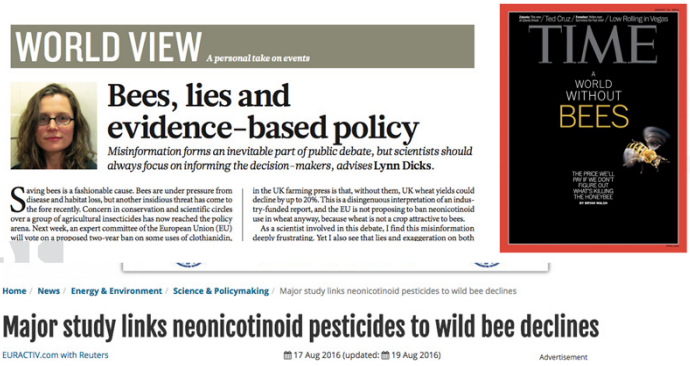
How do neonicotinoids affect bees and what is the evidence?



WORLD VIEW *A personal take on events*

Bees, lies and evidence-based policy

Misinformation forms an inevitable part of public debate, but scientists should always focus on informing the decision-makers, advises **Lynn Dicks.**

Saving bees is a fashionable cause. Bees are under pressure from disease and habitat loss, but another insidious threat has come to the fore recently. Concern in conservation and scientific circles over a group of agricultural insecticides has now reached the policy arena. Next week, an expert committee of the European Union (EU) will vote on a proposed two-year ban on some uses of clothianidin, in the UK farming press is that, without them, UK wheat yields could decline by up to 20%. This is a disingenuous interpretation of an industry-funded report, and the EU is not proposing to ban neonicotinoid use in wheat anyway, because wheat is not a crop attractive to bees.

As a scientist involved in this debate, I find this misinformation deeply frustrating. Yet I also see that lies and exaggeration on both

Home / News / Energy & Environment / Science & Policymaking / Major study links neonicotinoid pesticides to wild bee declines

Major study links neonicotinoid pesticides to wild bee declines

EURACTIV.com with Reuters 17 Aug 2016 (updated: 19 Aug 2016) Advertisement

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CAPITAL CITY UNIVERSITY

Europe bans neonicotinoids: shouldn't we?

ge **Wildlife** Energy Pollution

UK will back total ban on bee-harming pesticides, Michael Gove reveals

Exclusive: Research leads environment secretary to overturn government's previous opposition, making total EU ban much more likely

▲ Oilseed rape crops being sprayed. The seeds are treated with neonicotinoids and the flowers visited by bees. Photograph: Juice/Rex/Shutterstock

The UK will back a total ban on insect-harming pesticides in fields across Europe, the environment secretary, Michael Gove, has revealed.

EU agrees total ban on bee-harming pesticides

The world's most widely used insecticides will be banned from all fields within six months, to protect both wild and honeybees that are vital to crop pollination

▲ People protest ahead of the historic EU vote on a full neonicotinoids ban at Place Schuman in Brussels, Belgium. Photograph: Olivier Matthys/AP

The European Union will ban the world's most widely used insecticides from all fields due to the serious danger they pose to bees.

The ban on neonicotinoids, approved by member nations on Friday, is expected to come into force by the end of 2018 and will mean they can only

Neonicotinoids?

- They are "*nicotinic acetylcholine receptor agonists*": they bind to and block open nerve receptors in the insect brain.
- Most neonics are toxic to insects in minute quantities
  - the LD_{50} for ingestion of imidacloprid in honeybees is 5 nanograms per insect.

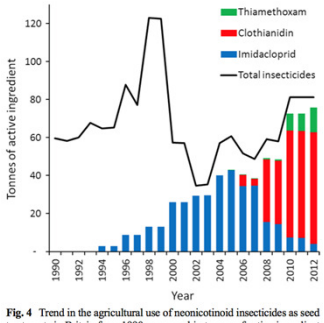
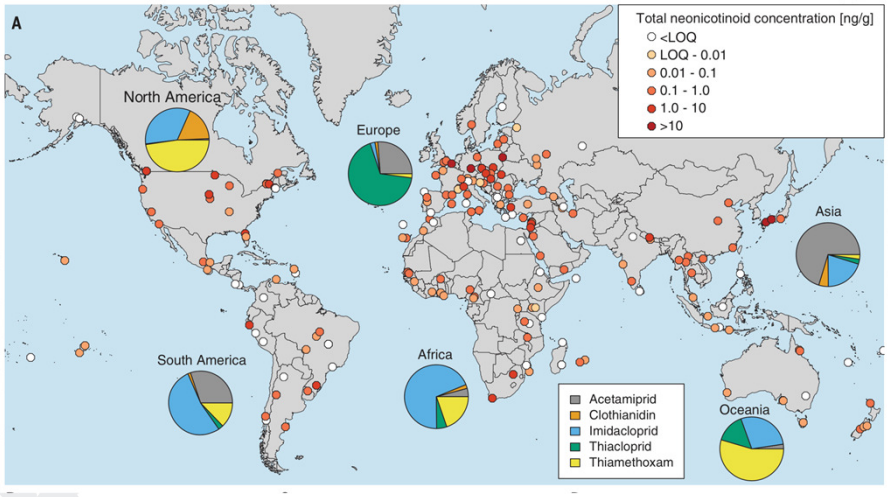


Fig. 4 Trend in the agricultural use of neonicotinoid insecticides as seed treatments in Britain from 1990, measured in tonnes of active ingredient per year (*bars*). The total usage of all insecticidal seed treaments (*solid line*) is also shown. Data from http://pusstats.csl.gov.uk/index.cfm

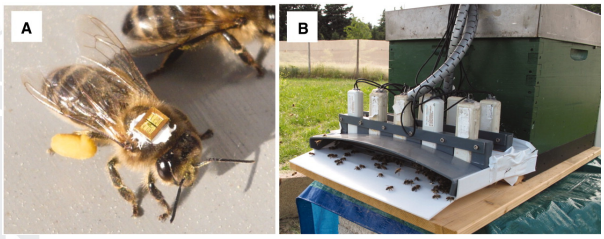
Neonics are everywhere



Mitchell et al. (2017) A worldwide survey of neonicotinoids in honey. Science 358: 109–111.

There is no question the neonics can hurt bees

- There can be lethal toxicity of neonicotinoids on bees
- Sub-lethal effects occur on factors such as longevity, foraging behaviour, feeding, learning and memory



"Nonlethal exposure of honey bees to thiamethoxam (neonicotinoid systemic pesticide) causes high mortality due to homing failure at levels that could put a colony at risk of collapse".

Henry (2012) A common pesticide decreases foraging success and survival in honey bees. *Science* 336: 348-350

But do realistic levels of Neonic exposure kill bees?

PLOS ONE

RESEARCH ARTICLE

Assessment of Chronic Sublethal Effects of Imidacloprid on Honey Bee Colony Health

Galen P. Dively[1]*, Michael S. Embrey[1], Alaa Kamel[2], David J. Hawthorne[1], Jeffery S. Pettis[3]

1 Department of Entomology, University of Maryland, College Park, MD, United States of America, **2** Analytical Chemistry Branch, Biological and Economic Analysis Division, Office of Pesticide Programs, US EPA, Fort George G. Meade, MD, United States of America, **3** USDA-ARS Bee Research Laboratory, Beltsville, MD, United States of America

of field doses (20 to 100 µg/kg) in pollen of certain treated crops could cause negative impacts on honey bee colony health and reduced overwintering success, but the most likely encountered high range of field doses relevant for seed-treated crops (5 µg/kg) had negligible effects on colony health and are unlikely a sole cause of colony declines.

Dively et al. (2015) Assessment of chronic sublethal effects of imidacloprid on honey bee colony health. PLoS ONE 10(3): e0118748.

A much-needed, multi-country, BIG study!

RESEARCH

NEONICOTINOIDS

Country-specific effects of neonicotinoid pesticides on honey bees and wild bees

B. A. Woodcock,[1]* J. M. Bullock,[1] R. F. Shore,[2] M. S. Heard,[1] M. G. Pereira,[2] J. Redhead,[1] L. Ridding,[1] H. Dean,[1] D. Sleep,[2] P. Henrys,[2] J. Peyton,[1] S. Hulmes,[1] L. Hulmes,[1] M. Sárospataki,[3] C. Saure,[4] M. Edwards,[5] E. Genersch,[6] S. Knäbe,[7] R. F. Pywell[1]

Neonicotinoid seed dressings have caused concern world-wide. We use large field experiments to assess the effects of neonicotinoid-treated crops on three bee species across three countries (Hungary, Germany, and the United Kingdom). Winter-sown oilseed rape was grown commercially with either seed coatings containing neonicotinoids (clothianidin or thiamethoxam) or no seed treatment (control). For honey bees, we found both negative (Hungary and United Kingdom) and positive (Germany) effects during crop

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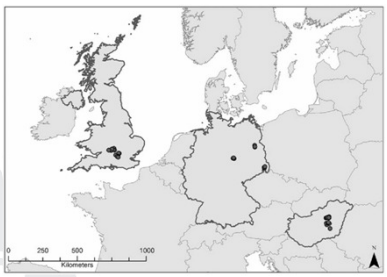
Woodcock et al. (2017) Country-specific effects of neonicotinoid pesticides on honey bees and wild bees. Science 356, 1393–1395.

A much-needed, multi-country, BIG study!

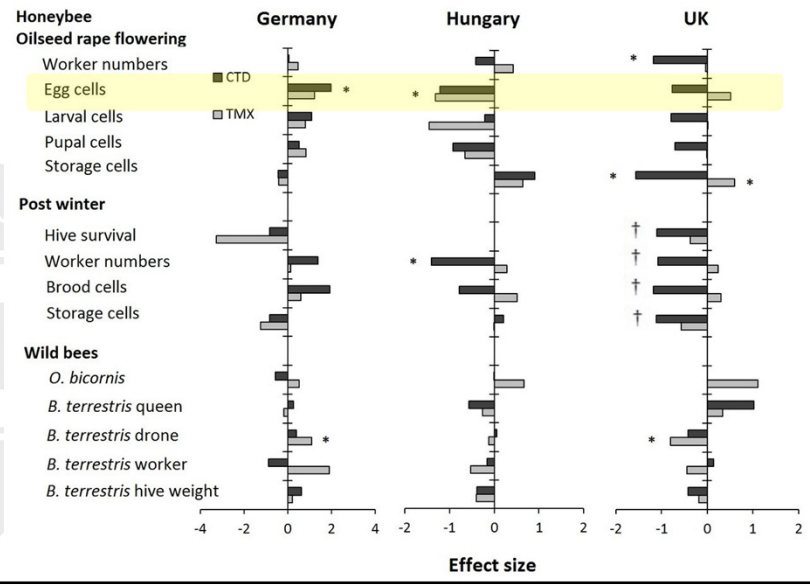


Tested the hypotheses that:

(i) exposure to seed treatments containing neonicotinoids affected the reproductive potential of managed and wild bee species, and

(ii) whether such effects differ between countries.

A very MIXED bag of results



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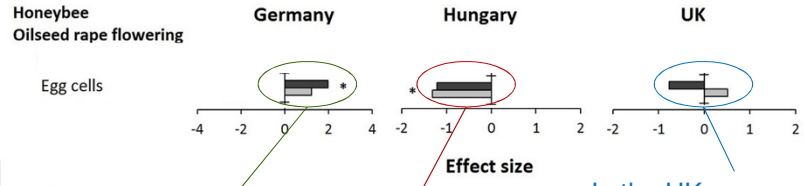
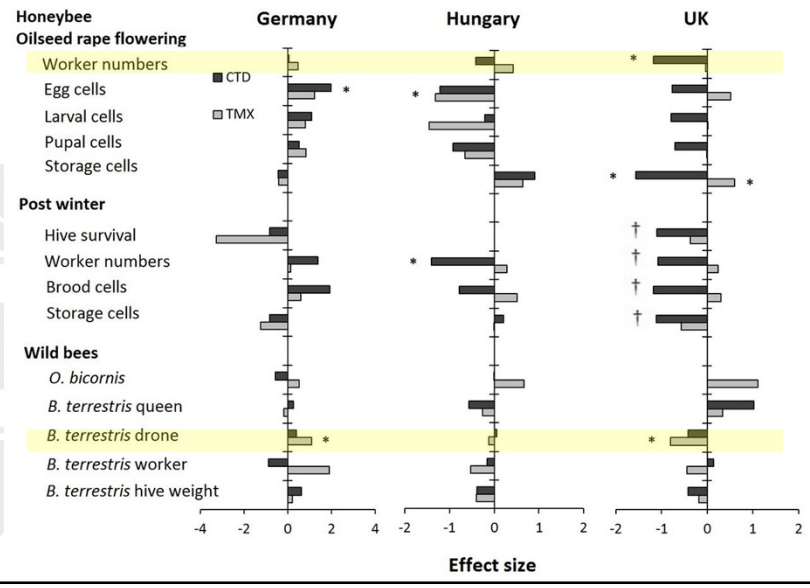


In Germany, neonics significantly **increased** the number of egg cells in honey bee hives (compared to controls).

In Hungary, neonics significantly **decreased** the number of egg cells in honey bee hives (compared to controls).

In the UK, one neonic **increased** and one **decreased** the number of egg cells in honey bee hives (compared to controls).

A very MIXED bag of results



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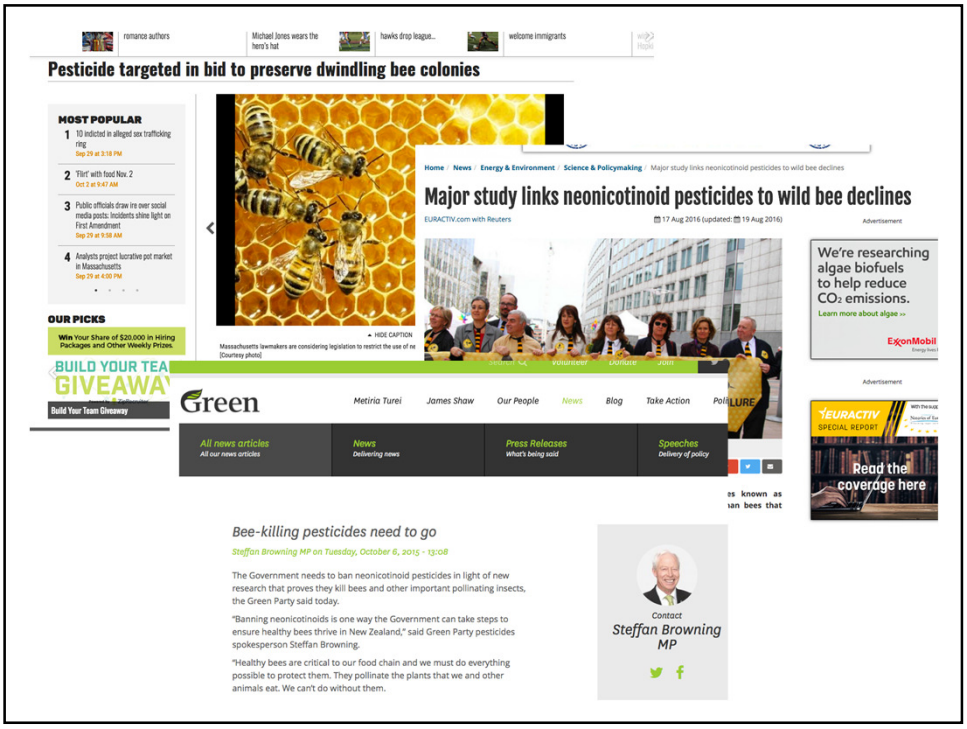
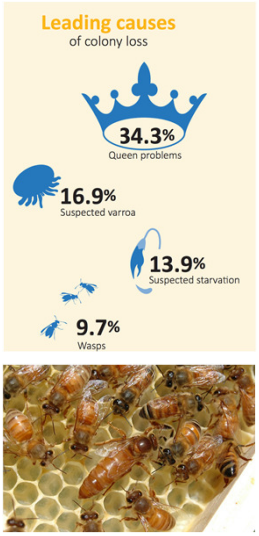
NATURE | NEWS
Largest-ever study of controversial pesticides finds harm to bees
Scientists say the industry-funded work confirms that neonicotinoids are harmful, but manufacturers question its conclusions.
Daniel Cressey
29 June 2017
Rights & Permissions
Frank Bienewald/LightRocket/Getty
Bees are harmed by neonicotinoid pesticides, according to a large-scale field study.
The largest study so far on the fraught question of whether neonicotinoid pesticides harm bees is providing new ammunition for those who argue against the use of the controversial chemicals.

theguardian
jobs dating more International edition
browse all sections
letters editorials
The evidence is clear: insecticides kill bees. The industry denials look absurd
Patrick Barkham
The largest field trials to date offer irrefutable proof. We need a total ban, now, to halt the sabotaging of our own best interests
'Most of us get the idea that without bees and other pollinating insects, human life would rapidly collapse.' Photograph: Thomas Kienzle/AFP/Getty Images
The extermination of 15,000 honey bees in Anglesey by council pest control officers who mistook the rare black bees for wasps is an unhappy accident. The fact it has made the news shows a society slowly coming to its senses.
Most of us get the idea that without bees and other pollinating insects, human life would rapidly collapse. Those of us who have lived long enough remember the



What should we do? Well, what kills bees here?



- Leading causes of colony losses include **queen problems**, suspected **varroa** and related complications, **suspected starvation**, and **wasps**.
- Losses to natural disasters, **robbing** by other bees, **American Foulbrood**, suspected **diseases**, accidents, **theft/vandalism**, and **Argentine ants**

Middle South Island bees suffer New Zealand's highest rate of colony loss

JOANNE HOLDEN
Last updated 14:00, March 22 2018

DOUG FIELD/STUFF

Pleasant Point Apiaries beekeeper Walker Jacobs works in the factory extracting honey.

South Canterbury beekeepers have faced a challenging summer with drought and the varroa mite impacting hives.

The Ministry for Primary Industries (MPI) released its Bee Colony Loss Survey report for 2017 on March 16, which sampled 30 per cent of New Zealand beekeepers to determine the rate of hive loss and the main reasons for it.

MPI aquatic and environment health manager Dr Michael Taylor said a severe drought for the middle of the South Island last year was the leading contributor to the jump in colony loss.

The drought's main impact was causing nectar and pollen sources to deplete, leading to bees dying from starvation, Taylor said.

For the middle of the South Island, encompassing Canterbury and the West Coast, the loss was 11.4 per cent compared to 7.2 per cent in 2016.

Pleasant Point Apiaries beekeeper Paul Bartrum said, however, the varroa mite - a parasite that attaches to bees and sucks fat from them - has been the main killer of his South Canterbury hives because the mites are gaining a resistance to treatments.

"It's certainly the biggest challenge facing beekeeping."

Too big, too close bee yards risk hive losses

JENNIFER EDER
Last updated 07:18, April 27 2018

SCOTT HAMMOND/STUFF

J Bush and Sons managing director Murray Bush says "greedy" beekeepers are cramming too many hives into one area, causing disease to run rampant and bees to starve.

As demand for mānuka honey peaks, so does the risk of disease and starvation in New Zealand's increasingly competitive beekeeping industry.

New Zealand lost 10 per cent of its beehives last year, a small fraction compared to other countries, but experts are warning a boom in the industry could lead to exponential hive losses.

The Ministry for Primary Industry's third annual survey on beehive losses was answered by 2066 beekeepers, representing 30 per cent of the country's bee colonies.

It warns that as the number of bee colonies rises, good beekeeping practices must be maintained to prevent the devastating hive losses seen in the United States and several European countries.

While we have **clear** "other" threats: Neonics *may* be important

- Bees die from many different causes
- We cannot rule out pesticides as contributing to disease susceptibility or queen failure….
- But are we like Hungary, Germany or the UK? (where the effects of neonics on bees seemed different in each)
- If beekeepers really want to know: **support a study**

Government policy should be driven by science (and an appropriate interpretation of science)

VICTORIA

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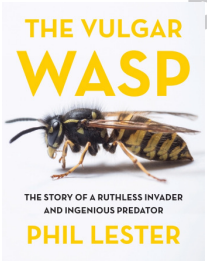
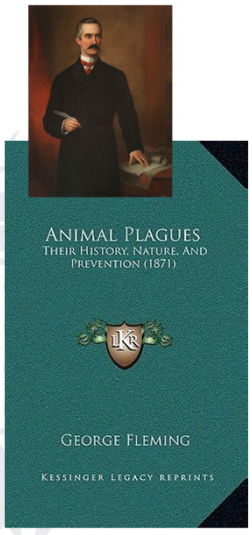
Thanks!

VICTORIA UNIVERSITY WELLINGTON
TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI

A "*great, spectacularly awesome book*" →
I have a few copies with me, but also available from
Victoria University Press http://vup.victoria.ac.nz



George Fleming on Bees



On medieval bee mortality events:

"Men gazed at the phenomena with astonishment, and even before they had a just perception of their nature, pronounced their opinions, which, as they were divided into strongly opposed parties, they defended with all the ardour of zealots."

Neonics are everywhere

RESEARCH

NEONICOTINOIDS

A worldwide survey of neonicotinoids in honey

E. A. D. Mitchell,[1,2*] B. Mulhauser,[2] M. Mulot,[1†] A. Mutabazi,[3‡] G. Glauser,[3] A. Aebi[1,4]

Growing evidence for global pollinator decline is causing concern for biodiversity conservation and ecosystem services maintenance. Neonicotinoid pesticides have been identified or suspected as a key factor responsible for this decline. We assessed the global exposure of pollinators to neonicotinoids by analyzing 198 honey samples from across

least frequent in South America and (table S4 and Fig. 1). Frequency of oc was highest for imidacloprid (51% of s and lowest for clothianidin (16%). M and average concentrations among posi ples were highest for acetamiprid and prid (table S5).

The frequency of occurrence of in neonicotinoid in honey samples and th tive contribution to the overall neoni concentration varied among the region Imidacloprid dominated overall concer in Africa and South America, thiacl Europe, acetamiprid in Asia, and thiam

- Measured the concentrations of five commonly used neonicotinoids— acetamiprid, clothianidin, imidacloprid, thiacloprid, and thiamethoxam—in 198 samples collected through a citizen science project

Neonicotinoid ban hit UK farmers hard

Bugs devour rapeseed crop in Britain as EU ban on pesticide to save bees comes into force

Leaves on a young shoot of rapeseed oil plant eaten by bugs. Photograph: Louise Gray

theguardian

October, 2014

Kendall, chairman of the Agriculture and Horticulture Development Board (AHDB), has already sprayed his crop in Bedfordshire three times this year with an alternative insecticide, before giving up, replanting and spraying again. He believes the pyrethroids he is using are worse for insects in the soil now, like ground-nesting bees and scarab beetles.

"There is a strong feeling among farmers that we are worse off and the environment is worse off," he says.

Neonics are in NZ honey

Country	Geographical coordinates		Precision *	Concentration [ng/g honey] ACE	CLO	IMI	THP	THM	% of EU MRL (in brackets below: MRL in ng/g) ACE (50)	CLO (10)	IMI (50)	THP (50)	THM (10)	Sum of % EU MRL #
New Zealand	35°52 S	174°26 E	1	< LOQ	< LOQ	< LOQ	< LOQ	0.344					0.69%	0.69%
New Zealand	43°58 S	170°20 E	3	0.034	< LOQ	0.063	0.018	0.337	0.07%		0.13%	0.04%	0.67%	0.90%
New Zealand	43°18 S	171°49 E	2	< LOQ	< LOQ	0.020	< LOQ	< LOQ			0.04%			0.04%
New Zealand	43°19 S	171°50 E	2	< LOQ	< LOQ	0.071	< LOQ	< LOQ			0.14%			0.14%

Concentration [ng/g honey] ACE	CLO	IMI	THP	THM
< LOQ	< LOQ	< LOQ	< LOQ	0.344
0.034	< LOQ	0.063	0.018	0.337
< LOQ	< LOQ	0.020	< LOQ	< LOQ
< LOQ	< LOQ	0.071	< LOQ	< LOQ

g) Sum of % EU MRL #
0.69%
0.90%
0.04%
0.14%

- Thiamethoxam and imidacloprid most common
- Values of < 0.377 ng/g [1 ng = one thousand-millionth of a gram]

Table S8. Compilation of statistically significant effects of neonicotinoids on honeybees, wild bees and other non-target pollinators and at Maximum Recommended Field Concentration (MRFC) or lower concentrations.

Pesticide	Measured variable	Reported effect	Concentration used [ng/g]	[ng/ml]	[ng/ind.]	Reference	
Imidacloprid	Mortality	Significant increase	0.7			Alaux et al. 2010	
Imidacloprid	Size of hypopharyngeal glands (HPGs)	Significant decrease in combination with *Nosema* infection	7			Alaux et al. 2010	Conc specifie informati by
Imidacloprid	Glucose oxidase activity	Significant decrease in combination with *Nosema* infection	7			Alaux et al. 2010	Conc specifie informati by
Imidacloprid	Foraging performance	-6% to -20%	1-10			Cresswell 2011	1
Thiamethoxam	Homing capacity of foraging bees	-10% to -32%		0.067		Henry et al. 2012	1.34 ng
Imidacloprid	Olfactory associative behavior of adult bees when larvae were exposed	Significant decrease			0.04	Yang et al. 2012	0
Imidacloprid	Mushroom body Kenyon cells (KC) neuronal firing and nicotinic response	Depolarization of KC & inhibition of Acetylcholine-evoked responses	2.56	2.56		Palmer et al. 2013	Mushroo a 10 depol sustani Nicotir
Clothianidin	Mushroom body Kenyon cells (KC) neuronal firing and nicotinic response	Depolarization of KC & inhibition of Acetylcholine-evoked responses	2.50	2.50		Palmer et al. 2013	Mushroo a 10 depol sustani Nicotir
Imidacloprid	Volume of hypopharyngeal gland's lobe	-15% to -16%	2.1 & 2.7			Hatjina et al. 2013	2.1 ng/g 2.7 ng/g
Imidacloprid	Bursting pattern of abdominal ventilation movements: inter-	+59%	2.1 & 2.7			Hatjina et al. 2013	2.1 ng/g 2.7 ng/g