

UNIVERSITY OF ILLINOIS EXTENSION

Illinois Migrant Council

PREPARING A NEW GENERATION OF ILLINOIS FRUIT AND VEGETABLE FARMERS

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http://www.newillinoisfarmers.org





PREPARING A NEW GENERATION OF ILLINOIS FRUIT AND VEGETABLE FARMERS

POLLINATION, POLLINATORS, AND CHALLENGES

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Illinois Migrant Council

Definitions, courtesy of Wikipedia

(with a few edits)

- <u>Pollination</u>: 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









- 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

E ILLINOIS fruit & vegetable FARMERS

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http://www.pollinator.org/NativeBee

Bumble bees ... wild and managed pollinators.







Orchard Bees.com

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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

Leafcutter bees









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









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	
Cucumber	2-3	
Pumpkin	1	Conserve squash bees
Squash	1	
Watermelon	1-5	

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



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

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



E-53-W



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: <u>http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0029</u> 268.
- 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. <u>http://www.xerces.org/wp-content/uploads/2012/03/Are-Neonicotinoids-Killing-Bees Xerces-Society1.pdf</u>



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 days1
Clothianidin	148–1,155 days²
Dinotefuran	138 days³
Imidacloprid	40–997 days ⁴
Thiacloprid	1–27 days⁵
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



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Comparison of UV Stability



Data obtained from published EPA registration documents

Slide Credit: R. Fletcher



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 ${\rm LD}_{50}^{\dagger}$
Acetamiprid	PNT	PNT	MT
Clothianidin	PNT	PNT	HT
Imidacloprid	MT	МТ	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	м	7.1 μg/bee ² -8.09 μg/bee ³	8.85–14.52 μg/bee³
Clothianidin	н	0.022 μg/bee ² 0.044 μg/bee ⁴	0.00379 µg/bee⁵
Dinotefuran	н	0.024 μg/bee ² 0.061 μg/bee ⁶	0.0076–0.023 µg/ bee⁵
Imidacloprid	н	0.0179 μg/bee ⁴ 0.243 μg /bee ⁷	0.0037 μg/bee ⁷ – 0.081 μg/bee ⁸
Thiacloprid	м	14.6 μg/bee²–38.83 μg/bee ⁹	8.51–17.3 μg/bee ⁹
Thiamethoxam	н	0.024 μg/bee ¹⁰ - 0.029 μg/bee ²	0.005 μg/bee ¹⁰

H = highly toxic; M = moderately toxic

Toxicity: Highly toxic: $LD_{30} \le 2 \mu g/bee$; Moderately toxic: $LD_{30} \ge -10.99 \mu g/bee$; Slightly toxic: $LD_{50} = 11-100 \mu g/bee$; Practically non-toxic: $LD_{50} \ge 100 \mu g/bee$.

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.



L				
	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	
1	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
 - <u>http://www.nrcs.usda.gov/wps/portal/nrcs/</u> <u>main/national/plantsanimals/pollinate/</u>
- Attracting Pollinators ...
 - <u>http://www.fs.fed.us/wildflowers/pollinators/</u> <u>documents/AttractingPollinatorsV5.pdf</u>
 - High Value Pollinator Plants
 - http://www.nrcs.usda.gov/Internet/FSE_DO CUMENTS/nrcs141p2_029849.pdf



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

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THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION





Upper Midwest Installation Guide and Job Sheet

Conservation Cover (327) for Pollinators





October 2012

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



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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Illinois Migrant Council

If you have questions ...

- University of Illinois Extension Local Food Systems and Small Farms team
 - <u>http://web.extension.illinois.edu/smallfarm</u>
- USDA's Start2Farm site

- http://www.start2farm.gov/



