

June 2, 2014 Dakota County MasterGardeners

Neonicotinoids or neonicotynyl insecticides and bees

www.entomology.umn.edu/cues

Visit pollinator conservation website:
Bulletins, posters, online workshop, research,



**Vera Krischik, Associate Professor, Depart
of Entomology, UMinnesota and others**

Save the bees by planting flowers and trees

- 1. Use contact insecticides on flowering plants, such as bifenthrin, cyfluthrin, neem, azadirachtin, and spinosad.**
- 2. Do not use systemic insecticides.**
- 3. Plant a seasonal phenology of native and garden plants for nectar and pollen.**
- 4. Only single-flowered plants, not double flowers, provide pollen and nectar.**
- 5. Provide overwintering habitat for bees.**
- 6. Do not kill queen bees in the spring/fall, they will not sting.**
- 7. Understand the different types of bees and wasps so you can conserve bees.**

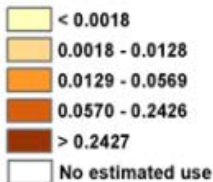
Imidacloprid use in agriculture 1994 and 2009

Estimated Agricultural Use for Imidacloprid , 1994

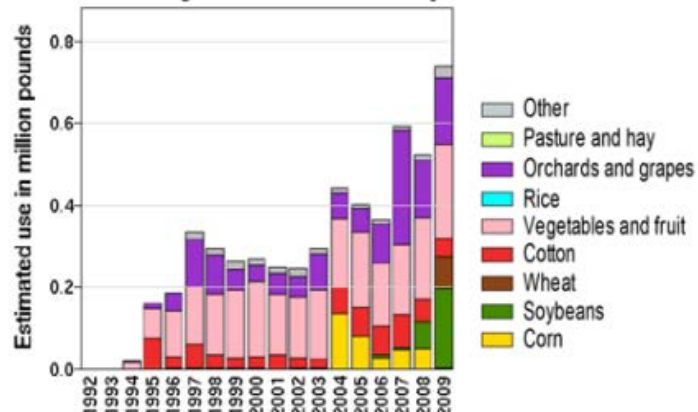
E Pest-Low



Estimated use on agricultural land, in pounds per square mile

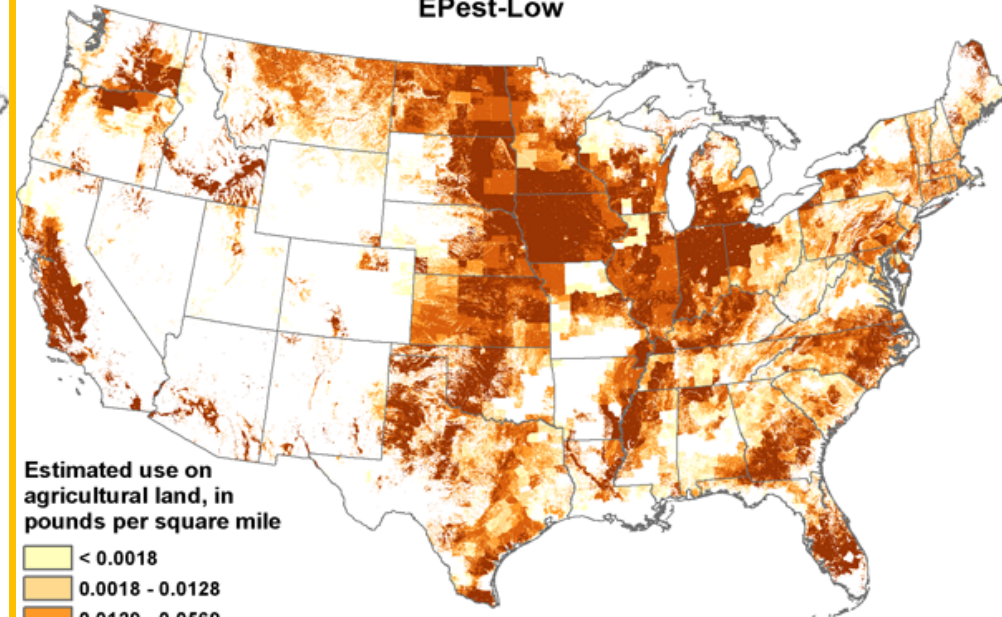


Use by Year and Crop

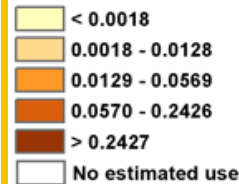


Estimated Agricultural Use for Imidacloprid , 2009

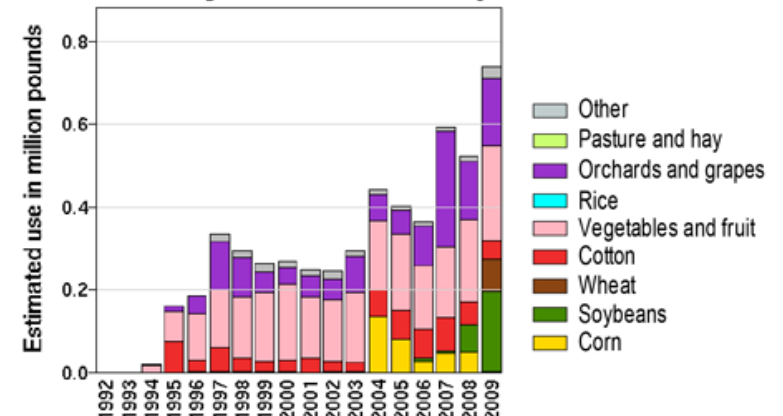
E Pest-Low



Estimated use on agricultural land, in pounds per square mile



Use by Year and Crop



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

Neonicotinyl insecticide toxicity
Sublethal dose: more than 20 ppb (2ng/bee)
reduces foraging, memory, and navigation

Aspirin 80mg = 80,000microg = 80,000,000ng

Lethal dose	Oral LD₅₀ ng/bee in 20µL	Pollen/ nectar ppb (ng/.1gbee)	Reference
imidacloprid	3.7-40	37-400	Schmuck et al. 2001, EFSA 2013
clothianidin	3-22	30-220	Iwas et al. 2004, EFSA 2013
dinotefuran	23-47	230-470	EFSA 2013
thaimethoxam	5-30	50-300	EFSA 2013

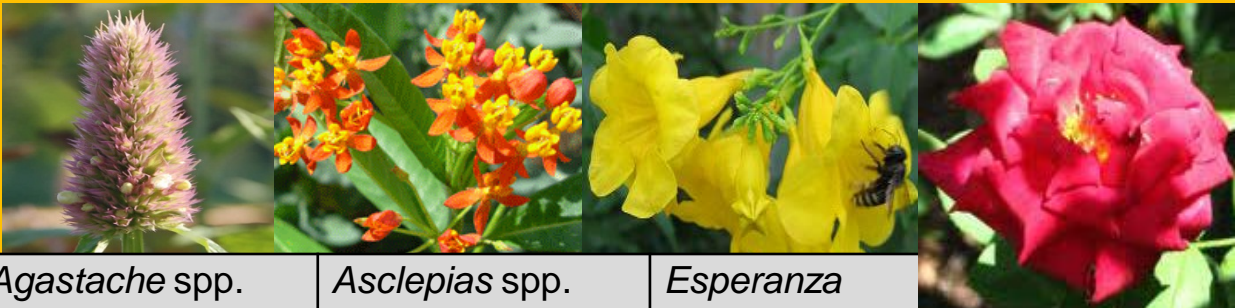


Causes change	Residue level
Common landscape flower residue	1,973 ppb
Kills honeybees in one sip	158-192 ppb
Altering honey bee behavior	6-100 ppb
Altering bumblebee behavior	10-30 ppb .
LD50 imidacloprid LD50 clothianidin	40 ng/bee=400 ppb 43 ng/bee=430 ppb

Residue in pollen and nectar, very few papers

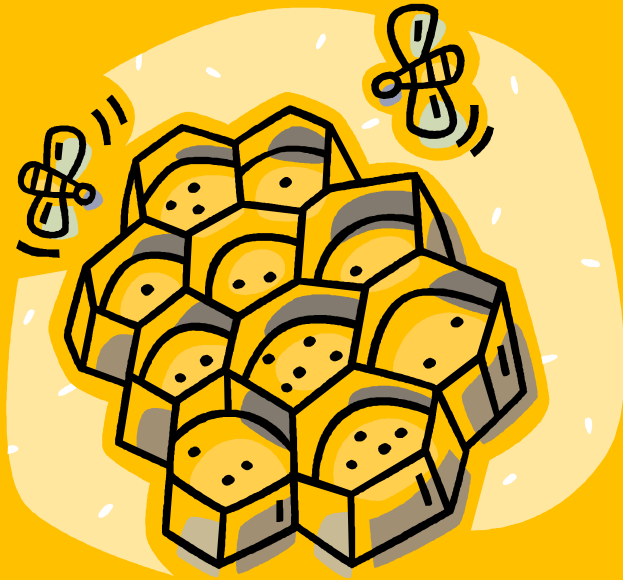
Plant	Imidacloprid ppb	Reference
Sunflower (treated-seed)	2 nectar 4 pollen	Schmuck et al. 2001
Pumpkin (soil drench)	4-12 nectar 37-87 pollen	Dively & Hooks 2010
Milkweed (soil drench)	1,973-6,000 ppb nectar	Krischik 2013
Eucalyptus tree (soil drench)	550 ppb nectar	Paine et al 2011
Horsechestnut tree (trunk injection)	5-283 ppb blossom	Bayer, unpulished,Maus et al. 2004b
Serviceberry (soil drench)	1,038- 2,816 ppb blossom	Bayer, unpublished, Doering et al. 2005a,b

Imidacloprid residue in landscape plants



Dose in mg/soil	Dead bees on <i>Agastache</i>	<i>Agastache</i> spp. nectar ppb	<i>Asclepias</i> spp. nectar ppb	<i>Esperanza</i> spp. nectar ppb	pollen ppb
0	0.6b	6b	3c	0c	26b
25	0.6b	52b	80c	8c	36b
50	0.5b	133b	175bc	21c	30b
300 1X 3 gal	1.1ab	1973b	1568bc	106c	95b
600 2X 3 gal	2.4a	5265ab	2950b	276b	332b
					566b

What are bees?



- » Most bees are solitary; honey bees, bumble bees, and some sweat bees are social.
- » Among the social bees, only honey bee colonies are perennial (survive year to year).
- » Solitary and social wasps are sometimes mistaken for bees. Social wasps have annual colonies like bumble bees.

Bumble bee colonies in the greenhouse



Bumble Bees, *Bombus* spp., Order Hymenoptera Family Apidae



Red-tailed bumble bee (*Bombus ternarius*)
Rob Routledge, Sault College, Bugwood.org



Common eastern bumble bee (*B. impatiens*)
David Cappaert, Michigan State University, Bugwood.org

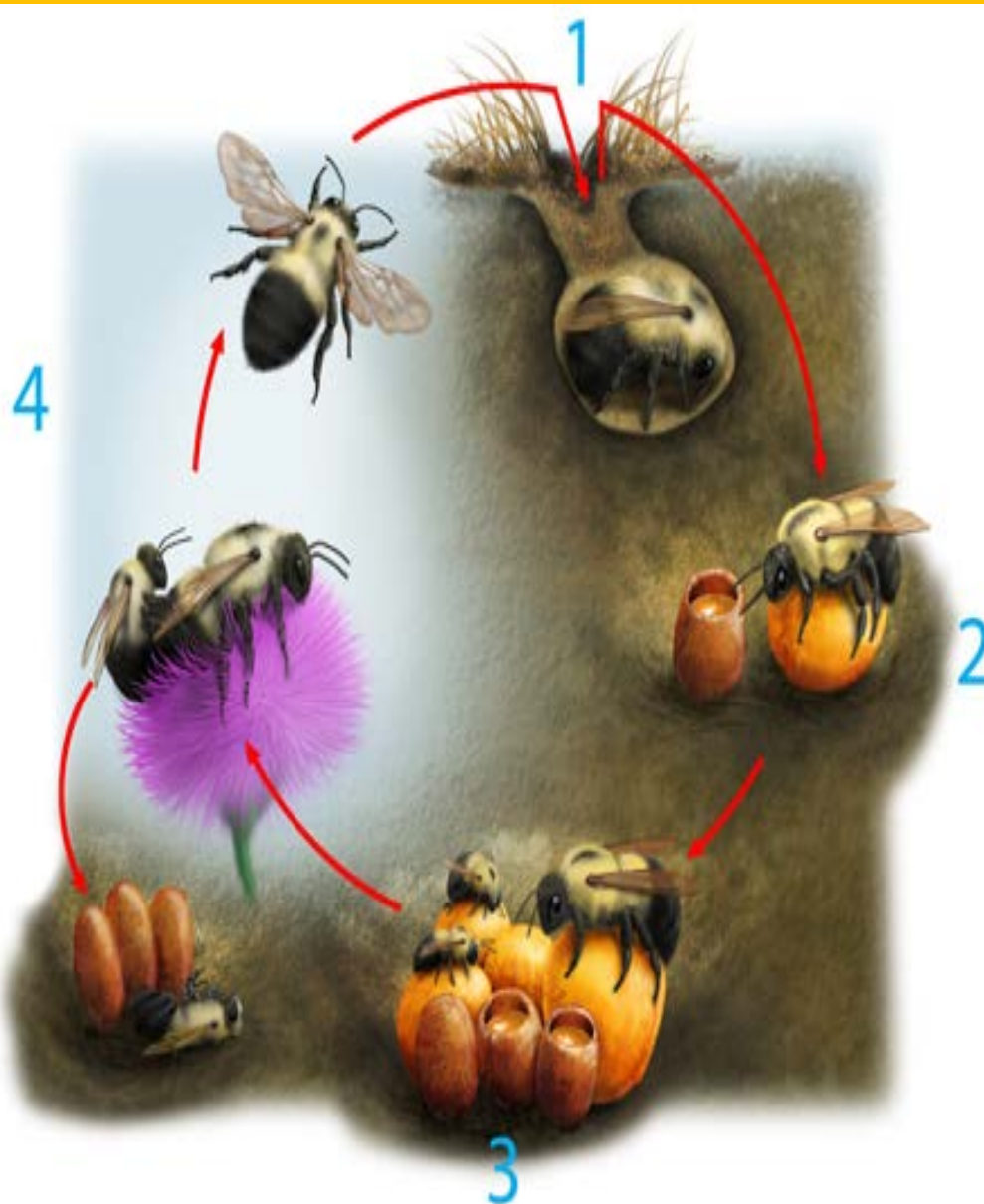
These large (10 to 23 mm), hairy bees are the only truly social bees native to the United States.

Colonies are annual.

Fecundated queens emerge in spring and begin colonies in the ground.

Queens mate with unrelated males before overwintering in the ground.

Bumble bee colony life cycle



1. A queen emerges from hibernation in spring and finds a nest site, such as an abandoned rodent burrow.

2. She creates wax pots to hold nectar and pollen, on which she lays and incubates her eggs.

3 In autumn the colony produces new queens and male bees.

4. Newly mated queens hibernate and the rest of the bees die.

Bumble Bee Colony



Inside a commercial bumble bee colony. Note capped brood cells, shiny “honey pots” full of nectar, and size difference between workers and two large queens (one is newly produced).

Honey Bee Colony



Inside a honey bee colony. Note capped brood cells containing pupae and open brood cells with larvae (unlike bumble bees, who cap cells immediately after laying eggs).



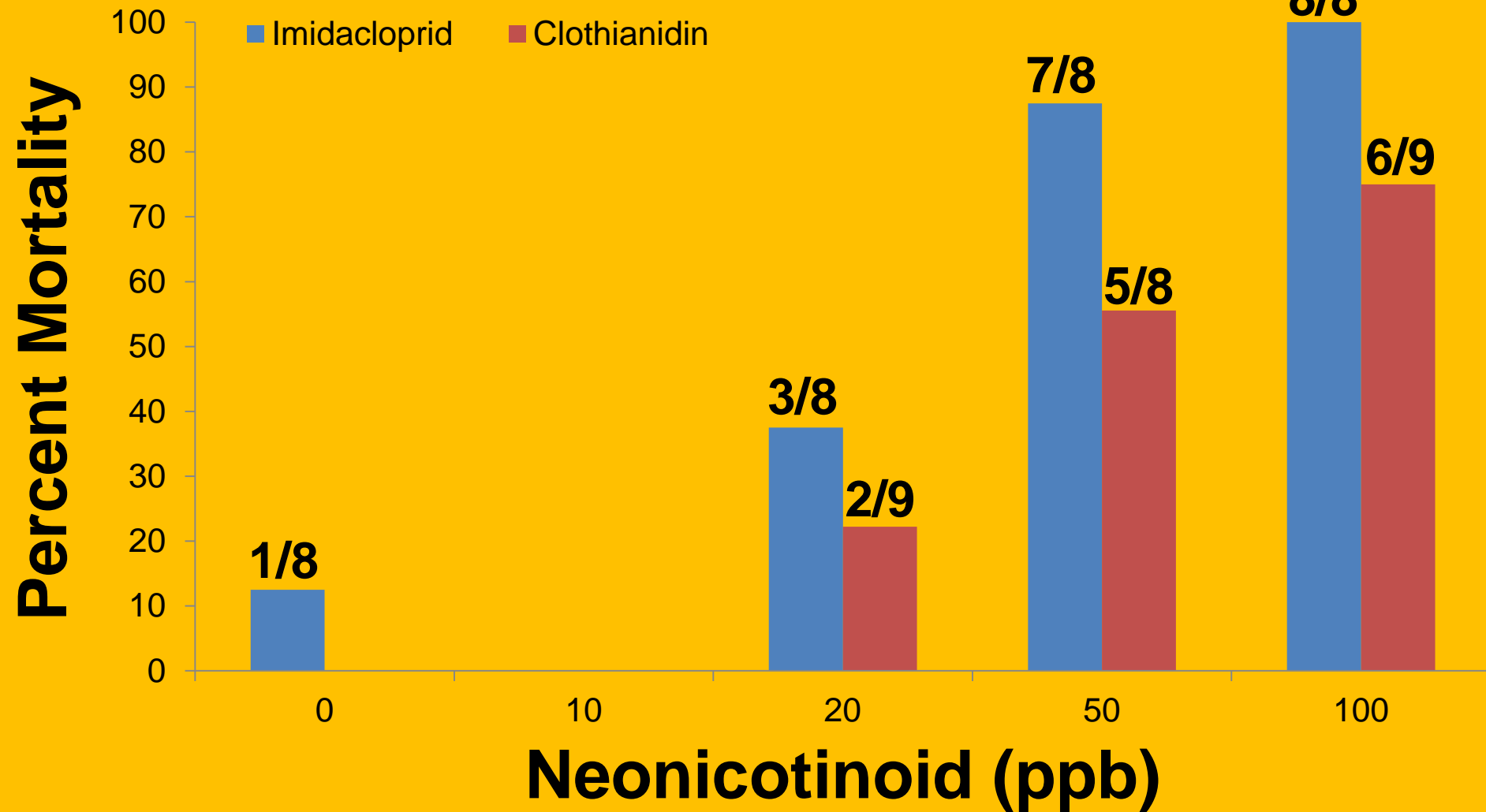
Neonicotinoids and bumblebees

- 0 ppb = control
- 10 ppb = pollen from seed treatments
- 20 ppb = NOEC from Bayer,
but affects behavior
- 50 ppb = Field pumpkin study
- 100 ppb = Lower level found in
landscape plants

LD50 imidacloprid 4-40 ng/bee = 40-400 ppb

LD50 \clothianidin 4 ng/bee = 40 ppb

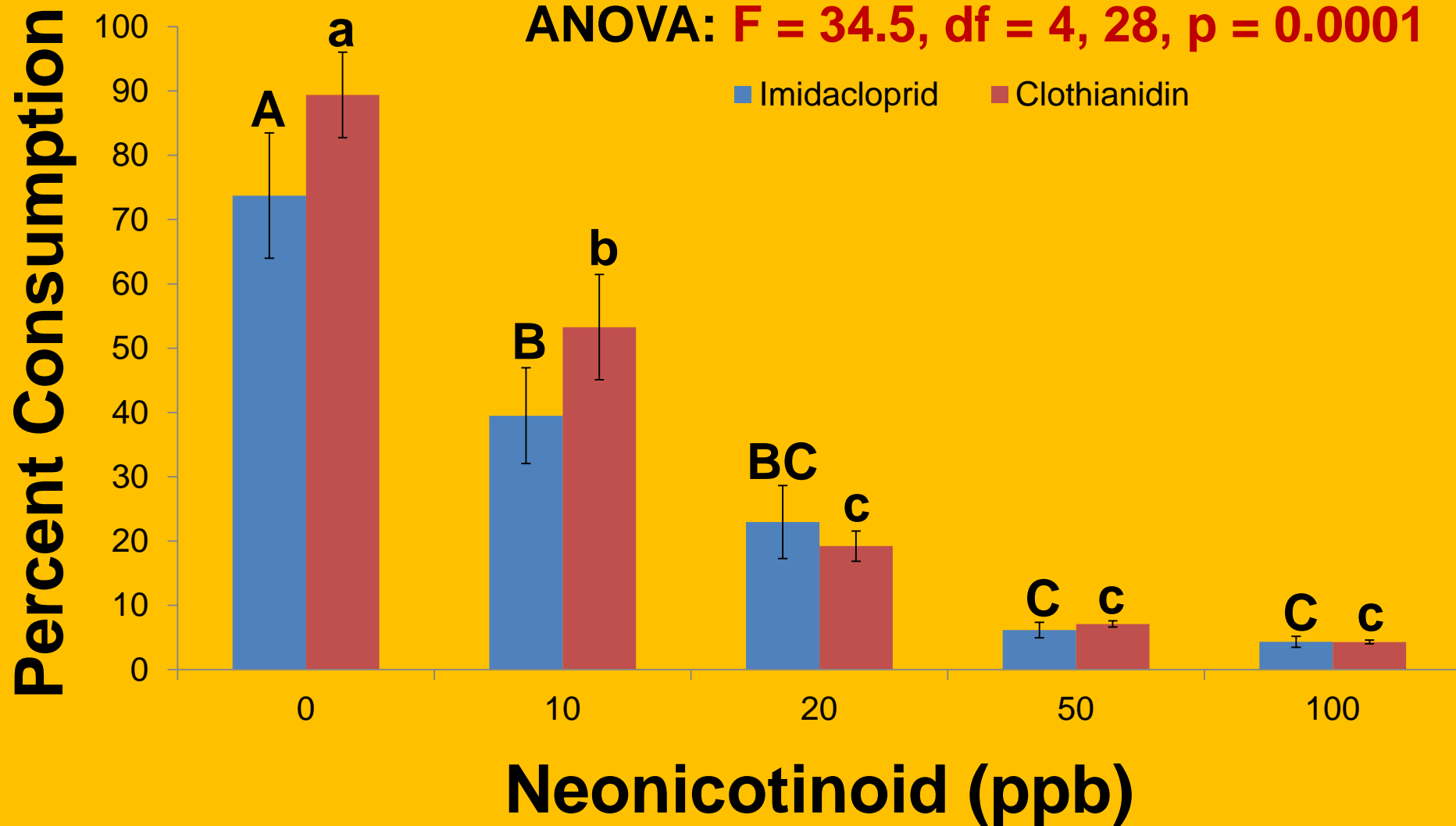
Queen mortality (week 8)



Sugar syrup consumption (Week 8)

ANOVA: $F = 22.2$, $df = 4, 35$, $p = 0.0001$

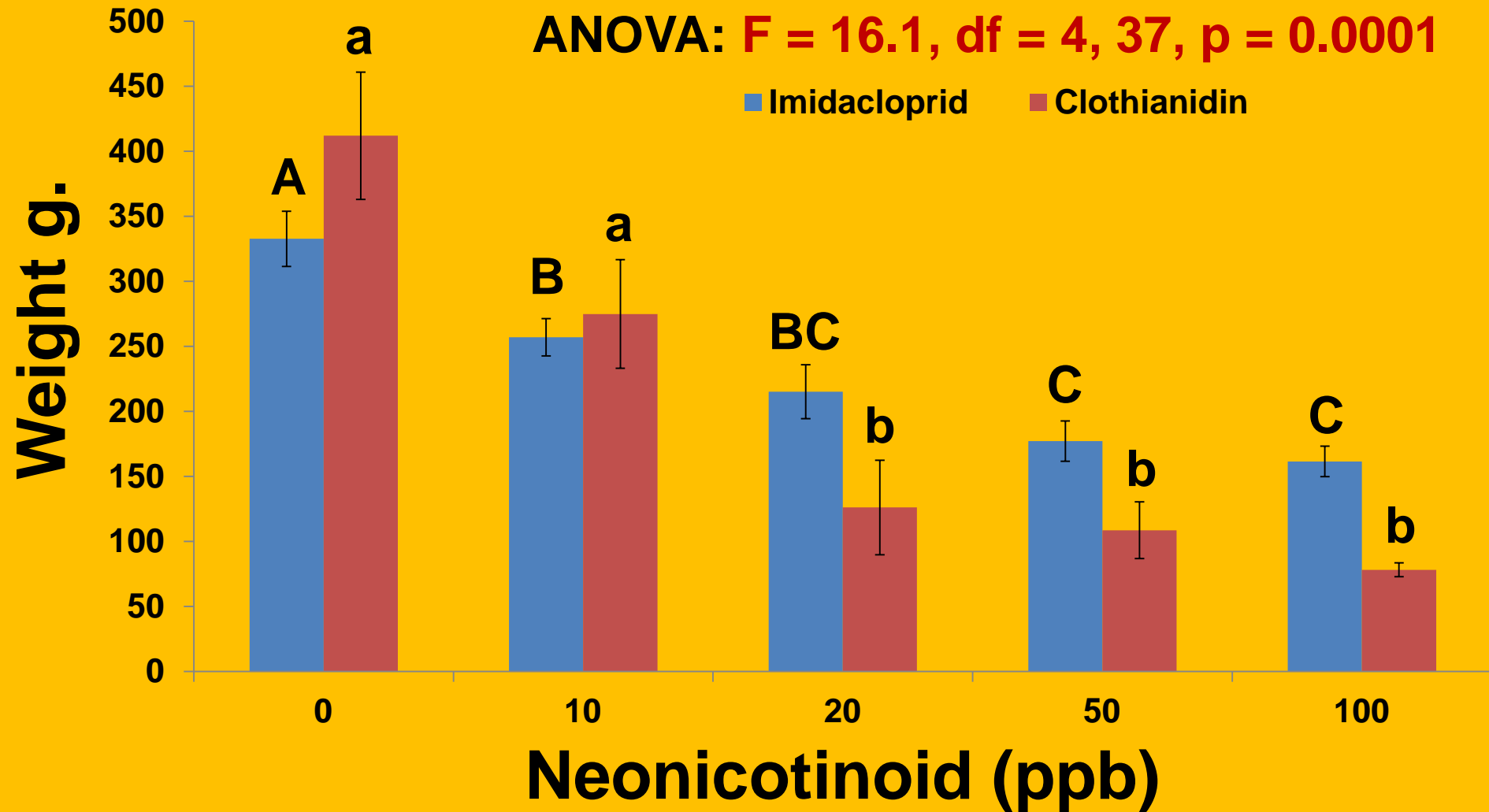
ANOVA: $F = 34.5$, $df = 4, 28$, $p = 0.0001$



Mean colony weight (final)

ANOVA: $F = 16.2$, $df = 4, 35$, $p = 0.0001$

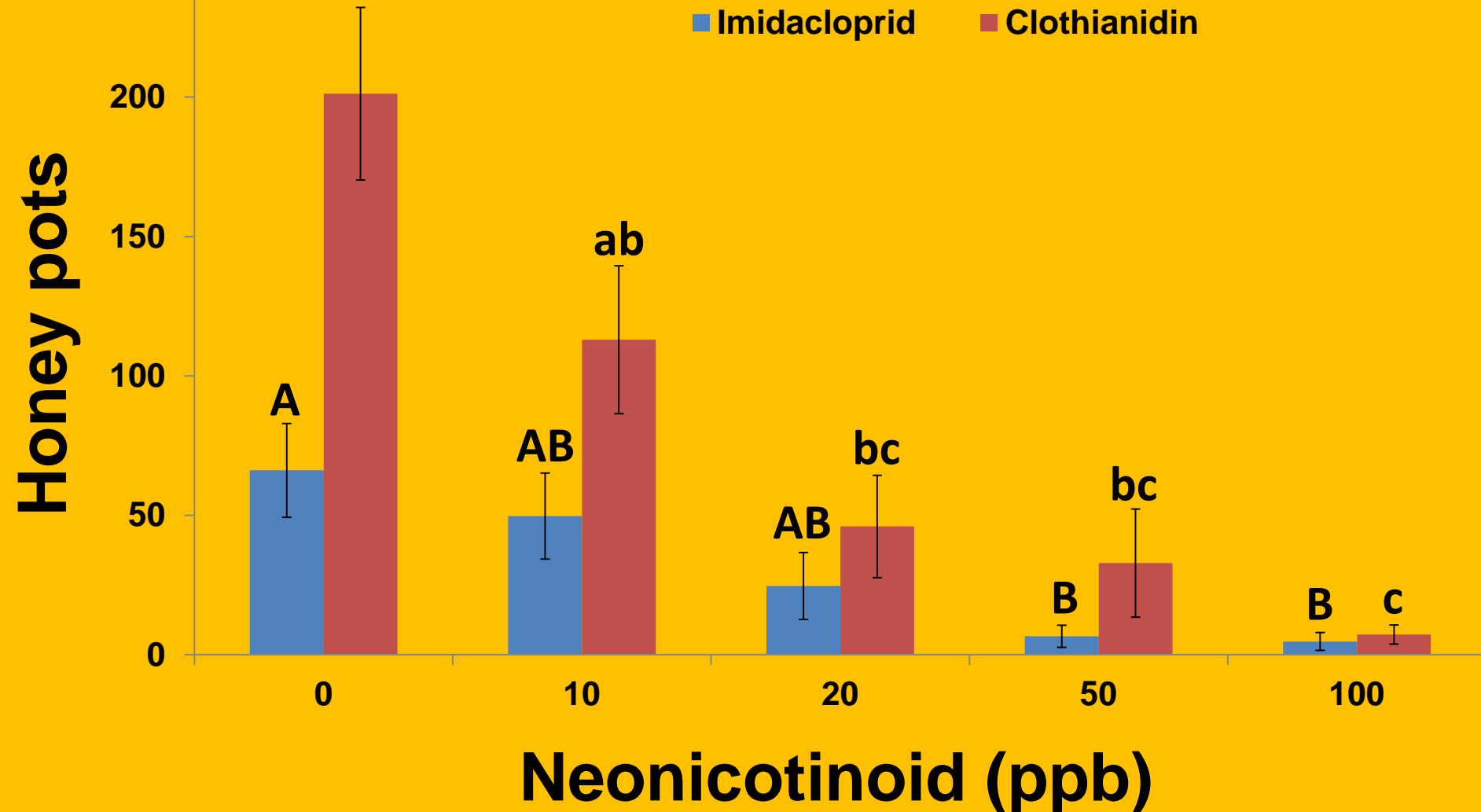
ANOVA: $F = 16.1$, $df = 4, 37$, $p = 0.0001$



Mean number of honey pots (final)

ANOVA: $F = 5.3$, $df = 4, 35$, $p = 0.0020$

ANOVA: $F = 12.7$, $df = 4, 37$, $p = 0.0001$



Bee Plants

How are plants pollinated?

- Pollen collects on hairs and scales of insects.
- Most bees also have specialized structures called corbiculae or scopae to collect pollen.



5443358

Bee Plants

Early Season Bloomers



Serviceberry
(*Amelanchier* spp.)



Pussy willow
(*Salix discolor*)

Bee Plants

Early Season Bloomers

Eastern US Native



Carolina lupine
(*Thermopsis villosa*)



Siberian squill
(*Scilla siberica*)

Photos:

Carolina lupine: Prairie Moon Nursery, www.prairiemoon.com

Siberian squill: Heike Löchel (fotografiert von Heike Löchel) [CC-BY-SA-2.0-de (<http://creativecommons.org/licenses/by-sa/2.0/de/deed.en>)], via Wikimedia Commons

Bee Plants

Early to Mid Season Bloomers



Wild rose
(*Rosa* species)



Basswood, linden
(*Tilia americana*)

Bee Plants

Early to Mid-Season Bloomers



Garden sage
(*Salvia nemorosa* 'May Night')



Catmint
(*Nepeta x faassenii*)

Bee Plants

Mid Season Bloomers



Purple prairie clover
(*Petalostemum candida*)



Swamp milkweed
(*Asclepias incarnata*)

Bee Plants

Mid Season Bloomers



Billard's spiraea
(*Spiraea x billardii* 'Triumphans')



Catnip
(*Nepeta cataria*)

Bee Plants

Mid to Late Season Bloomers



Anise hyssop
(*Agastache foeniculum*)



Wild bergamot
(*Monarda fistulosa*)

Bee Plants

Mid to Late Season Bloomers



Sunflower
(*Helianthus* species)



Globethistle
(*Echinops* species)

Bee Plants

Late Season Bloomers



New England aster
(*Symphyotrichum novae-angliae*)



Goldenrod
(*Solidago species*)

Bee Plants

Late Season Bloomers



Korean angelica
(*Angelica gigas*)

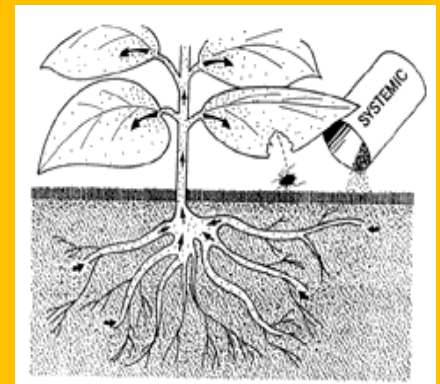


Stonecrop
(*Sedum* species)

Contact compared to systemic 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



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)

Linden trees: Imidacloprid applied to linden to kill adult JB, but linden is a favorite bee plant



Incident



Residue data confirmed dinotefuran. Another bee kill occurred in Hillsboro, OR. Trees were covered in nets and dinotefuran was banned for 6 months until Jan 2014 in Oregon.

Incident

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 vosenesenskii*