf

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Neonicotinoid Insecticides

- Krupke, C.H., G.J. Hunt, B.D. Eitzer, G. Andinao, and K. Gvien. 2012. Multiple Routes of Pesticide Exposure for Honey Bees Living Near Agricultural Fields. PLOS ONE: http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0029268.

- Dively, G.P., and A. Kamel. 2012. Insecticide Residues in Pollen and Nectar of a Cucurbit Crop and their Potential Exposure to Pollinators. Journal of Food and Agricultural Chemistry 60 (18): 4449-4456. http://pubs.acs.org/doi/abs/10.1021/jf205393x.

- Hopwood, J., M Vaughan, M. Shepperd, D. Biddinger, E. Mader, S. Hoffman-Black, and C. Mazzacano. Are Neonicotinoids Killing Bees? Xerces Society. http://www.xerces.org/wp-content/uploads/2012/03/Are-Neonicotinoids-Killing-Bees_Xerces-Society1.pdf

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Characteristics of Neonicotinoids

- Persistence
- Likelihood of Transport (solubility)
- Toxicity

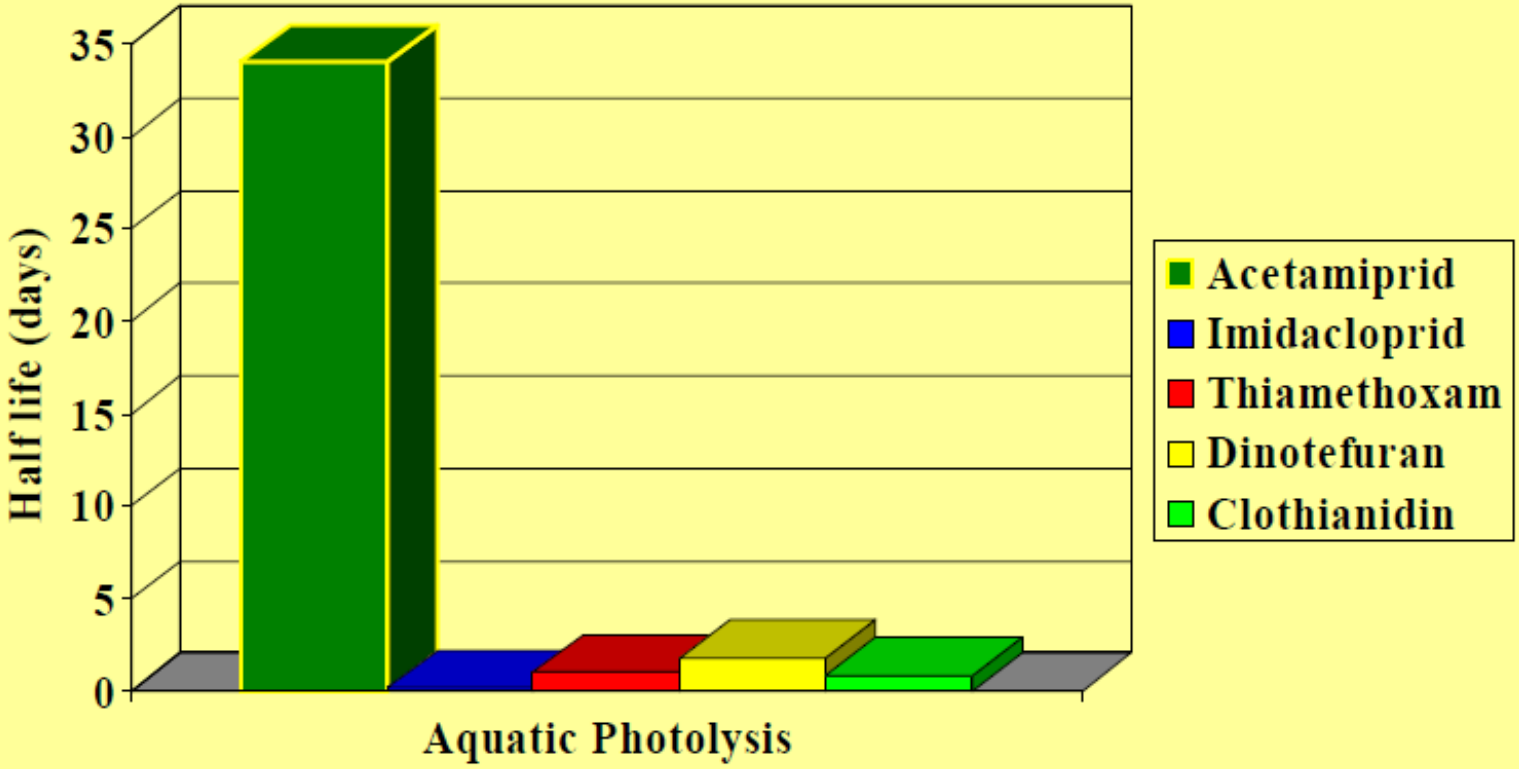
Table 3.1 Half-life in Soil of Neonicotinoids

Neonicotinoid	Half-life in Soil (aerobic soil metabolism)
Acetamiprid	1–8 days[1]
Clothianidin	148–1,155 days[2]
Dinotefuran	138 days[3]
Imidacloprid	40–997 days[4]
Thiacloprid	1–27 days[5]
Thiamethoxam (See note below)	25–100 days[6]

Note: Clothianidin is a primary metabolite of thiamethoxam.

Sources: 1. EPA 2002; 2. EPA 2003a; 3. EPA 2004; 4. NPIC 2010; 5. EPA 2003b; 6. Syngenta Group 2005

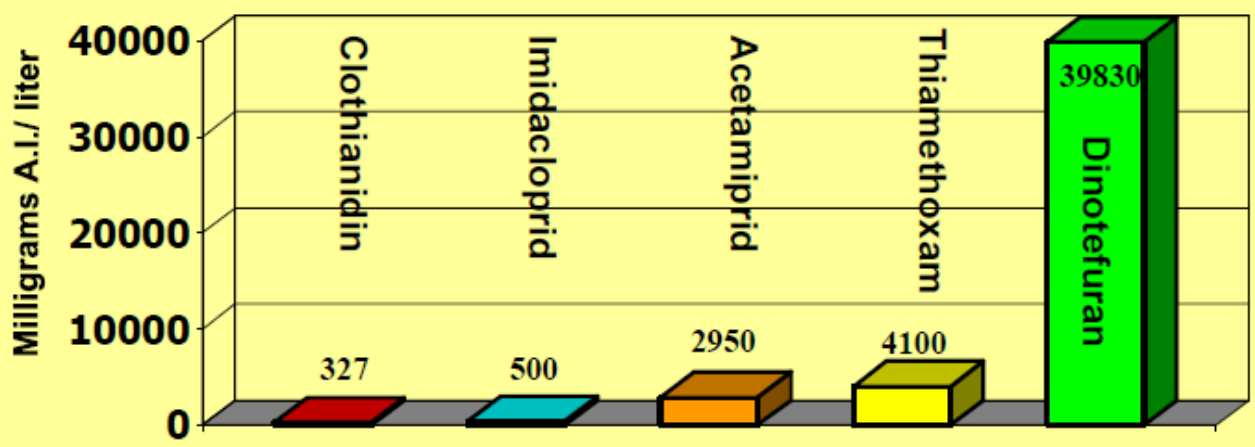
Comparison of UV Stability



Data obtained from published EPA registration documents

Slide Credit: R. Fletcher

Relative Water Solubility of Neonicotinoids:



Information sources
Clothianidin (Celero), Acetamiprid (Tristar), Dinotefuran (Safari) – EPA Pesticide Fact Sheet
Imidacloprid (Marathon), hianethoxam (Flagship) – MSDS for Products

Slide information courtesy J. Chamberlin

Solubility of permethrin (Pounce)is 0.4 ppm; solubility of chlorpyrifos (Lorsban) is 1 ppm … in comparison with most other insecticides, the neonicotinoids are more soluble in water than most.

Table 1. Neonicotinoid pesticide mammalian toxicities (mg/kg of body weight).

Common name	**Rat oral LD_{50}**	**Rabbit dermal LD_{50}**
Acetamiprid	450	>2,000 (Tristar®)
Clothianidin	>5,000	>2,000 (Acceleron®)
Imidacloprid	4,870 (Gaucho®)	>2,000 (Admire®)
Thiamethoxam	>5,000	>2,000

Table 2. Neonicotinoid pesticide wildlife toxicity ranges.

Common name	**Bird acute oral LD_{50} (mg/kg)***	**Fish LC_{50} (ppm)****	**Bee LD_{50} †**
Acetamiprid	PNT	PNT	MT
Clothianidin	PNT	PNT	HT
Imidacloprid	MT	MT	HT
Thiamethoxam	ST	PNT	HT

Table 5.1 Toxicity of Neonicotinoids

Neonicotinoid	Known Toxicity to Honey Bees[1]		
		Contact LD_{50}	Oral LD_{50}
Acetamiprid	M	7.1 µg/bee[2]–8.09 µg/bee[3]	8.85–14.52 µg/bee[3]
Clothianidin	H	0.022 µg/bee[2]–0.044 µg/bee[4]	0.00379 µg/bee[5]
Dinotefuran	H	0.024 µg/bee[2]–0.061 µg/bee[6]	0.0076–0.023 µg/bee[6]
Imidacloprid	H	0.0179 µg/bee[4]–0.243 µg /bee[7]	0.0037 µg/bee[7]–0.081 µg/bee[8]
Thiacloprid	M	14.6 µg/bee[2]–38.83 µg/bee[9]	8.51–17.3 µg/bee[9]
Thiamethoxam	H	0.024 µg/bee[10]–0.029 µg/bee[2]	0.005 µg/bee[10]

H = highly toxic; M = moderately toxic

Toxicity: Highly toxic: LD_{50} < 2 µg/bee; Moderately toxic: LD_{50} 2–10.99 µg/bee; Slightly toxic: LD_{50} 11–100 µg/bee; Practically non-toxic: LD_{50} >100 µg/bee.

Sources: 1. WSDA 2010; 2. Iwasa et al. 2004; 3. EC 2004b; 4. EPA 2003a; 5: EC 2005; 6. EPA 2004; 7. Schmuck et al. 2001; 8. Nauen et al. 2001 ; 9. EC 2004a; 10. Syngenta Group 2005.

Imidacloprid	Application as seed dressing, soil drench, granules, injection, or spray to a wide range of field and tree crops, as well as ornamental plants, trees, and turf. (Also, topical use on pets for flea control and application to buildings for termite control.)	Admire Gaucho Imicide Provado Macho Malice Sepresto Widow Wrangler	Bayer Advanced 3-in-1 Insect, Disease, & Mite Control Bayer Advanced 12 Month Tree & Shrub Insect Control Bayer Advanced 12 Month Tree & Shrub Protect & Feed Bayer Advanced Fruit, Citrus & Vegetable Insect Control Bayer Advanced All-in-One Rose & Flower Care concentrate DIY Tree Care Products Multi-Insect Killer Ferti-lome 2-N-1 Systemic Hi-Yield Systemic Insect Spray Hunter Knockout Ready-To-Use Grub Killer Lesco Bandit Marathon Merit Monterey Once a Year Insect Control II Ortho Bug B Gon Year-Long Tree & Shrub Insect Control Orhto MAX Tree & Shrub Insect Control Surrender Brand GrubZ Out
Thiacloprid	Application as foliar spray to cotton and pome fruit crops.	Calypso	
Thiamethoxam	Application as seed dressing, soil drench, injection, granules, or foliar spray to a wide range of field crops, as well as ornamental plants and turf.	Actara Adage Crusier Centric Platinum	Flagship Maxide Dual Action Insect Killer Meridian

So …

- Expect increasing regulatory action of some kind in the next few years (maybe).
- Until then … we should not use neonicotinoids that are especially toxic to bees if applications (even seed treatments) will result in bee kill. Particularly toxic neonics include …
  - Imidacloprid (Admire Pro, many homeowner products)
  - Thiamethoxam (Actara, Platinum)
  - Clothianidin (Poncho seed treatments)
  - Dinotefuran (Scorpion, Venom)
- Use of these products (imidacloprid and thiamethoxam) as seed treatments on cucurbits presents little or no systemic risk, but later uses do result in more significant contamination of pollen and nectar.
- Seed treatments on seedcorn … the large scale of use presents real risks, with little evidence of real need to reduce losses to insects

Habitat management

- NRCS EQIP for pollinator habitat
  - http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/plantsanimals/pollinate/
- Attracting Pollinators …
  - http://www.fs.fed.us/wildflowers/pollinators/documents/AttractingPollinatorsV5.pdf
  - High Value Pollinator Plants http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs141p2_029849.pdf

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http://www.xerces.org/wp-content/uploads/2013/01/InstallGuideJobSheet_UpperMidwest_CnsrvCvr.pdf

The Xerces Society
for Invertebrate Conservation

NRCS
Natural Resources Conservation Service
Plant Materials Program
USDA United States Department of Agriculture

Center for Integrated Agricultural Systems (CIAS)

The University of Wisconsin Madison

Conservation Cover (327) for Pollinators

Upper Midwest

Installation Guide and Job Sheet

October 2012

University of Illinois Extension

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http://www.xerces.org/wp-content/uploads/2013/04/using-farmbill-programs-for-pollinator-conservation-2ndEd.pdf

USDA United States Department of Agriculture

May 2015

Biology Technical Note No. 78, 2nd Ed.

Using 2014 Farm Bill Programs for Pollinator Conservation

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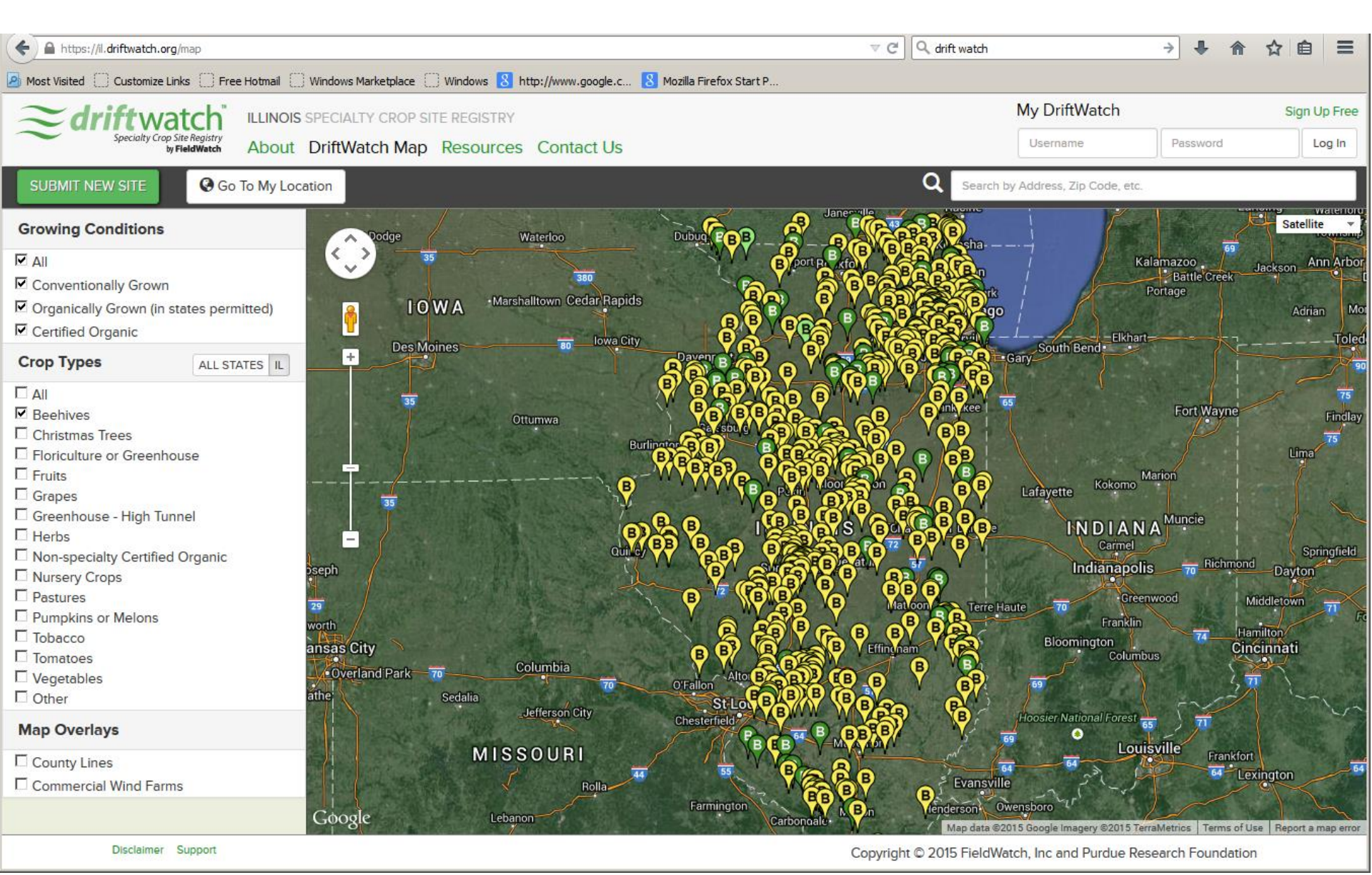
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ILLINOIS SPECIALTY CROP SITE REGISTRY
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Contact Us
My DriftWatch
Sign Up Free
Username
Password
Log In
SUBMIT NEW SITE
Go To My Location
Search by Address, Zip Code, etc.
Growing Conditions
All
Conventionally Grown
Organically Grown (in states permitted)
Certified Organic
Crop Types
ALL STATES
IL
All
Beehives
Christmas Trees
Floriculture or Greenhouse
Fruits
Grapes
Greenhouse - High Tunnel
Herbs
Non-specialty Certified Organic
Nursery Crops
Pastures
Pumpkins or Melons
Tobacco
Tomatoes
Vegetables
Other
Map Overlays
County Lines
Commercial Wind Farms
Satellite
IOWA
MISSOURI
INDIANA
Dodge
Waterloo
Marshalltown
Cedar Rapids
Des Moines
Iowa City
Ottumwa
Burlington
Quincy
Kalamazoo
Battle Creek
Jackson
Ann Arbor
Portage
Adrian
Elkhart
South Bend
Gary
Fort Wayne
Findlay
Lima
Marion
Kokomo
Lafayette
Muncie
Carmel
Indianapolis
Richmond
Springfield
Dayton
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Terre Haute
Franklin
Bloomington
Columbus
Hamilton
Cincinnati
Effingham
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Louisville
Frankfort
Lexington
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