A more recent research on neonicotinoids and bees

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It's no longer a mystery.
We know what's killing the bees.
They're being poisoned by neonicotinoid insecticides
Neonicotinoid Pesticides Are Killing the Bees
If we don't act n
WE ARE ALL BEEKEEPERS!
PRESENTED BY EARTHJUSTICE
BEES' TOXIC PROBLEM
Nearly 1/3 of all honeybees in the country have perished in just a few years, and honeybees pollinate 1/3 of all the food we eat. This is a closer look at a major cause of widespread bee die-offs, what it means to us, and how we can help.
THE SWEET LIFE
Most bees leave the hive and spend their days collecting nectar and pollen from flowering plants, trees, and crops.
PROBOSCIS
All day, the worker bee flies from flower to flower, using its long, hairy tongue to pull liquid nectar from plants. The bee's transfer of pollen between blossoms enables many plants reproduce.
HONEY STOMACH
The bee stores nectar in its "honey stomach." It brings nectar back to the hive and deposits it into the honeycomb made of beeswax.
POLLEN BASKET
The bee collects pollen, part of the bee's diet. The bee stores pollen in its "pollen basket."
WINGS
Bees flit their wings to dry up liquid nectar, transforming it into their food store for the year: gooey honey. Humans are lucky to get the leftovers.
A study in Sweden monitored how bees respond to neonicotinoids in the wild.
POLLINATORS
Bee studies stir up pesticide debate
The threat that neonicotinoids pose to bees becomes clearer.
BY DANIEL CRESSEY
es can't wait more years.
nd neither can we.
The United States Environmental Protection Agency estimates it will be 2018, 5 years from now, before it makes a decision on this deadly class of pesticides.
HELP PROTECT FOOD CHOICES
Save-Bees.org

The number of articles has nearly doubled in the past 5 years

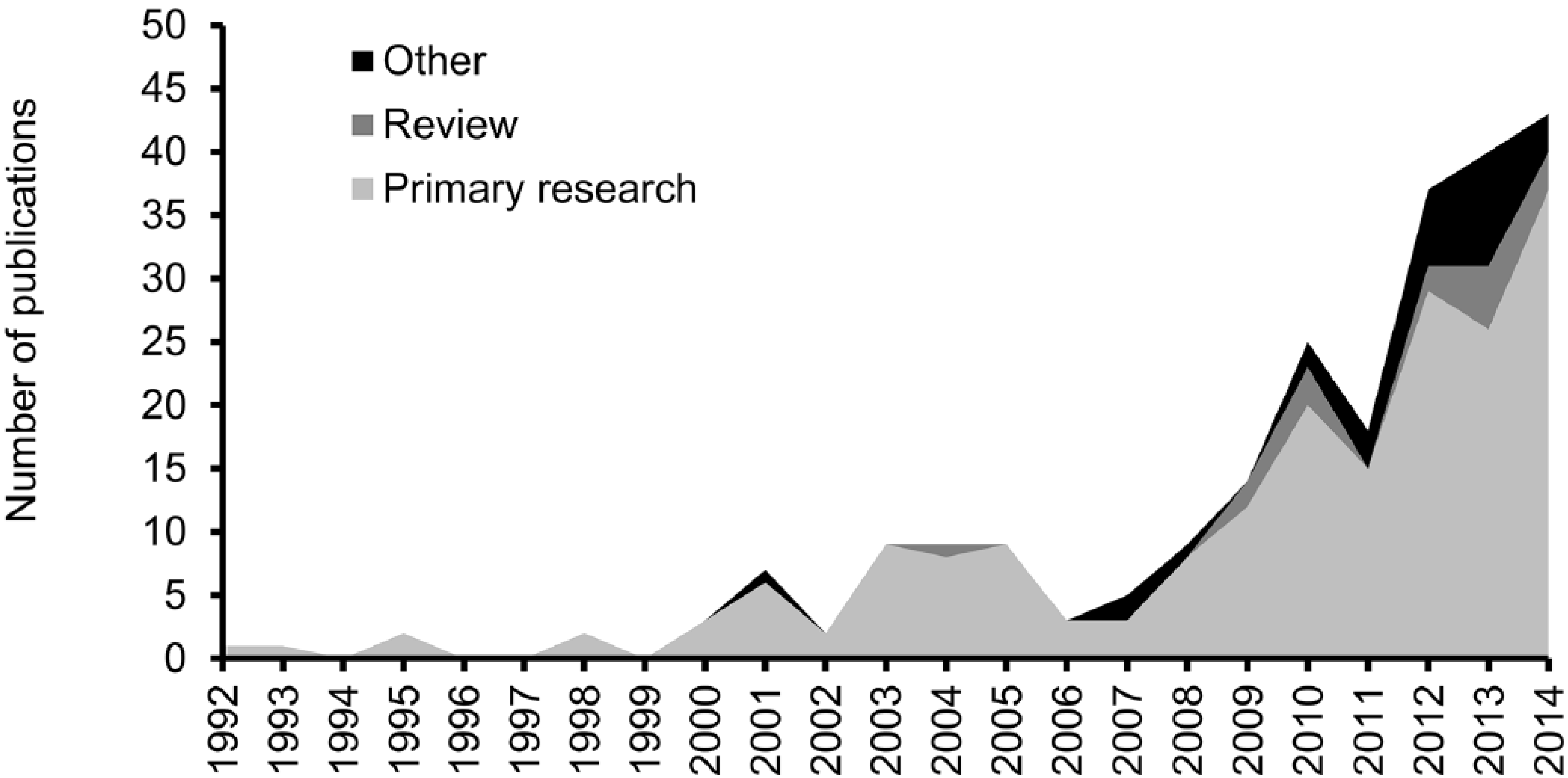


Fig 2. Development of research on the effect of neonicotinoids on bees over time. The single meta-analysis study was published in 2011 [12] and is not included in this figure. Data for 2015 (not complete; see text) included 20 primary research publications, 2 reviews and 6 other publications (not included in figure).

doi:10.1371/journal.pone.0136928.g002

Lundin et al. 2015

Potts et al. 2010

Causes of Decline

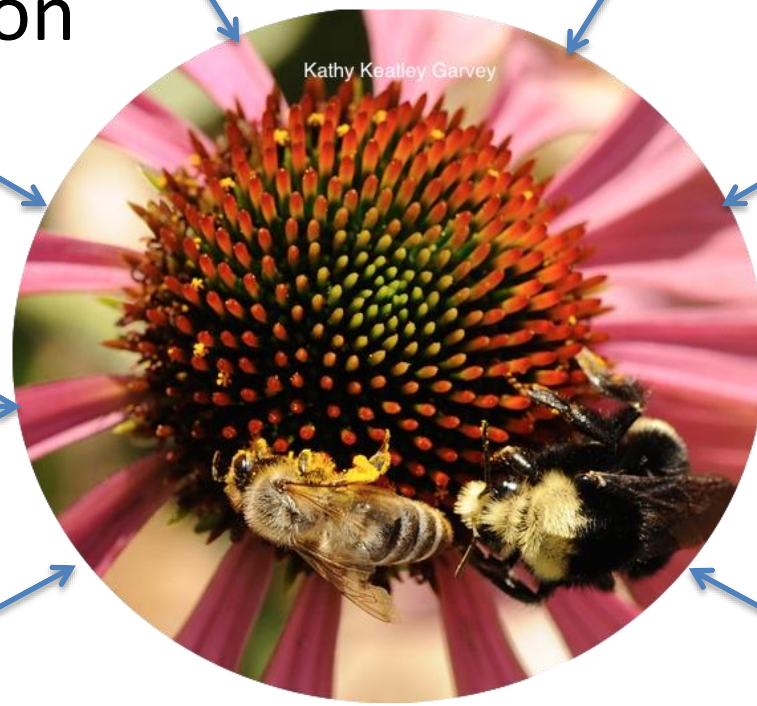
Habitat Loss & Fragmentation

Genetics

Nutrition

Invasive Species

Pathogens



Climate Change

Pesticides

Parasites

Overwintering and Pollination Stress

Potts et al. 2010

Causes of Decline

Pesticides
(neonics)

Some critiques of previous research

- Doses not field-realistic
- Lack of field studies
- Insufficient research on:
  - The effects on wild bees
  - Interactions with other stressors

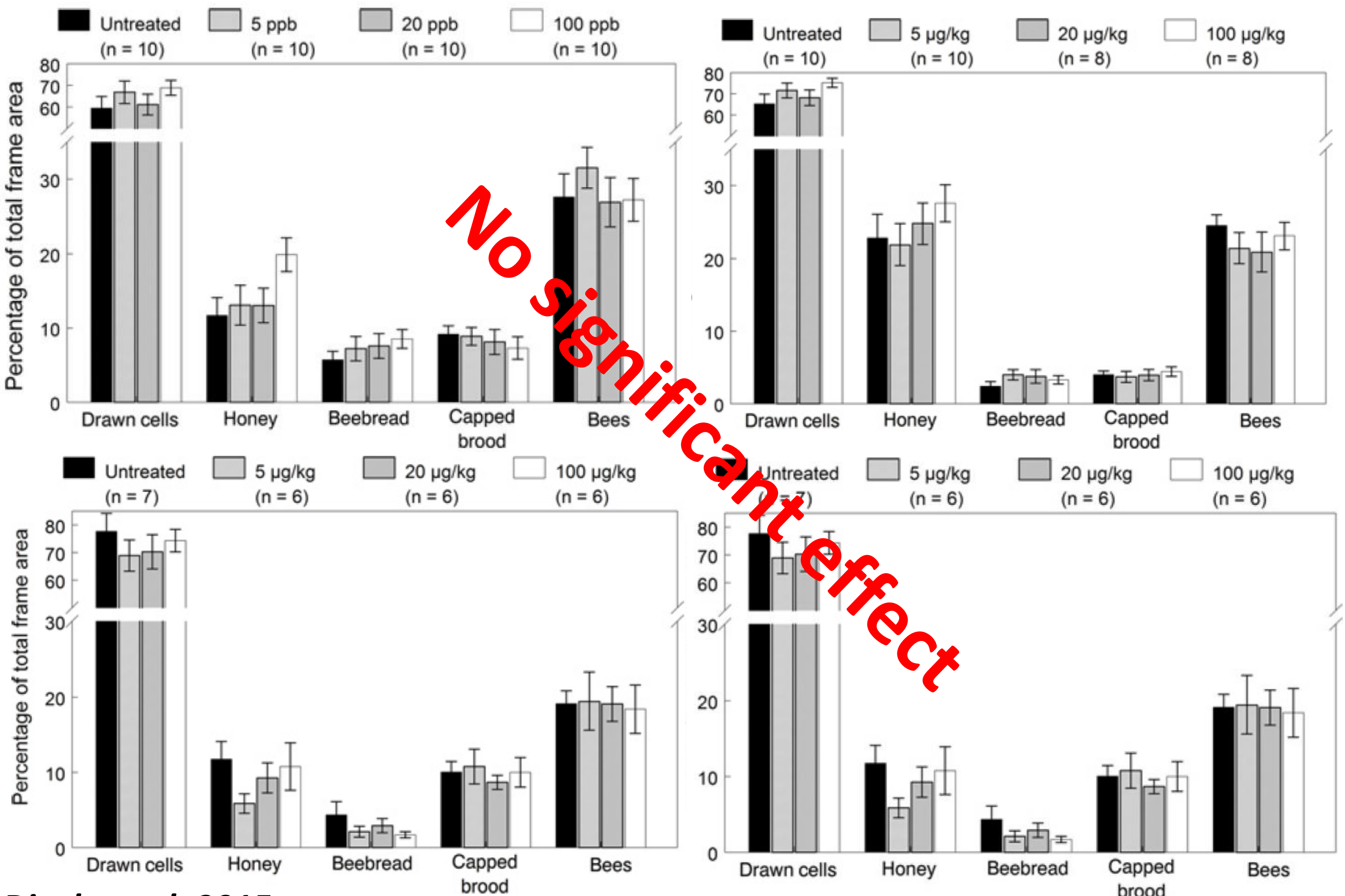
Chronic effects of imidacloprid on honey bees

- A colony study
  - Fed imidacloprid (IMD) at 5, 20, 100 µg/kg (ppb)
    - 5 and 20 µg/kg reported high range for seed-treatment
  - Chronic exposure for 12 weeks
    - A worst-case scenario
- Checked colony strength (biweekly), food stores, foraging activity, survival (overwintering included), parasite loads
- Also tracked residues of IMD in bees, bee bread, honey, larvae, royal jelly

Dively et al. 2015

At the end of exposure

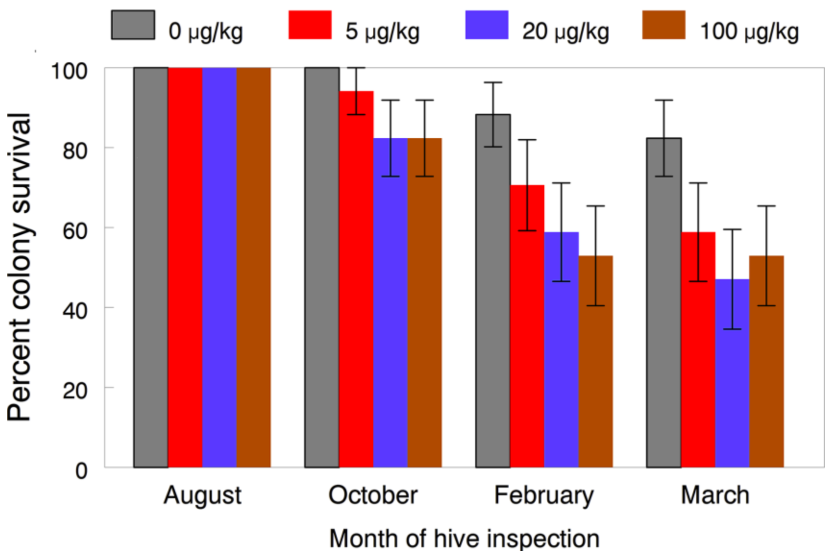
Before overwintering



Dively et al. 2015

- **Lower overwintering survival in year 1**
  - **Due to higher queen replacement and broodless period**
- **BUT not the same response in year 2**
  - **Likely other factors involved in the previous year**

Year 1 and 2 overwintering



Dively et al. 2015

- **Significantly higher supersedure of queens in colonies treated with thiamethoxam (TMX; 5 µg/kg) and clothianidin (CLO; 2 µg/kg)**
- **Effect on adult bee and brood population**
  - **Synergistic effects of the two neonicotinoids?**
- **Effect of genetic background of the queen**

Sandrock et al. 2014

Conclusions

- **IMD residues in stored food varied dependent on route of exposure**
  - **Some non-detectable likely due to dilution effect and degradation**
- **Possible negative effect after chronic exposure to high range of field doses, but most likely encountered doses have negligible effect**
  - **NO effect on foraging activity**
  - **NO effect on colony strength**
  - **OVW effect suggesting delayed toxicity**
  - **Pest and parasite effects**
    - **No effect on *Nosema***
    - **Varroa mite counts correlated with IM exposure**

Dively et al. 2015

1

Varroa mites

2

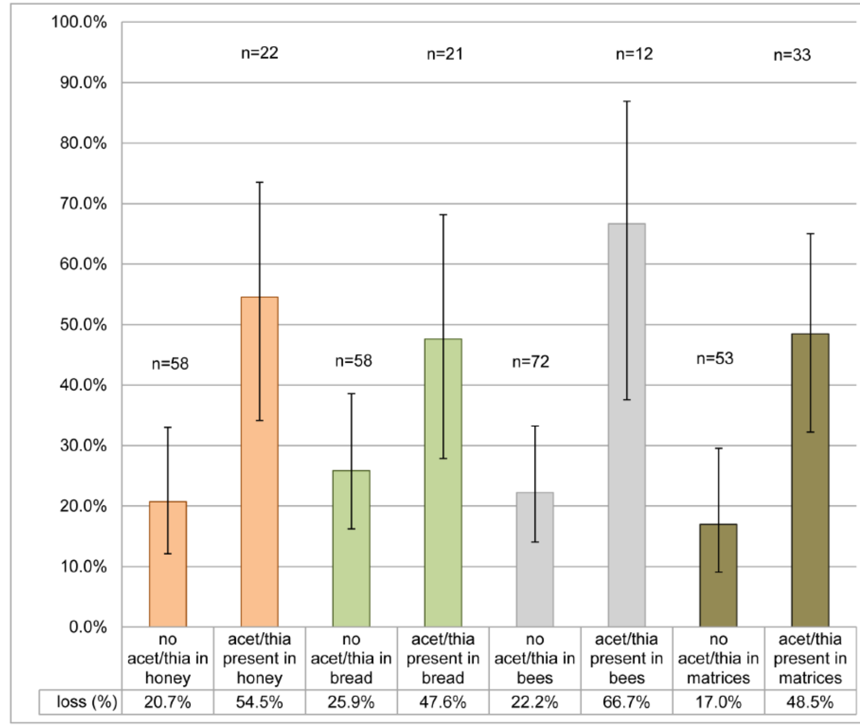


Fig 2. Percentage of colonies lost, with 95% confidence intervals, for colonies with/without acetamiprid or thiacloprid present.

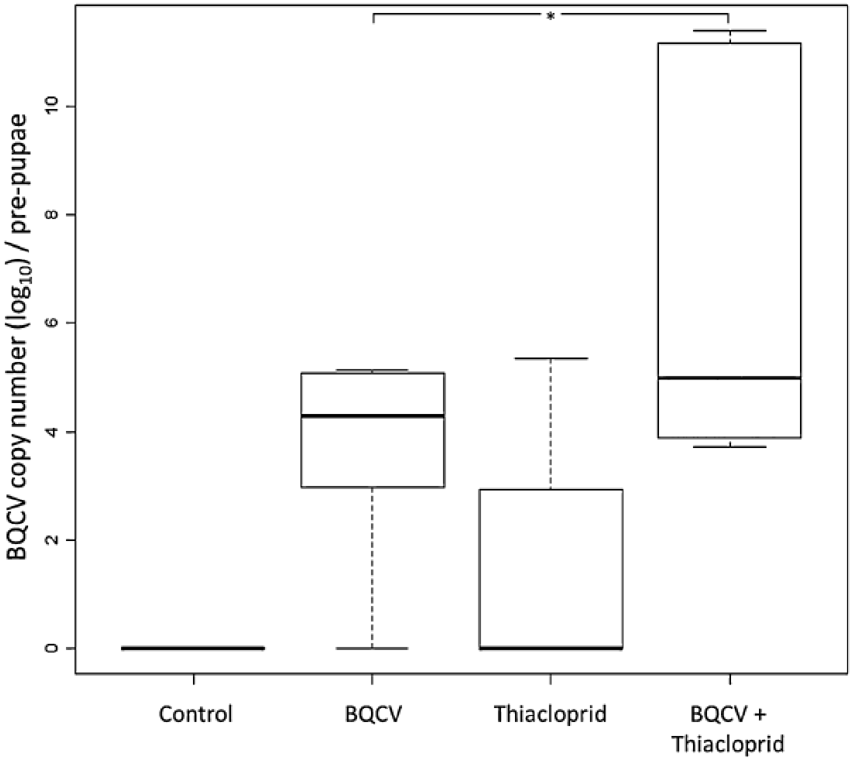
doi:10.1371/journal.pone.0131611.g002

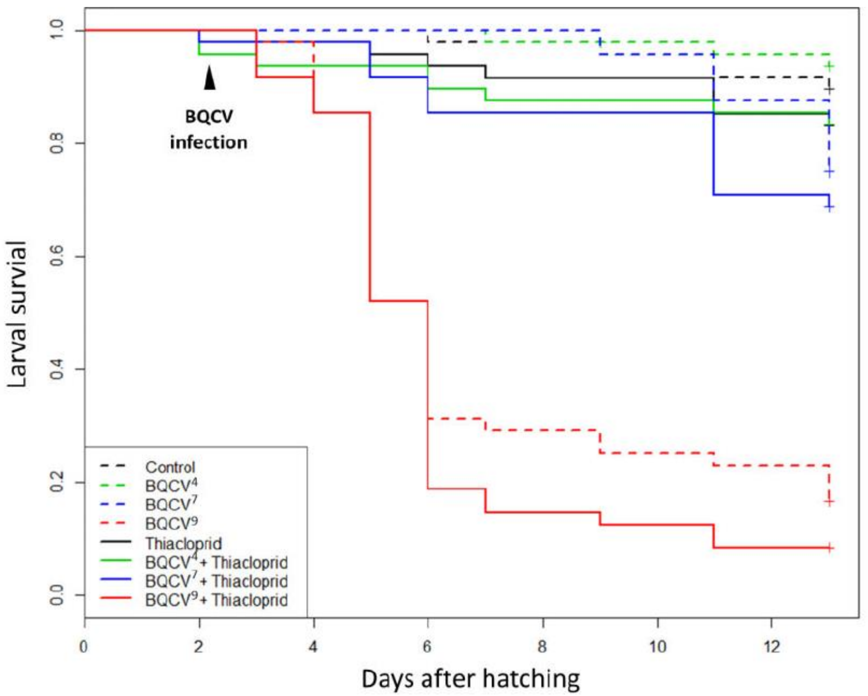
Correlation of various factors with winter colony loss in Netherlands (86 colonies)

van der Zee et al. 2015

Staveley et al. 2014 **analyzed 39 factors in relation to colony loss. Concluded neonicotinoids unlikely to be the sole cause but could be a contributing factor.**

Interaction of neonicotinoids and viruses





Thiacloprid increase copies of BQCV in honey bees and eventually larval and adult mortality

Doublet et al. 2015

Table 2. Number of studies examining the effect of neonicotinoids on different bee species.

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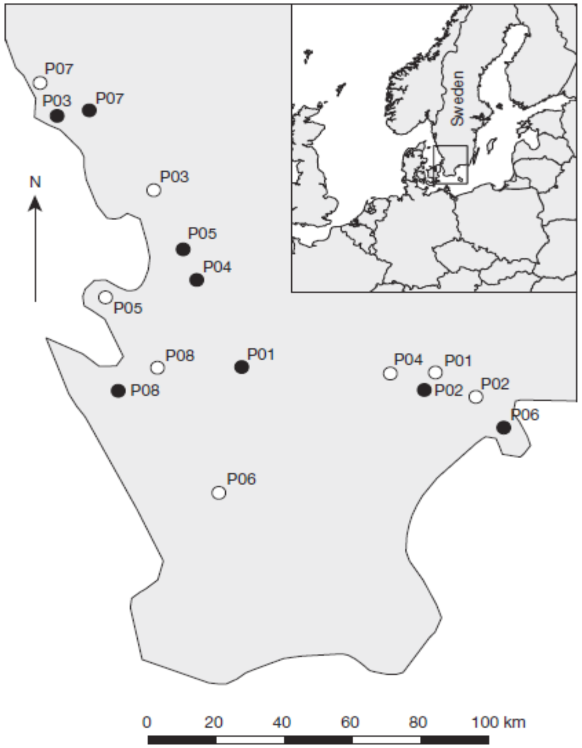
Melipona quadrifasciata	3
Osmia bicornis	2
Osmia lignaria	2
Bombus hypocrita	1
Bombus ignitus	1
Bombus occidentalis	1
Bombus patagiatus	1
Nannotrigona perilampoides	1
Nomia melanderi	1
Osmia cornifrons	1
Scaptotrigona postica	1

doi:10.1371/journal.pone.0136928.t002

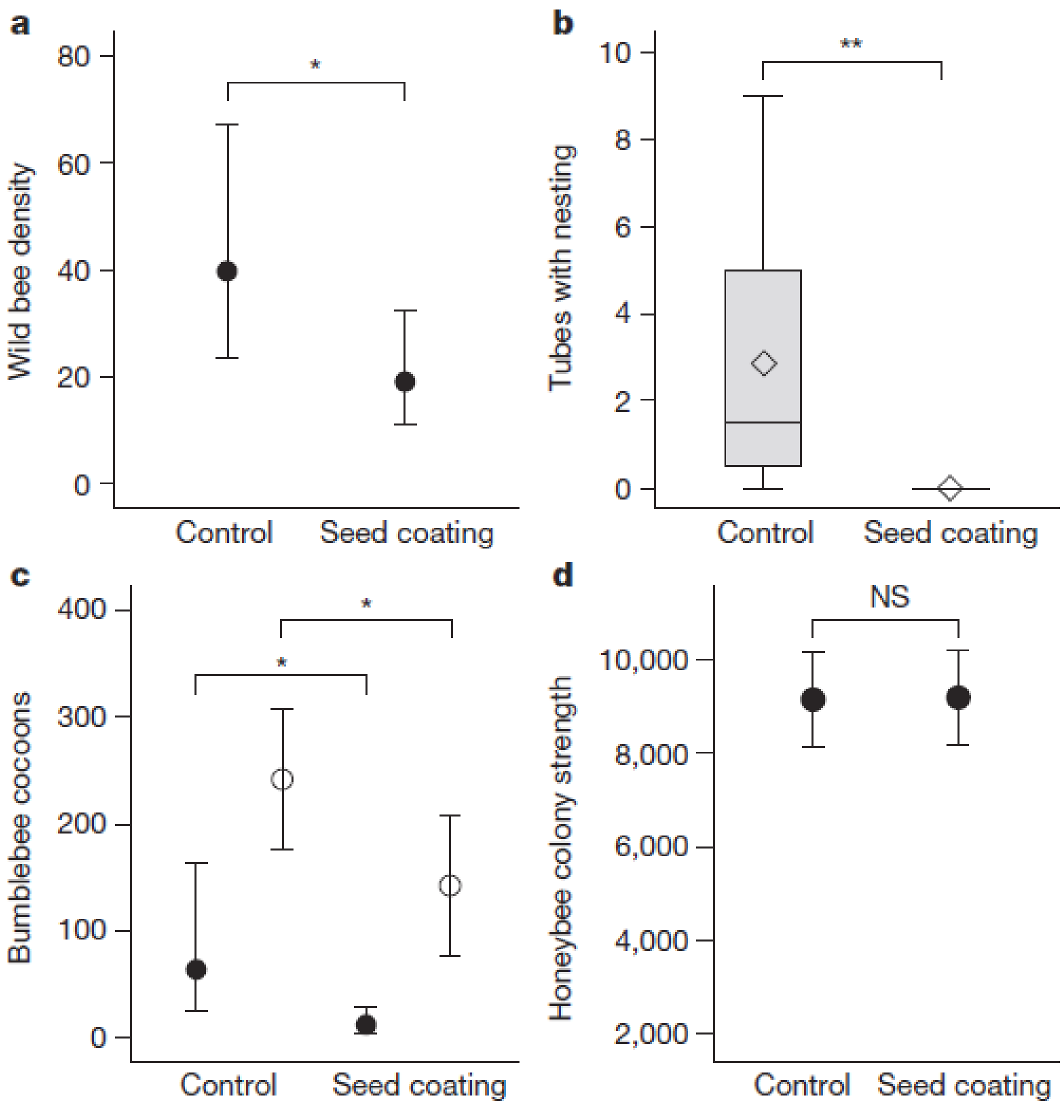
Lundin et al. 2015

Field exposure to clothianidin

- Oilseed rape field study
  - 16 fields
    - Seed treatment
      - Clothianidin + pyrethroid
    - Tracked orchard bees, bumble bees and honey bees



Rundlof et al. 2015



Honey bees seemingly better at dealing with neonicotinoids than bumble bees and wild bees

~58% of pollen collected by honey bees was from oilseed rape

~80% of bumble bee collected pollen was from oilseed rape

***Garbuzov et al. 2015 found that honey bees collected minimal pollen from oilseed rape**

Rundlof et al. 2015

Corn seed treatment and the effects on bumble bees

- Placed *Bombus impatiens* colonies next to conventional (TMX or CLO) or organic fields
  - Remained until end of pollen shed
- Measured clothianidin residue in pollen collected by bumble bees
  - 0.1-0.8ppb in treated fields
- Tracked several colony parameters

Cutler and Scott-Dupree 2014

Table 1 Effects (mean ± SD) on commercial *Bombus impatiens* colonies when exposed during pollen shed to corn (*Zea mays*) grown from conventional seed treated with neonicotinoid insecticide or certified organic seed, Ontario 2013

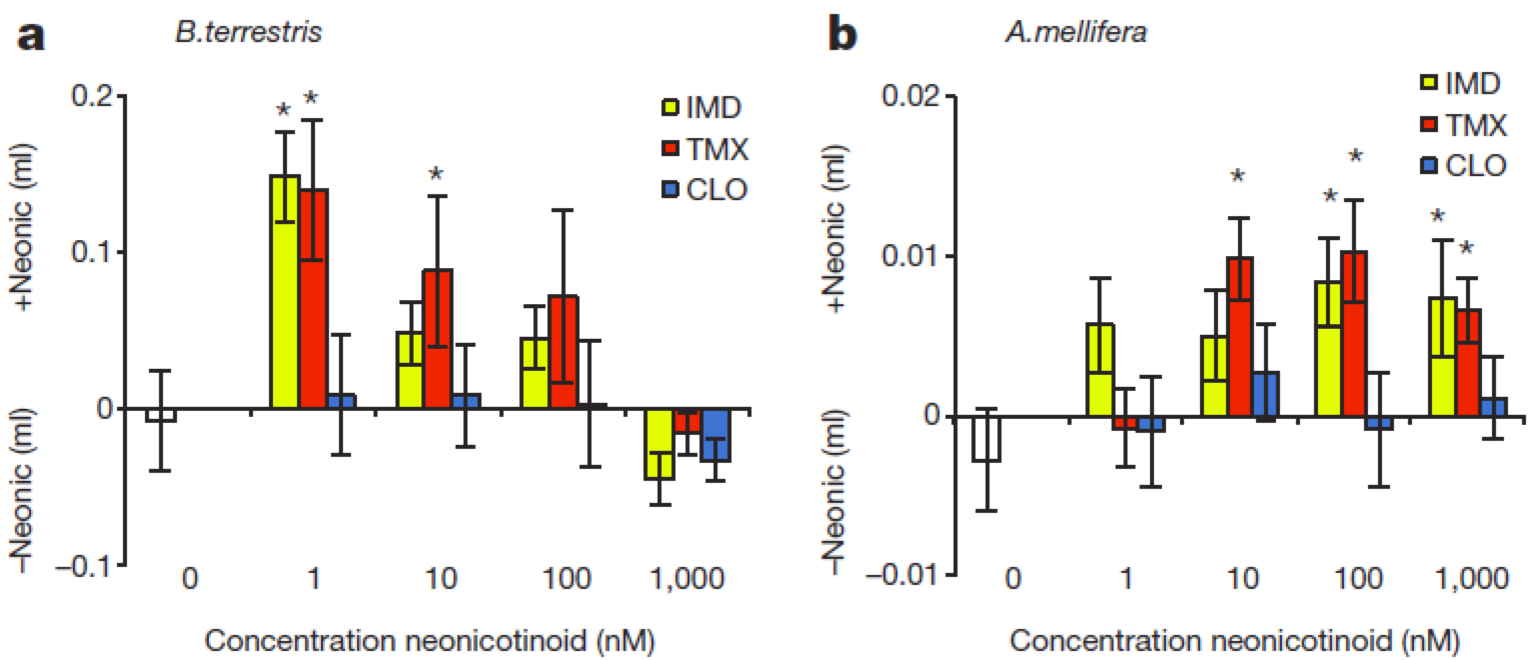
Endpoint measure (per hive)	Corn seed type		t test statistics
	Conventional	Organic	
Hive weight (g)	883.3 (156.2)	843.2 (80.4)	$t_6 = -0.46$, $P = 0.66$
No. honey pots	331.3 (127.8)	270.2 (55.7)	$t_6 = -0.88$, $P = 0.41$
No. pollen pots	32.6 (21.9)	19.2 (5.0)	$t_6 = -1.19$, $P = 0.28$
No. brood cells	554.8 (93.9)	505.0 (54.7)	$t_6 = -0.91$, $P = 0.39$
No. workers	96.0 (15.1)	127.9 (17.2)	$t_6 = 2.80$, $P = 0.032$
Worker weight (g)[a]	6.7 (1.9)	9.1 (1.2)	$t_6 = 2.12$, $P = 0.078$
No. drones	99.5 (41.0)	112.1 (10.6)	$t_6 = 0.59$, $P = 0.57$
Drone weight (g)[a]	7.3 (3.4)	11.1 (1.9)	$t_6 = 1.90$, $P = 0.10$
No. queens	9.2 (2.1)	7.5 (1.2)	$t_6 = -1.41$, $P = 0.21$
Queen weight (g)[a]	3.1 (0.9)	2.2 (0.4)	$t_6 = -1.82$, $P = 0.12$

[a] Total dry weight of all bees

- **Low risk to *B. impatiens***
  - **Variety of pollen collected, corn low and only in 2/8 colonies**
    - **Could have increased risk when no other forage available**
  - **Avoid contaminated pollen?**

Cutler and Scott-Dupree 2014

Bumble bees and honey bees don't avoid contaminated sugar water



Seemingly prefer IMD or TMX laced sugar solution

Kessler et al. 2015

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Cutler and Scott-Dupree 2014

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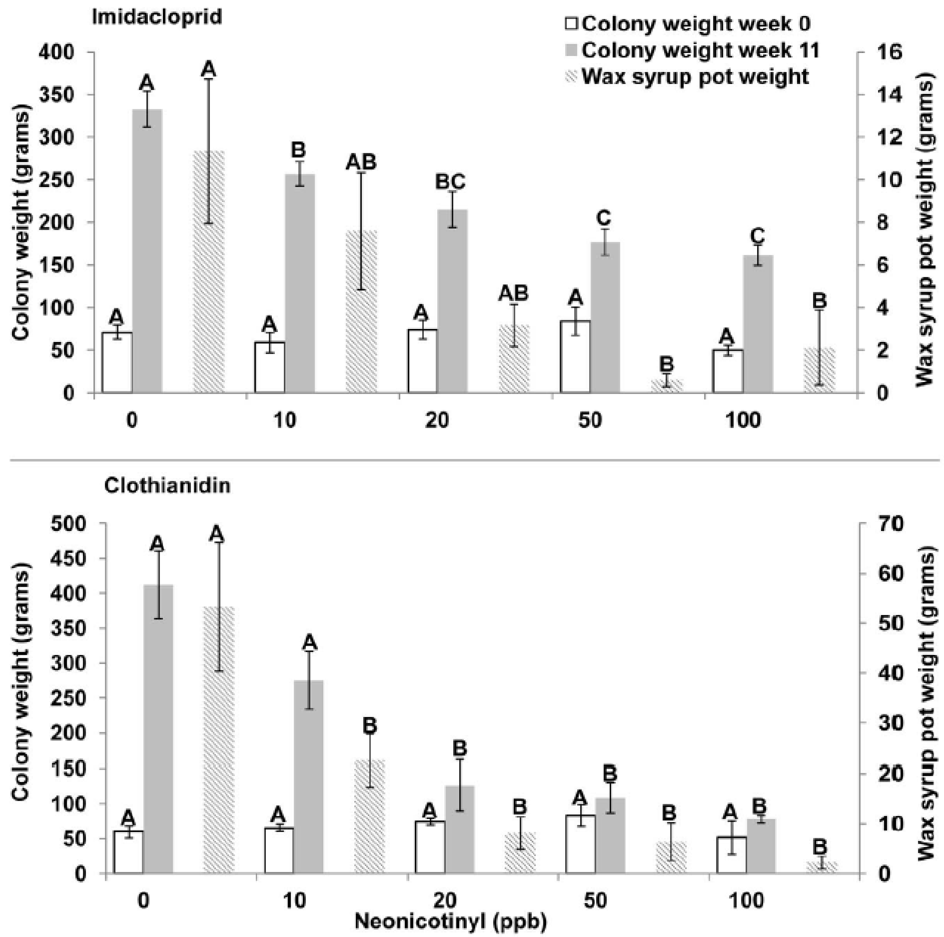
  - **Recovery?**

Cutler and Scott-Dupree 2014



Reduced bumble bee colony and pot weight

Scholer and Krischik et al. 2015

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    - **Could have increased risk when no other forage available**
  - **Avoid contaminated pollen? NO**
  - **Recovery? POSSIBLE**

Cutler and Scott-Dupree 2014

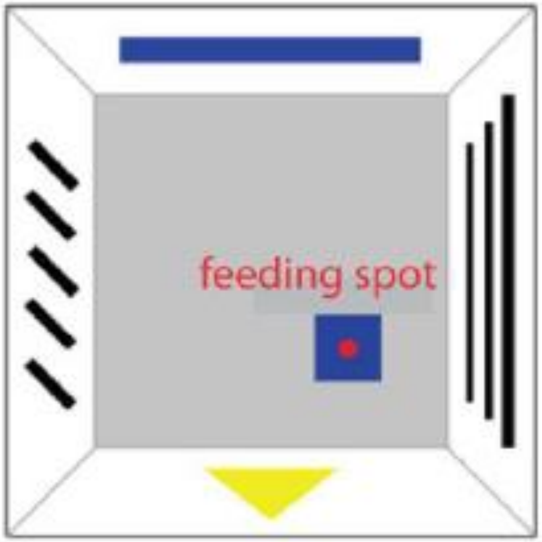
Table 2 Number of insects (mean ± SD) on tassels of dehiscing corn (*Zea mays*) grown from conventional seed treated with neonicotinoid insecticide or certified organic seed, Ontario 2013

Insect	Number insects counted (20 min)		Wilcoxon statistics
	Conventional	Organic	
Bombus impatiens	0.37 (0.76)	0.06 (0.36)	$Z = -1.10$, $P = 0.27$
Other *Bombus*	0.31 (0.54)	0.13 (0.37)	$Z = -1.05$, $P = 0.29$
Apis mellifera	0.06 (0.27)	0.44 (0.82)	$Z = 1.23$, $P = 0.22$
Solitary bees	4.25 (3.61)	1.44 (1.63)	$Z = -2.70$, $P = 0.007$
Other insects	9.00 (4.62)	8.50 (4.18)	$Z = 0.13$, $P = 0.89$

Cutler and Scott-Dupree 2014

Effects of clothianidin on *Osmia cornuta* – a laboratory test

- Fed 0.76 ng/bee (0.076 ppm) one hour prior to testing
- Trained bees to find food in an arena
  - Using visual cues
- CL interfered with sensory response and retrieval of navigational memory



Jin et al. 2014

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doi:10.1371/journal.pone.0136928.t002

Lundin et al. 2015

Improving environmental persistence data for neonicotinoids

- **Residues in eight crops across the US**
  - **Alfalfa, almonds, apples, blueberry, corn, cotton, cantaloupe, pumpkin**
- **Expensive to test**

Pesticide	Crop	Residue (ppb)
Acetamiprid	Apple	60.6
Clothianidin	Cotton	1.0
Imidacloprid	Apple	15.9
Thiacloprid	Apple	85.0
Thiamethoxam	Alfalfa	12.7

Frazier, Mussen et al. 2015

Other potential sources of neonicotinoid exposure for bees

- **Seed dust, pollen, nectar, spray**
- **Bees also need water!**
- **Puddle water in corn fields presents a potential hazard to honey and other bees**

Samson-Robert et al. 2014; Schaafsma et al. 2015

Pesticide registration

- Many things to be considered when evaluating bee pesticides safety for registration
- Changes by EPA
  - Re-evaluating neonicotinoid applications
  - Changes in pesticide risk assesment

What now?

- **Neonicotinoids can cause sublethal effects**
  - **Honey bees seem to be the most resilient**
  - **Need for separate risk assessment for other bees (Cabrera et al. 2015)**
- **Other factors may be interacting with neonicotinoids to increase the effects**
  - **Keep this in mind with pesticide risk assessment**
  - **Stresses importance of incorporating filed studies into risk assessment**

Potts et al. 2010

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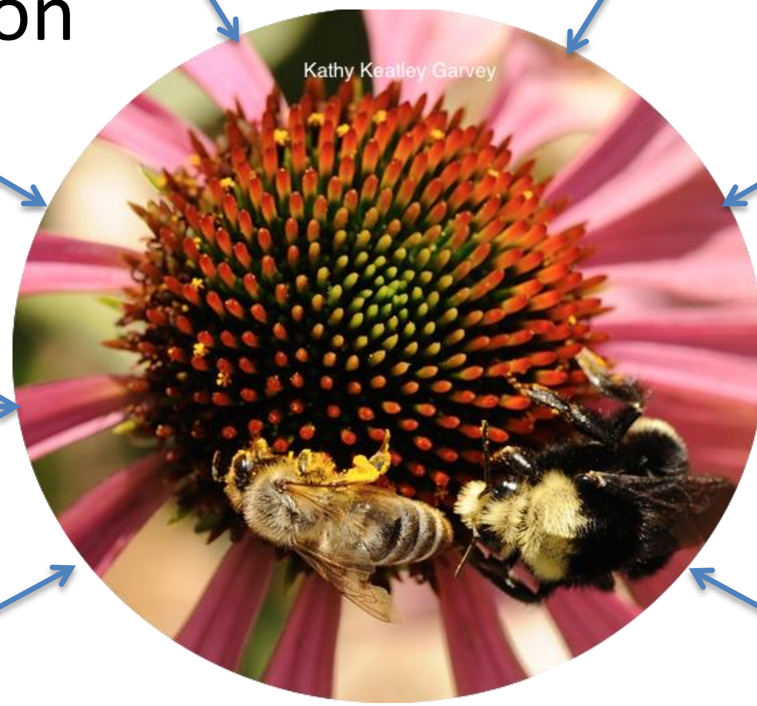
Nutrition

Habitat Loss
& Fragmentation

Invasive
Species



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Climate
Change

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Overwintering and Pollination Stress