

# **Dec 9, 2013, Environment, natural resources, agriculture finance, Protecting bees by understanding systemic insecticides**



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**Protecting bees by understanding systemic insecticides**

**Visit [www.entomology.umn.edu/cues](http://www.entomology.umn.edu/cues)**

**“Pollinator conservation” section of website, online bulletins on bees and insecticides, Master Gardeners workshop, papers, videos, research**





# So why should we care about bees?

- Bees pollinate native plants that produce seeds and fruits for wildlife from bears to voles.
- 300 bee pollinated plants are commonly used as a food source (McGregor 1976).
- 35% of the food we eat is pollinated by bees (Klein et al. 2007, Vaughan and Black 2007).



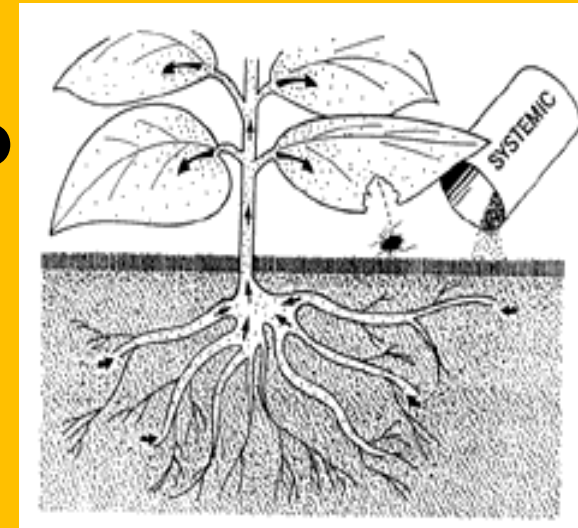
# **Controversy over neonicotinyls and bees**

- **2013 June: European Union enacts a 2 year ban on neonicotinyl insecticides starting in December 2013**
- **2013 January: European Union concludes neonicotinyl treated-seed are a bee risk**
- **2012 March: US Beekeepers petition for clothianidin to be withdrawn from sale**
- **2008-2011: Bee deaths are linked to the planting of neonicotinyl treated-seed crops**
- **2009: California calls for a review of the effects of neonicotinyl insecticides on bees**
- **2004-2009: New York restricts use of imidacloprid, thiamethoxam, dinotefuran, and clothianidin**
- **1996: France bans imidacloprid use as treated-seed on sunflowers, Germany, Spain, Italy and Slovenia, follow**

# Contact compared to systemic insecticides

## Contact insecticides:

- Many used; sprayed on foliage
- Insect must eat leaf or walk on leaf to be killed
- Toxicity lasts 1-3 weeks
- Flowers that open after spraying do not contain insecticides.



## Systemic insecticides:

- Uncommon; treated-seed, soil drench, trunk-inject
- Insect must eat leaf, pollen, or nectar to be killed
- Toxicity can last for months to years, unknown
- Flowers that open will have the insecticide in pollen and nectar for months to years, unknown

# Threats to bees: soybean aphid management

Organophosphates + Pyrethroids, are very toxic to bees.

## Organophosphates

- Dimethoate is highly toxic, LD<sub>50</sub> 15 ng/bee
- Chlorpyrifos is toxic, LD<sub>50</sub> 70 ng/bee
- Methyl parathion is highly toxic, LD<sub>50</sub> 11 ng/bee
- Coumaphos is 180 times less toxic, with LD50 of 2030 ng/ bee

## Pyrethroids

- Esfenvalerate is highly toxic, LD<sub>50</sub> 15 ng/bee
- Cyfluthrin is highly toxic, LD<sub>50</sub> 37ng/bee
- Zeta-cypermethrin is extremely toxic, LD50 2 ng/bee
- Lambda cyhalothrin is highly toxic, LD<sub>50</sub> 38 ng/bee
- Permethrin is extremely toxic, LD<sub>50</sub> 8 ng/bee

# Systemic insecticides

## Systemic

### Organophosphates

aldicarb (Temik), oxamyl (Vydate), dimethoate (Cygon)

### Neonicotinyl

imidacloprid (Marathon, Merit), clothianidin, thiamethoxam, dinotefuran

### Novel mode of action

pymetrozine (Endeavor)

## Translaminar, or local, systemic activity

Microbial- abamectin (Avid)

IGR- pyriproxyfen (Distance)

PR- chlorfenapyr (Pylon)

SP-spinosad (Conserve)

OP- acephate (Orthene)

C-Carbofuran (Furadan)

**Neonicotinyl insecticide toxicity to bees**  
**Sublethal dose: more than 20 ppb (2ng/bee)**  
**reduces foraging, memory, and navigation, LD50**  
**studies evaluate for mortality, not foraging**



zmescience.com

| <b>Lethal dose</b>  | <b>Oral LD<sub>50</sub><br/>ng/bee<br/>in 20μL</b> | <b>Pollen/<br/>nectar ppb<br/>(ng/.1gbee)</b> | <b>Reference</b>                              |
|---------------------|--|---|---|
| <b>imidacloprid</b> | <b>3.7-40</b>                                      | <b>37-400</b>                                 | <b>Schmuck et al.<br/>2001,<br/>EFSA 2013</b> |
| <b>clothianidin</b> | <b>3-22</b>  | <b>30-220</b>                                 | <b>Iwas et al. 2004,<br/>EFSA 2013</b>        |
| <b>dinotefuran</b>  | <b>23-47</b>                                       | <b>230-470</b>                                | <b>EFSA 2013</b>                              |
| <b>thaimethoxam</b> | <b>5-30</b>  | <b>50-300</b>                                 | <b>EFSA 2013</b>                              |



## Water solubility: Neonicotinyl insecticides

|  | imidacloprid      | clothianidin | dinotefuran | thiameth-oxam        | emamectin benzoate |
|--|-------------------|--------------|-------------|----------------------|--------------------|
| name                                   | Merit<br>Marathon | Arena        | Safari      | Flagship<br>Meridian | Tree<br>age        |
| KOC                                    | 132-310           | 160          | 23          | 64                   | 283,000            |
| Solubility<br>(mg/l)                   | 514               | 259          | 259         | 327                  | 101                |
| LD50<br>(acute rat<br>oral)<br>(mg/kg) | >5,000            | 4,870        | >2,000      | 5,523                | 1,516              |

dinotefuran is 80 times more water soluble than imidacloprid  
emamectin benzoate has very low mobility (KOC) and long duration

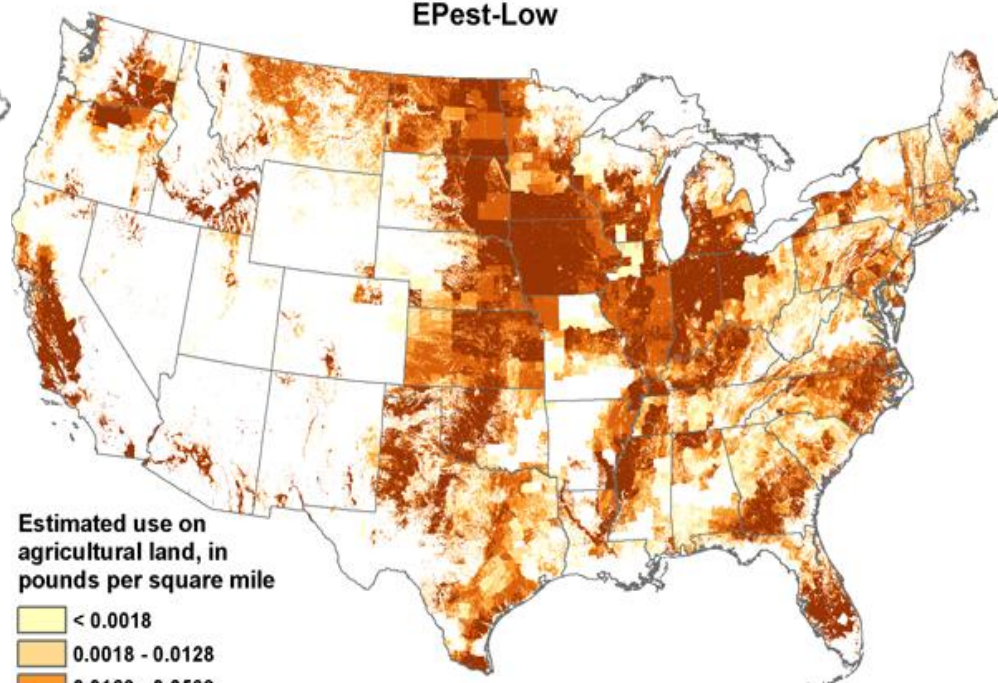
# Estimated Agricultural Use for Imidacloprid , 1994

E Pest-Low

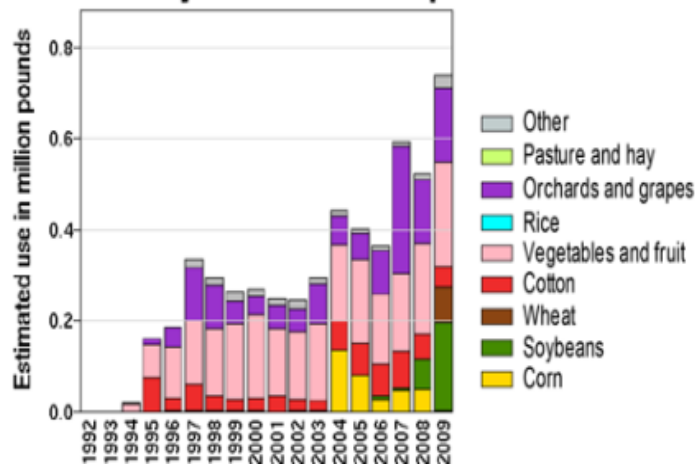


# Estimated Agricultural Use for Imidacloprid , 2009

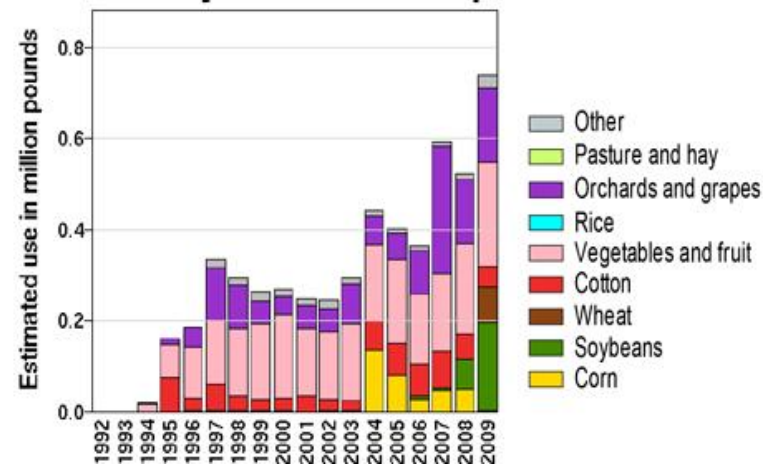
E Pest-Low



## Use by Year and Crop

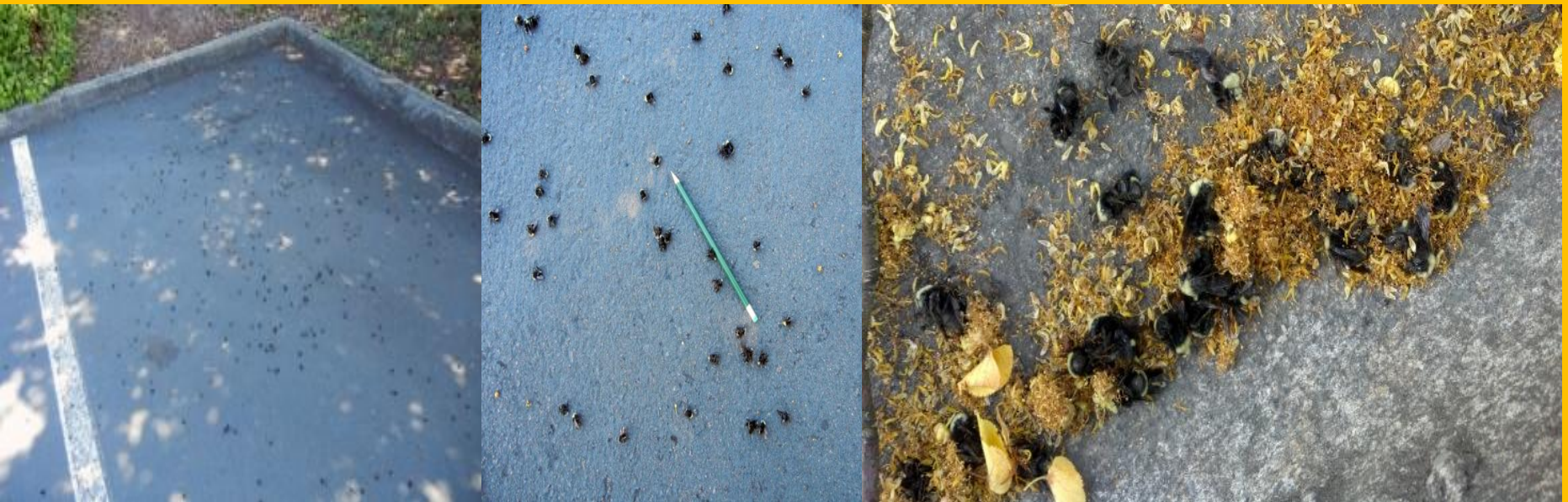


## Use by Year and Crop



# Incident, Very little published data on neonicotinyl residue in pollen and nectar of trees.

Around 25,000 bumblebees and others were found dead under trees at the Target store in Wilsonville, Oregon on Monday, June 17th. The neonicotinyl insecticide dinotefuran (label Safari) was applied pre-bloom according to label.



*Dead in the parking lot, Bombus vosnesenskii*



# Incident



**Residue data confirmed dinotefuran, but data was not released by Oregon Depart. Agriculture. Another bee kill occurred in Hillsboro, OR. Trees were covered in nets and dinotefuran use is banned for 6 months in Oregon.**



# Neonicotinyl insecticide use in 2011

**143/442 US million acres use neonicotinyl insecticides**  
**83+ million acres of corn have neonicotinyl treated-seed and**  
**honeybees use corn for pollen**

| Active ingredient (ai) in lbs |              |              |              |
|-------------------------------|--------------|--------------|--------------|
|                               | imidacloprid | clothianidin | thiamethoxam |
| MN                            | 52,048       | 43,663       | 68,876       |
| CA                            | 348,247      | 3,812        | 30,687       |
| US                            | 700,000      | 1,2000,000   | 990,000      |



| Site                       | Imidacloprid Treatment Rate                           |
|----------------------------|---|
| Seed treatment Gaucho*     | 0.11 mg AI<br>imidacloprid/1 plant<br>FRENCH RESEARCH |
| Field crops                | 4 mg/sg ft<br>little research                         |
| Greenhouse/<br>nursery pot | 300 mg AI/pot<br>Krischik research                    |
| Landscape,<br>rose         | 630 mAI/plant<br>Krischik research                    |
| 15 in DBH<br>24 in DBH     | 50 g AI<br>76 g AI<br>NOT RESEARCHED                  |

## **Residue in pollen and nectar, very few papers, 172 ppb kills a bee**

| <b>Plant</b>                                    | <b>Imidacloprid ppb</b>                 | <b>Reference</b>                                      |
|---|---|---|
| <b>Sunflower<br/>(treated-seed)</b>             | <b>2 nectar<br/>4 pollen</b>            | <b>Schmuck et al. 2001</b>                            |
| <b>Pumpkin<br/>(soil drench)</b>                | <b>4 - 12 nectar<br/>37 - 87 pollen</b> | <b>Dively &amp; Hooks 2010</b>                        |
| <b>Milkweed<br/>(soil drench)</b>               | <b>6000 ppb nectar</b>                  | <b>Krischik 2013</b>                                  |
| <b>Eucalyptus tree<br/>(soil drench)</b>        | <b>550 ppb nectar</b>                   | <b>Paine et al 2011</b>                               |
| <b>Horsechestnut tree<br/>(trunk injection)</b> | <b>5-283 blossom</b>                    | <b>Bayer, unpulished,Maus et al. 2004b</b>            |
| <b>Serviceberry<br/>(soil drench)</b>           | <b>1,038- 2,816<br/>blossom</b>         | <b>Bayer, unpublished,<br/>Doering et al. 2005a,b</b> |

**Systemic insecticides are only one factor contributing to bee decline, but we need to understand their effects on bee foraging and colony health.**

