

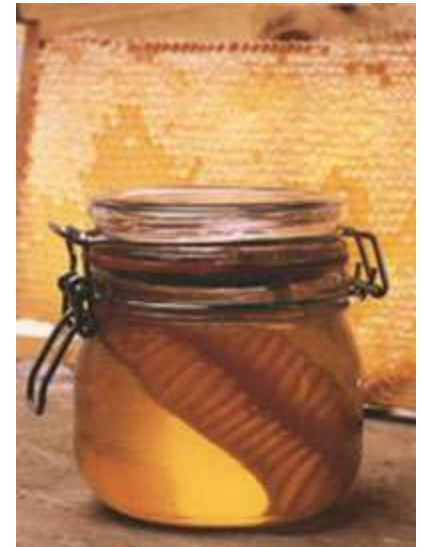
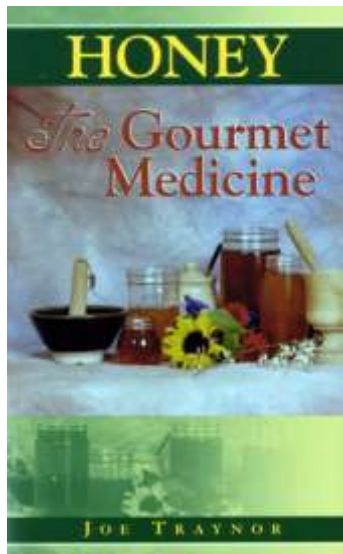
“Neonics and You: Effects of Neonicotinyl Pesticides on Honey Bees, Bumblebees, and You”



www.beelab.umn.edu

Judy Wu-Smart (PhD candidate)
Dept. of Entomology
University of Minnesota

The Importance of Bees



Honey bee products



Honey



Beeswax



Venom pain relief



Renewing cream



Gastroduodenal ulcer treatment



Propolis cough elixir



Royal jelly soap



Nectar supplement



Arthritis remedy

Nutritional requirements of all bees

- Pollen - protein
- Nectar – carbohydrates
- Water



Pollination Happens

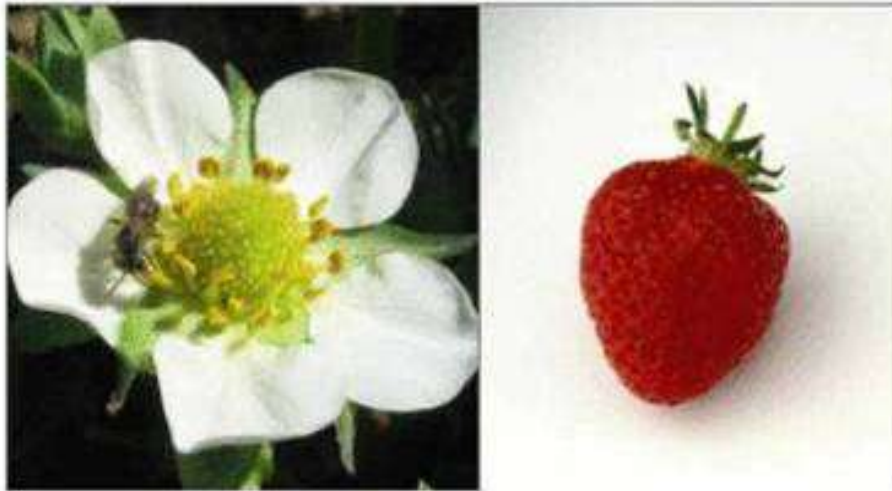
Pollination

increases yield, uniformity, size and sweetness of fruits and vegetables

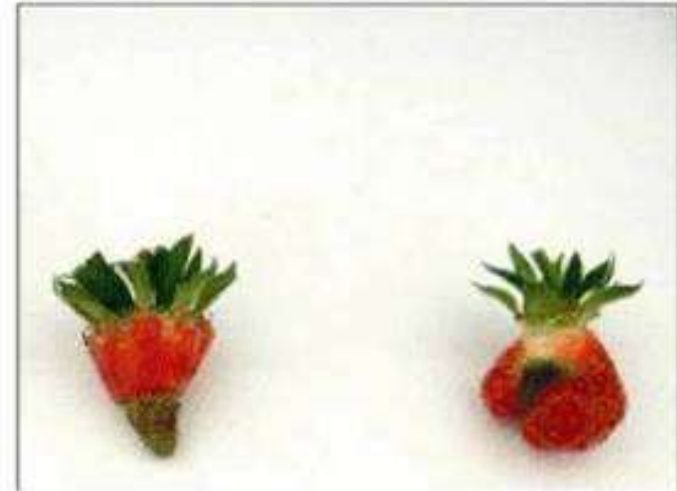


Cross-pollination by insects

Self & Wind pollination



VS.



CAPTION: Effects of cross-pollination by insects on the development of strawberry.

CREDIT: Mining bee (*Andrena subopaca*) visiting strawberry flower by Catrin Westphal; Strawberry photos by Kristin M. Krewenka based on pollination experiment in Germany.

Importance of honey bees

\$19 billion in US crop value

1/3 of our diet

“Moves taking days and over thousands of kilometres would be expected to be stressful on the bees, as well as on the beekeepers.”

- DR. PETER KEVAN, UNIVERSITY OF GUELPH

JUNK FOOD: Some honeybees suffer from diets that include artificial supplements, “concoctions akin to energy drinks and power bars” (Barrionuevo, 2008).

A NATURAL TASK ON AN UNNATURAL SCALE: As the demand for greater crop yields continues to increase far beyond what nature ever conceived, so too does our dependence on migratory beekeeping to keep food on our plates (Traister, 2008).

Confinement, temperature fluctuation, and mechanical vibration can be especially stressful to honeybees.

180,000 hives
300,000 hives
300,000 hives
70,000 hives
60,000 hives

CORN SYRUP
100% SOY PROTEIN

FORAGE AND LEGUME:

Alfalfa, Buckwheat Clover (numerous varieties) ,Sweet clover (numerous varieties), Lespedeza (bush), Trefoil, Vetches

FRUIT CROPS:

Apple, Apricot, Avocado, Berry (blackberry, blueberry, cranberry, gooseberry, huckleberry, raspberry, strawberry), Carambolo, Cherry, Citron, Citrus (grapefruit, lemon, mandarin, nectarine, pummelo, tangelo, tangerine), Currants, Dewberry, Jujube, Kiwi, Litchi, Mango, Muskmelons (cantaloupe, casaba, crenshaw, honeyball, honeydew, persian melon), Passion Fruit, Peach, Pears, Persimmon, Plum, Prune, Watermelon

NUT CROPS:

Almond, Coconut, Cacao, Coffee, Cashew, Kola nut, Chestnut, Macademia



VEGETABLE CROPS:

Artichoke, Chinese cabbage, Pimenta, Asparagus, Dill, Pumpkin, Broccoli, Eggplant, Radish, Brussel sprouts, Garlic, Rutabaga , Cabbage, Kale , Sapote, Carrots, Kolhrabi, Squash, Cauliflower, Leek, Turnip, Celeriac, Mustard, Celery, Onion, Chayote, Parsley, Chicory, Pepper, Lima beans, Collards, Cucumber

OILSEED CROPS:

Cotton, Rape, Safflower, Soybeans, Sunflower, Tung

HERBS/SPICES:

Anise, Allspice, Chives, Cinnamon, Coriander, Fennel, Lavender, Mint, Mustard, Nutmeg, Oregano

OTHER:

Berseem, Cicer milkvetch, Cut flower seeds, Longan, Lotus, Niger, Quinine, Sainfoin



Your breakfast without bees

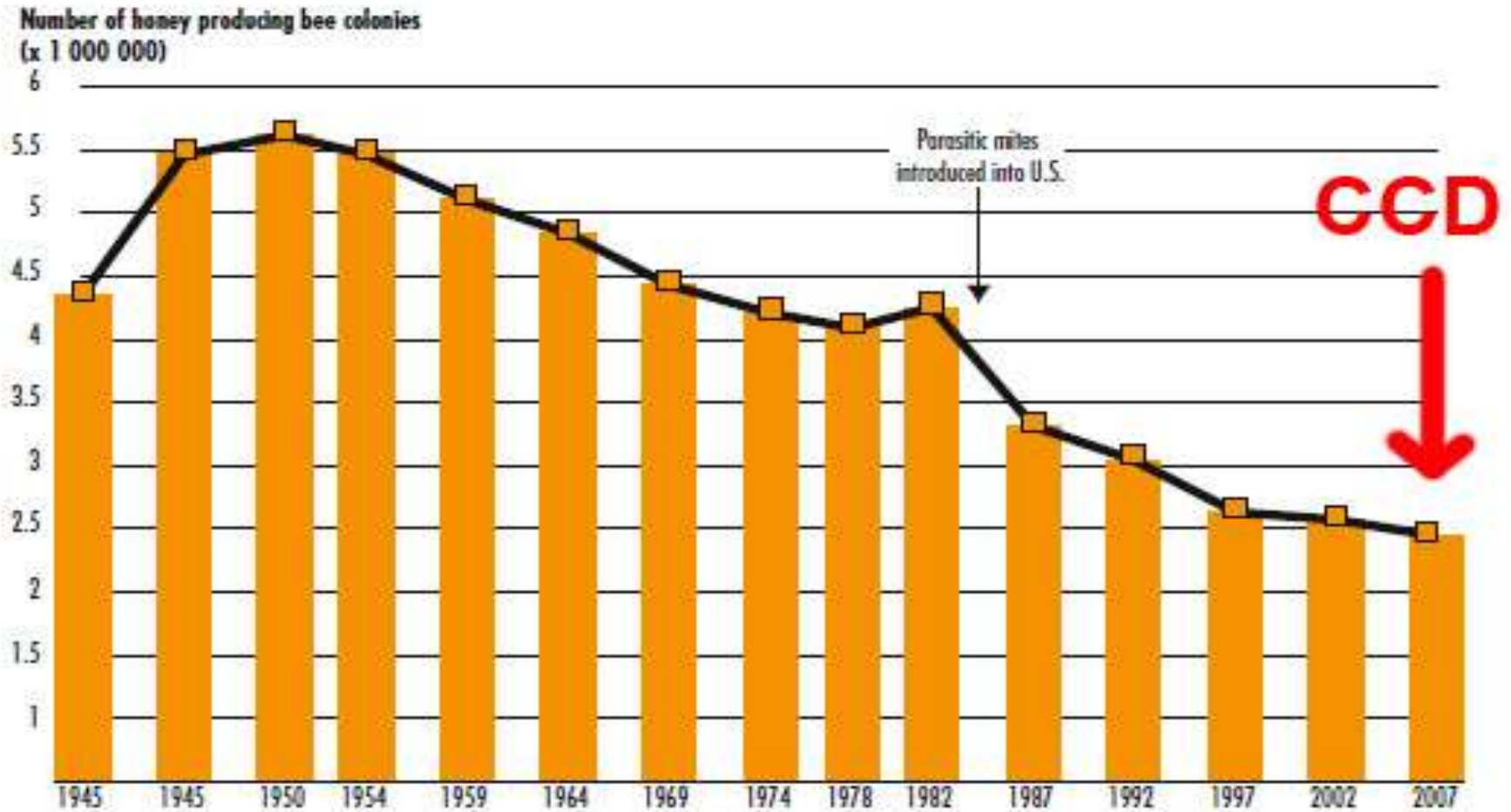


Scientific American April 2009

Value of crops in US that depend on pollination:
>18.9 billion
(**\$217 billion worldwide**)

Decline in U.S. honey bee colonies 1945-2007

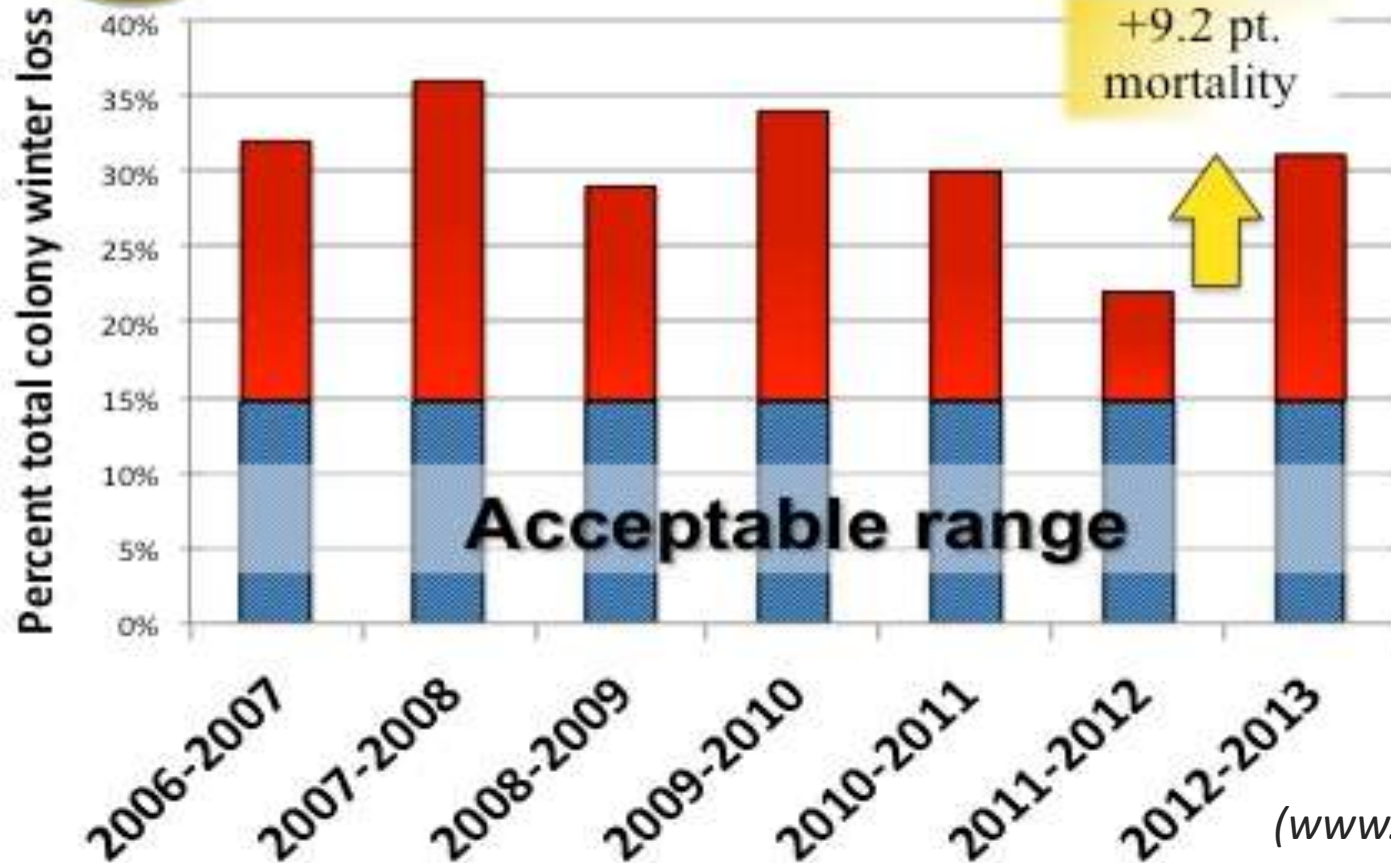
Figure 4: US honey-producing colonies



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.



Managed honey bee colony losses in the US



Since 2006, 30% of all honey bee colonies die annually

Beekeepers struggle to replace about 80% of their loss

Colony collapse disorder (CCD):

- Symptoms: rapid depopulation & absence of older workers



- 61 contributing factors to CCD: poor nutrition, migratory stress, *Varroa* mites, *Nosema spp.*, pesticides, tracheal mites, viruses, bacterial, wax moths, hive beetles,.....

(vanEngelsdorp et al. 2009, 2010)

Large Colony



Small Colony



Commercial beekeeping operations may have tens of thousands of hives. Here, hives wait in a "holding yard" for transport to the almond orchards for pollination. Photograph: USDA-ARS, Bart Smith.

Wild Bee Pollinators Also in Decline



Over 4,000 species in the US

“Visitation by wild insects and honey bees promoted fruit set independently, so pollination by managed honey bees supplemented, rather than substituted for, pollination by wild insects.”

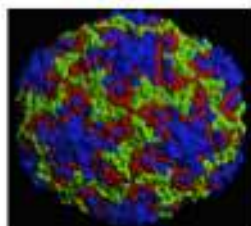
Science 2013 – *Wild Pollinators Enhance Fruit Set of Crops Regardless of Honey Bee Abundance*

Why are colonies dying? A puzzle of interactions

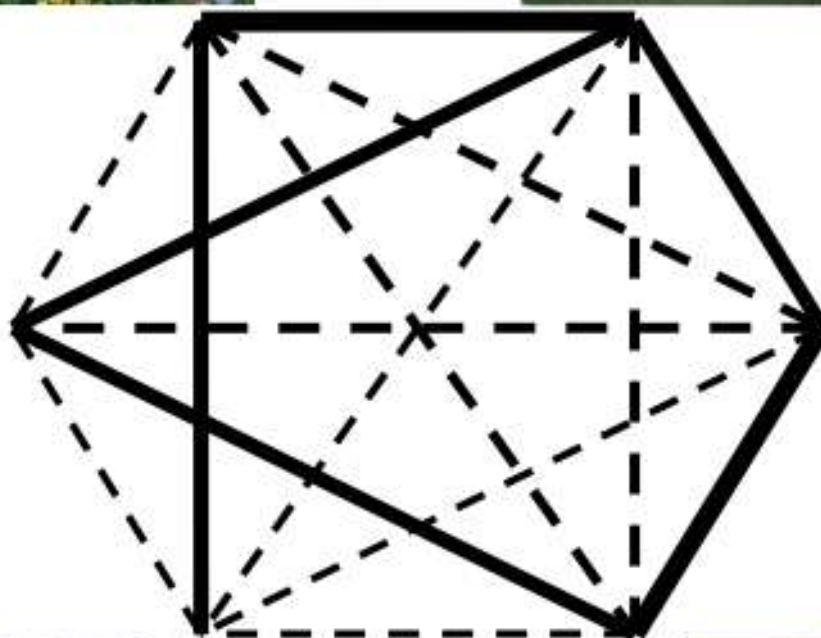
Lack of flowers -
poor nutrition



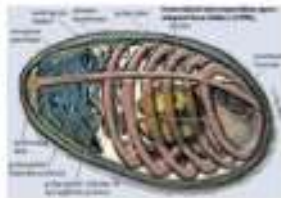
Environmental
Pesticides



Viruses



In-Hive
Pesticides



Gut pathogen: *Nosema*



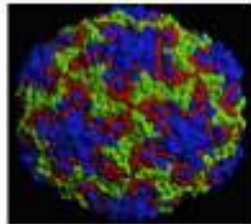
Mite parasites

Why are colonies dying? A puzzle of interactions

Lack of flowers -
poor nutrition



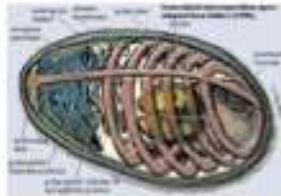
Environmental
Pesticides



Viruses



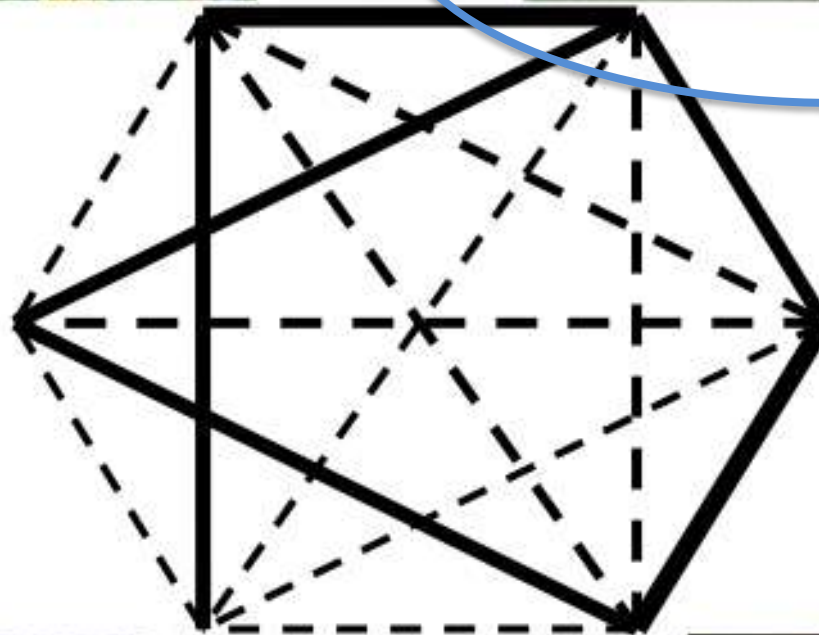
In-Hive
Pesticides



Gut pathogen: *Nosema*



Mite parasites



“Pesticides”



What's
on my
food?

- Definition: any substance used to kill an undesired pest
 - Insecticide
 - Herbicide
 - Fungicide
 - Rodenticide
 - Bactericide
 - Larvicide/ovicide
- Agricultural: protection of large scale food crops
- Urban & landscape: domestic purposes
- Applied various ways: spray, chemigation, granular, injection, dusting
- Bee exposure: oral (nectar, pollen, water), dermal, or respiratory
- Bee kills occur from direct contact or from residues

Every pollen load a honey bee brings home
6-30 detectable **pesticides**



Types of insecticides

- Pyrethroids
- Organophosphates
- Carbamates
- Neonicotinoids
- Insect Growth Regulators
- Organochlorines
- Chlorinated Cyclodienes

Bee packs pollen grains on hind legs to carry to colony

Honey bees store pollen in wax combs



Michael Traynor

Variety of pollens with different protein contents

Pesticide exposure to bees

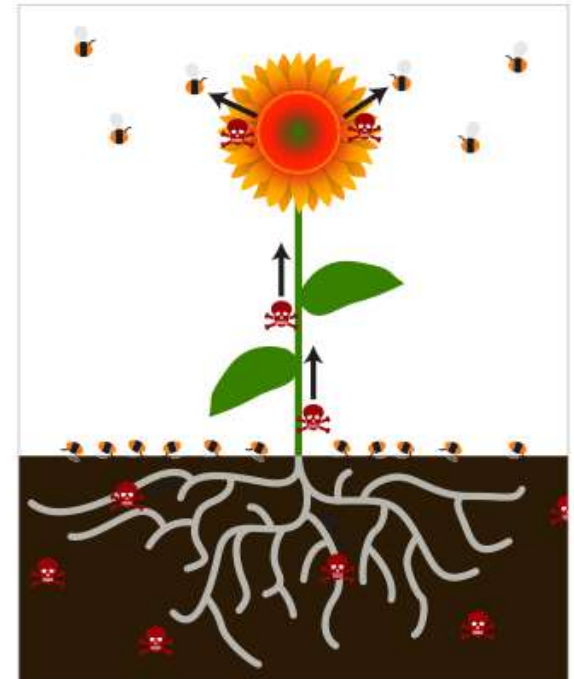
Mullin et al. 2010 study

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

121 different pesticides and metabolites within 887 wax, pollen, bee and associated hive samples.

over 47% had both **in-hive miticides** fluvalinate and coumaphos, and chlorothalonil, a widely-used **fungicide**

60% of the 259 wax and 350 pollen samples contained at least one **systemic pesticide** (fungicide, herbicide, insecticide)



Interactions

Multiple chemicals may interact with one another and cause different effects.

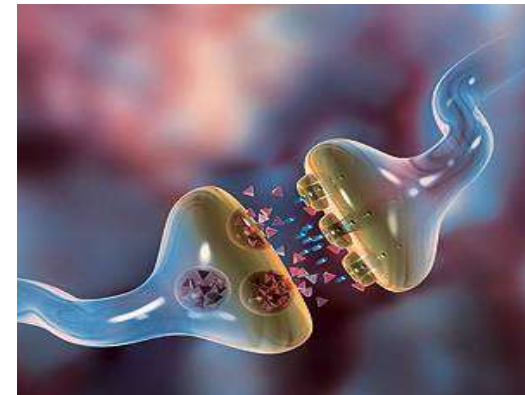
- Additive ($1+1=2$)
- **Synergy ($1+1>2$)**
- Inhibitory ($1+1<2$)



Pesticides can also interact with other pathogens (ex. Neonicotinoids increase susceptibility to *Nosema* infection)

Difficult to study effects of every possible interaction between pesticides found in the environment

Neonicotinoids



Mode of action:

- Insecticide targets various piercing/sucking pests
- attacks central nervous system
- constant transmission of nerve signals
- system is exhausted = paralysis then death

-systemic action: translocates to all parts of plant (nectar/pollen)

Active ingredient:

Trade Name(s)

Imidacloprid

Merit, Marathon, Provado

Clothianidin

Poncho, Arena, Celero

Thiamethoxam

Centric, Cruiser, Flagship

Dinotefuran

Safari, Starkle, Abarin

Thiacloprid

Calypso, Bariard, Destroyer....

Neonicotinoid systemic insecticide use



Agricultural uses



Urban landscape uses



Approved for 140+ crops & numerous garden and horticultural products

Not all neonicotinoids are equal



Known toxicity to honey bees

Neonicotinoid		Contact LD50	Oral LD50
Acetamiprid	M	7000 ng/bee (70000 ppb)	9000 ng/bee (90000 ppb)
Clothianidin	H	20 ng/bee (200 ppb)	4 ng/bee (40 ppb)
Dinotefuran	H	24 ng/bee (240 ppb)	8 ng/bee (80 ppb)
Imidacloprid	H	18 ng/bee (180 ppb)	4 ng/bee (40 ppb)
Thiacloprid	M	14600 ng/bee (146000 ppb)	8500 ng/bee (85000 ppb)
Thiamethoxam	H	24 ng/bee (240 ppb)	5 ng/bee (50 ppb)

***LD50: lethal dose kills 50% of test population**

Agricultural bee kills

Crop planting dust = acute exposure Clothianidin



Urban landscape bee kills

- Oregon (50,000 bumble bees killed by Safari (Dinotefuran))



“The bumblebees were literally falling out of the trees. To our knowledge this is one of the largest documented bumblebee deaths in the Western U.S. It was heartbreaking to watch.”
—Rich Hatfield, Conservation Biologist, Xerces Society, Portland

**Oregon Bumblebee Deaths Up to 50,000
after Neonicotinoid Safari Sprayed On Trees**

FoodDemocracyNow.org

#StopMonsanto #LabelGMOs

[Wilsonville trees netted after 50,000 bees die | KOIN.com](#)

Imidacloprid sub-lethal effects

IMD exposure	Sub-lethal effect on honey bee workers	References
6 ppb	disruption of feeding	Colin et al. 2004
24 ppb	disrupts learning & olfactory conditioning	Decourtye et al. 2004
10-100 ppb	decrease/abnormal foraging	Kirchener 1999; Yang et al 2008

What about effects on the queen?



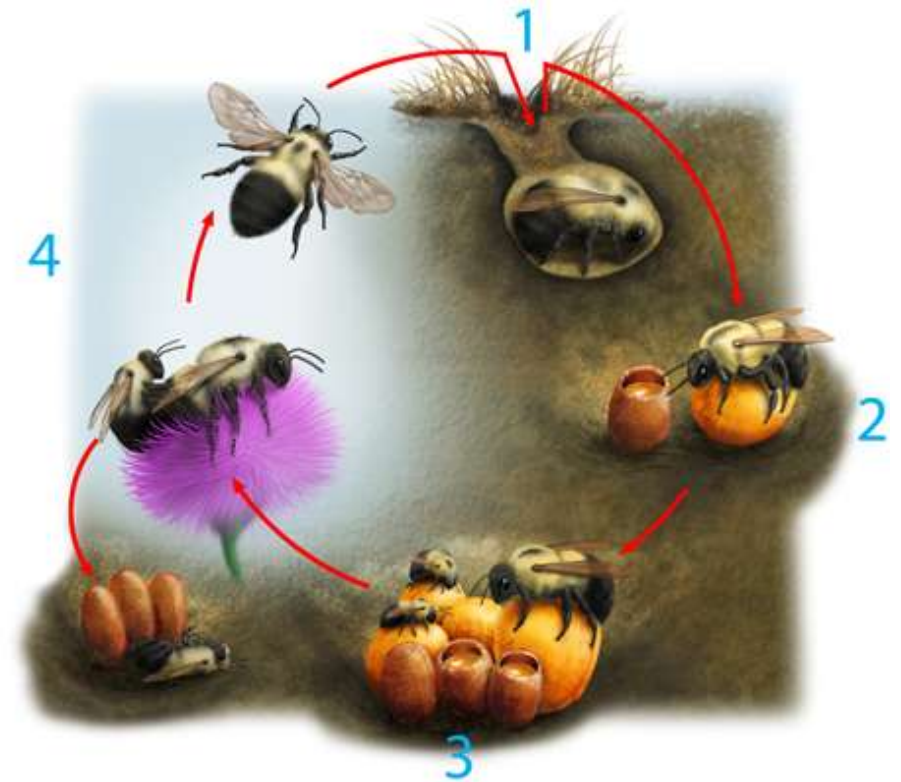
Queen and Worker Bees on Comb



Effects on bumble bees

Whitehorn et al 2012 Science

Neonicotinoid pesticide reduced bumble bee colony growth and queen production



Exposure: Imidacloprid residues

Application	Residue levels	Reference
Seed trt (Gaucho)	1.9 ppb sunflower (nectar)	Schmuck et al. 2001
Seed trt (Gaucho)	0.6-0.8 ppb canola (nectar)	Scott-Dupree & Spivak 2001
Soil trt	3-10 ppb purple tansy (nectar)	Wallner et al. 1999
Soil trt	15-27 ppb buckwheat (nectar)	Krischik et al. 2007
Soil trt	150-300 ppb canola (pollen)	2010 study (crop rate)
Soil trt	2000-3800 ppb canola (pollen)	2010 study (urban landscape rate)



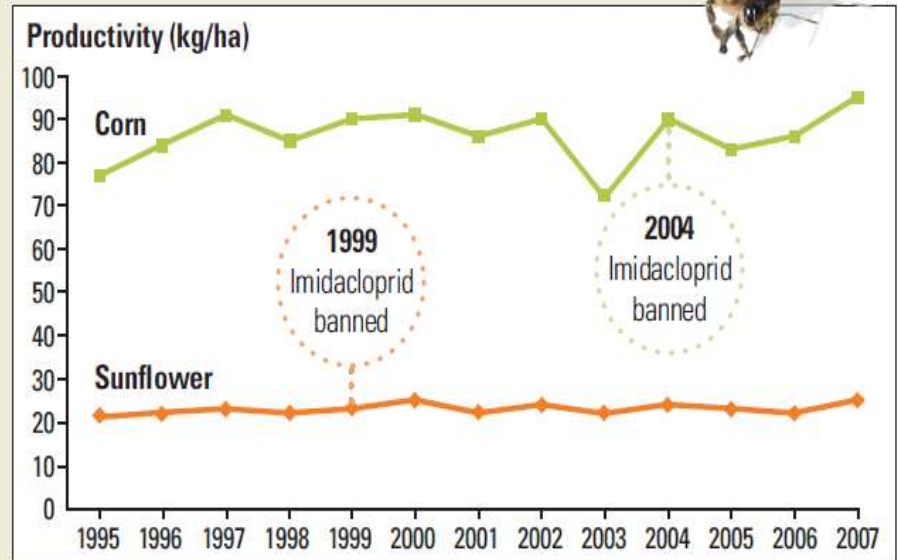
Recent Science article

How Big a Role Should Neonicotinoids Play in Food Security?

Proponents of neonicotinoid-treated seeds claim that the chemicals offer many benefits besides killing pests, including improved plant vigor and higher yields. The business itself has certainly boomed. Almost all the corn and about one-half of the soybeans in the United States are grown from insecticide-treated seeds. "The companies are marketing them aggressively," says Paul Mitchell, an agricultural economist who studies pest management at the University of Wisconsin, Madison.

But how important are neonicotinoid seed treatments for agriculture? Agronomist Palle Pedersen, technology manager for seed care at Syngenta, says that treated corn seed produces an extra 9 bushels an acre above a national average of about 160. "We've seen a dramatic yield increase," he says. But researchers studying soybeans and other major crops have found treated seeds can come up short.

A 2-year trial of treated soybeans in South Dakota, for example, found no yield benefit. Insecticide concentration in the plants was too low by the time the major pest, aphids, arrived, according to a study published last year in the *Journal of Pest Science* by Jonathan Lundgren of the U.S. Department of Agriculture in Brookings, South Dakota. He says that his findings mirror those of other trials. A worrying postscript: The neonic-



Steady. Farmers kept yields after France banned neonicotinoid-treated seeds.

icide with fungicides, which are known to help prevent losses from disease.

Another reason that some scientists debate the overall value of the seed treatments is that the pests they target—such as wireworms, Japa-

Downloaded from www.science



“Admittedly, they do not increase yield all of the time, but the larger body of data says that they do provide an increase in yield a high percentage of time,” -Bayer CropScience

Are neonics really helping?

- Some studies suggest no yield benefit (more needed)
- Increase yields in crops due to neonics *plus* fungicides which are known to prevent losses from disease. Can't tease out if it's an effect on fungicide or neonic
- Target pests: wireworms, Japanese beetles, seed corn maggots are not major pests and are already controlled by GM crops

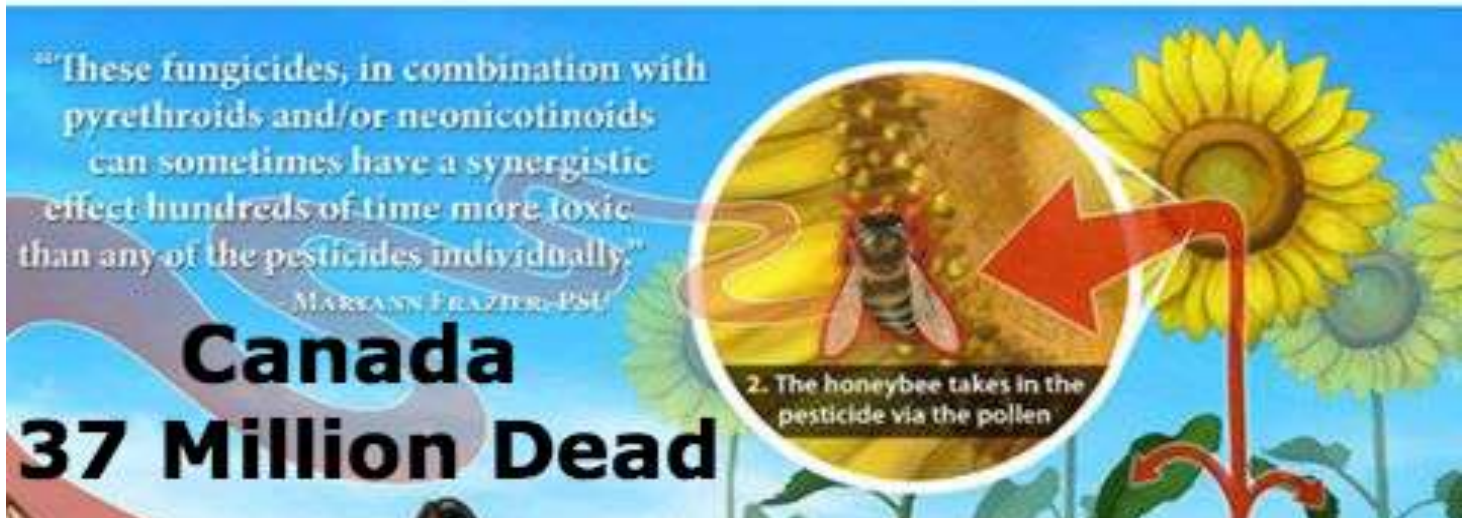


Residues in nursery plants



"54 percent of common garden plants purchased at top retailers contained neonicotinoids at levels that could harm or kill bees and other pollinators and offer no warning to the consumer."

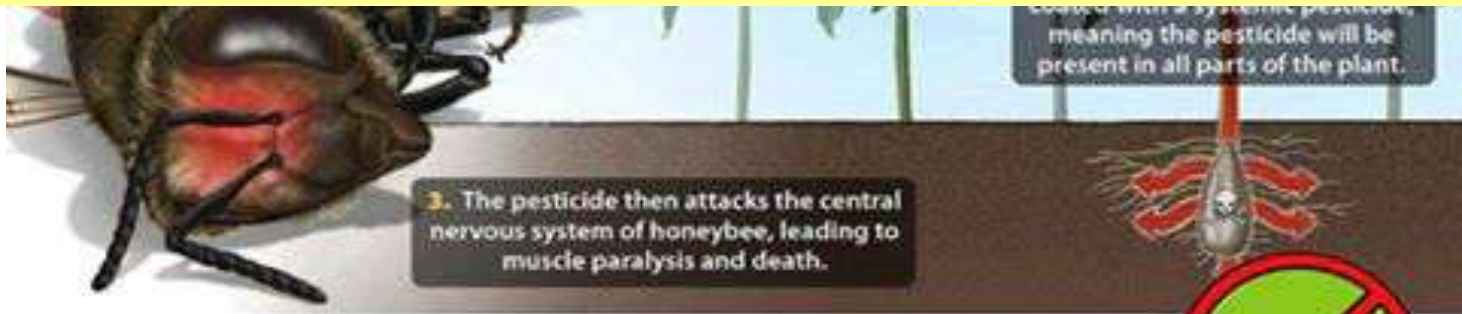
Europe got the message...



Main issues with GMO:

Herbicide tolerant crops = no flowering weeds = poor nutrition

Bt resistance = addition chemical treatments



When will the U.S.?

gmo-awareness.com



Keep in mind neonicotinoids are not the only danger.....

Recent Minneapolis example:



- Honey bee colonies killed by high levels of fipronil:
- 3 different locations
- Urban neighborhood
- Systemic insecticide
- Used for turf and lawn pests

What can you do?



Grow organic bee-friendly plants

Practice non-toxic pest control

Buy neonic-free products

Change perceptions (cosmetics)

Talk to garden centers

Spread the word