How do neonicotinoids affect bees and what is the evidence?

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Europe bans neonicotinoids: shouldn’t we?
Neonicotinoids?

- They are “nicotinic acetylcholine receptor agonists”: they bind to and block open nerve receptors in the insect brain.
- Most neons are toxic to insects in minute quantities – the LD₅₀ for ingestion of imidacloprid in honeybees is 5 nanograms per insect.

Neonics are everywhere

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".


But do realistic levels of Neonic exposure kill bees?

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

**NEONICOTINOIDs**

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


Neonicotinoid seed dressings have caused concern worldwide. We used 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 spread. It is not clear whether these negative effects are due to soil residues or to pollen and nectar contamination. For bumble bees, the only managed bee species tested, we found no effect in Hungary, and exposure to neonicotinoids reduced worker nectar production in Germany. For wild bees, we found moderate negative effects for Apis mellifera in Germany, and no effect in Hungary (Fig. 1).


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

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

- **Honeybee Oilseed rape flowering**
  - Worker numbers
  - Egg cells
  - Larval cells
  - Pupal cells
  - Storage cells

- **Post winter**
  - Hive survival
  - Worker numbers
  - Brood cells
  - Storage cells

- **Wild bees**
  - *O. bicornis*
  - *B. terrestris* queen
  - *B. terrestris* drone
  - *B. terrestris* worker
  - *B. terrestris* hive weight

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The evidence is clear: insecticides kill bees. The industry denials look absurd

Patrick Barkham

The largest field trials to-date offer irreducible proof. We need a total ban, now, to suit the safeguard of our own best interests.
What should we do? Well, what kills bees here?

**Leading causes of colony losses include**
- queen problems
- suspected varroa and related complications
- suspected starvation
- wasps

- Losses to natural disasters, robbing by other bees, American Foulbrood, suspected diseases, accidents, theft/vandalism, and Argentine ants
Pleasant Point Apiaries beekeeper Paul Bartrum said the Varroa mite is "certainly the biggest challenge facing beekeeping."

South Canterbury beekeepers have found a challenging summer with drought and the varroa mite impacting hives. The Ministry for Primary Industries’ DPI released its Bee Health (New Zealand) Apiary report for 2017, which estimated 33 per cent of New Zealand beekeepers to have lost the entire hive and the main reasons for it. MAF aquatic and environment health manager Dr Michael Tait said a survey sought 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 sugar and pollen sources to dry up, leading to bees dying from starvation, Tait said.

For the middle of the South Island, encompassing Canterbury and the West Coast, the loss was 14.4 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 spreads from them - was the main killer at his South Canterbury hive because the hives are gaining a resistance to treatments.

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

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

"[Stuart and Bees managing director Howard Rush's] 'golden' manukas are harvesting too many from the one hive, leaving the industry in a vulnerable position to varroa," Rush said.

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

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)
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)
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Thanks!

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

George Fleming on Bees
Neonics are everywhere

A worldwide survey of neonicotinoids in honey

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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 the globe in October, 2014.

• 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

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

- 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 at Maximum Recommended Field Concentration (MRFC) or lower concentrations.

<table>
<thead>
<tr>
<th>Pesticide</th>
<th>Measured variable</th>
<th>Reported effect</th>
<th>Concentration used (ng/g)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imidacloprid</td>
<td>Mortality</td>
<td>Significant increase</td>
<td>0.7</td>
<td>Alaux et al. 2010</td>
</tr>
<tr>
<td></td>
<td>Size of hypopharyngeal glands (HPGs)</td>
<td>Significant decrease in combination with Nosema infection</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Glucose oxidase activity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Imidacloprid</td>
<td>Foraging performance</td>
<td>-6% to -20%</td>
<td>1-10</td>
<td>Crosswell 2011</td>
</tr>
<tr>
<td>Thiamethoxam</td>
<td>Homing capacity of foraging bees</td>
<td>-10% to -32%</td>
<td>0.067</td>
<td>Henry et al. 2012</td>
</tr>
<tr>
<td>Imidacloprid</td>
<td>Offactory associative behavior of adult bees when larvae were exposed</td>
<td>Significant decrease</td>
<td>0.04</td>
<td>Yang et al. 2012</td>
</tr>
<tr>
<td>Imidacloprid</td>
<td>Mushroom body Kenyon cells (KC) neuronal firing and nicotinic response</td>
<td>Depolarization of KC &amp; inhibition of Acetylcholine-evoked responses</td>
<td>2.56 &amp; 2.56</td>
<td>Palmer et al. 2013</td>
</tr>
<tr>
<td>Clothalidin</td>
<td></td>
<td></td>
<td></td>
<td>Mushroom &amp; depolarization of Nicotinic</td>
</tr>
<tr>
<td>Imidacloprid</td>
<td>Volume of hypopharyngeal gland’s lobe</td>
<td>-15% to -16%</td>
<td>2.1 &amp; 2.7</td>
<td>Hatjina et al. 2013</td>
</tr>
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<td></td>
<td>Bursting pattern of abdominal ventilation movements: inter-</td>
<td></td>
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</tr>
</tbody>
</table>

[LOQ: Limit of quantification]