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When and where neonicotinoids are bad for bees

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The impact of neonicotinoids on bees has always been a contentious issue, not least because reported evidence of their effects has been variable. Neonicotinoids are most often applied to crop seeds, rather than sprayed directly on plants. As the plant grows the pesticide moves though the roots, leaves and flowers providing protection against pests. Unfortunately pests are not the only thing feeding on plants, and bees collecting their pollen and nectar can also become exposed. Levels of neonicotinoids found in pollen and nectar are often very low (e.g. in parts per billion) so the effect on bees can therefore be more subtle, with one of the most widely reported impacts being the loss of foraging honeybees who become disorientated due to the impact of the chemicals on their brains. Over time this has been shown to reduce the number of bees in colonies, and has the potential to affect long term colony survival (read also the breaks:
A dangerous habit: bees prefer pesticide-contaminated nectar and
The use of neonicotinoid pesticides affects wild bee populations). While many studies have identified negative effects on honeybees and wild bees they have often been criticised for not reflecting what we see in the real world. For example, laboratory doses of neonicotinoids often represent the upper limit of what you may find under agricultural conditions and these experiments are often very short term. The study just published by the Centre for Ecology & Hydrology, and funded in part by industry, describes the biggest "real world" experiment of neonicotinoid effects. The results provide important new evidence to inform this debate.
The study comprised a large scale trial on 33 farms in three countries (UK, Germany and Hungary) where we sowed oilseed rape that was either treated or not treated with the two most commonly used neonicotinoids (Clothianidin or Thiamethoxam). Large areas of the crop (on average 60 ha) were sown on each farm representing typical practice. For honeybees, we found for the first time evidence of negative effects of a neonicotinoid under real agricultural conditions. Specifically, bees on Hungarian and UK farms exposed to clothianidin in the previous year suffered higher mortality over the winter. This is the first time this has been shown and is something considered by the European Food Safety Authority (EFSA) (who assess the safety of pesticides for consumers in the EU) to be one of the three most important measures with which they assess impacts of pesticides on honeybees. Another key measure for understanding pesticide impacts on honeybees is a reduction in honeybee numbers when they feed on the treated crop. Again, we also find that when honeybees foraged on clothianidin treated oilseed rape their numbers were reduced, although only in the UK. In Germany, we either didn't find an effect of neonicotinoids, or in some cases we even found a positive effect (egg numbers when the crop was flowering). These differences between countries were surprising, and pointed to a more complex story. However, by looking in detail at each country we were able to make some deductions about what was happening. As is the

case when people are sick or have a poor diet so they become far more likely to succumb to other stresses, so the same thing appears to be happening for the honeybees. In Hungary and the UK honeybees were more diseased (Varroa mites and the fungal parasite Nosema) and had poor diets dominated by oilseed rape (there was few other flowers to feed on). It was in these countries where we found negative effects of neonicotinoids. In contrast, the bees in Germany were much healthier and had a more diverse diet not dominated by oilseed rape. It is also likely that the late flowering crop in Germany may have contained lower levels of neonicotinoids as over longer periods of time they would be more likely to disappear. As a result while the bees were exposed to less pesticides, the crop benefiting from neonicotinoids use may have provided a healthier more flowering crop which the bees temporarily benefited from.

In addition to the honeybees we also looked at two wild bee species (a bumblebee, *Bombus terrestris* and a solitary mason bee, *Osmia bicornis*) and found that their reproductive success (new queens in the case of bumblebees and egg cells for solitary bees) was significantly reduced when their food contained higher concentrations of neonicotinoids. Overall, this study is further evidence that neonicotinoids can have negative effects on bees under real world conditions. However, it also highlights that the negative effects (at least for honeybees) are often context dependent. A good agricultural environment rich in wild flowers (particularly early in the year) and better approaches to managing honeybee health may mean that it may be possible to reduce the effects of exposure to neonicotinoids. However, good evidence derived from new robust and large-scale field experiments would be needed to test if this is true.