Part A Set Task Information

Article 1:

Bees may become addicted to nicotine-like pesticides, study finds

Bees have a preference for sugar solutions laced with the pesticides, scientists say, as a separate landmark field trial shows neonicotinoids harm bee populations.

A foraging red-tailed bumblebee: a study says bees get a 'buzz' from nicotine-like pesticides in much the same way as smokers are stimulated by tobacco.
Photograph: Jonathan Carruthers/PA
Karl Mathiesen

Bees may become addicted to nicotine-like pesticides in the same way humans get hooked on cigarettes, according to a new study, which was released as a landmark field trial provided further evidence that such neonicotinoids harm bee populations.

In a study published in the journal Nature, scientists from Newcastle Univeristy showed that bees have a preference for sugar solutions that are laced with the pesticides imidacloprid and thiamethoxam, possibly indicating they can become hooked on the chemicals.

Also published in Nature on Wednesday was a study that has been endorsed as the most conclusive evidence yet that the group of pesticides, neonicotinoids, harm wild bee populations, which include bumblebees and solitary bees.

Scientists from Lund University in Sweden carried out the first successful 'real world' experiment on the effect of neonicotinoids on bees and found that wild bee populations halved around fields treated with them. Bumblebee hives stopped growing and produced less queens where the chemical was present. However the study did not find evidence that more robust honeybees, which are used to pollinate many crops, were affected.

Dr Maj Rundlöf, the lead author of the study, said the impacts on wild bees were "dramatic". "I think it's really important evidence when discussing how neonicotinoids used in real agricultural landscapes influence bees," she said.

Dave Goulson, a bee expert at Sussex University, not involved in the research, hailed the findings as hugely significant.

"At this point in time it is no longer credible to argue that agricultural use of neonicotinoids does not harm wild bees." He said the paper was "a major step forwards in clarifying the neonicotinoid debate… This was the first fully field-realistic, well-replicated trial so far, an impressive piece of work."

Previous field experiments on neonicotinoids have been shown to be inadequate. The current EU moratorium on the use of a group of neonicotinoids on certain crops has been criticised, particularly by the UK government, on the basis that field evidence of neonicotinoids harming bee populations has been difficult to obtain.

Nick von Westenholz, chief executive of the Crop Protection Association that represents neonicotinoid producers Bayer and Syngenta, said: "The latest studies in Nature must be seen in the context of an ongoing campaign to discredit neonicotinoid pesticides, regardless of what the real evidence shows."

He said Rundlöf's results were questionable as the levels of the pesticide found in pollen on the bees was higher than in previous studies, suggesting that Rundlöf had treated the crops herself rather than using industry-standard seeds. Rundlöf said the rapeseed in the study were treated following the manufacturers' recommendations.

"Bayer CropScience is pleased the Swedish study demonstrates yet again there is no effect of neonicotinoids on honeybee colonies in realistic field conditions, consistent with previous published field studies," said a spokesman for the agrochemical giant. But it criticised the methodology of Rundlöf's experiment and said the study offered no proof of increased bee deaths.

Rundlöf said the field trial was not sensitive enough to detect anything less than a 20% drop in colony strength. Honeybee colonies are larger and contain far more worker bees than wild bees, meaning it would take longer for neonicotinoids to impact the hives.

Dr Christopher Connolly, from the Medical Research Institute at Dundee University, said: "Much longer periods would be required to detect deficits in honeybee colonies." He said the evidence of the effect on bumblebees was a "major advance".

In the other study published on Wednesday, a team at Newcastle University in England discovered bees cannot detect the presence of neonicotinoids at

low levels. In fact for two varieties of pesticide they tended to prefer toxin-laced sucrose.

Scientists suggested the chemicals, which have a similar molecular structure to nicotine, may be affecting the reward centres in a bee's brain in the same way humans are affected by cigarettes.

Professor Geraldine Wright, who led the study, said that the addictive effect was not something they had tested for and was only a hypothesis.

"Like nicotine they are essentially amplifying the rewarding properties of the sucrose solution that they are located in and the bees think its more rewarding so they go back to that food tube to drink more of it," she said. Previous studies have showed rat' brains responding to neonicotinoid in this way.

Wright said she was confident the evidence that bees cannot taste neonicotinoids would be replicated in the field. This contradicts previous suggestions, again from the UK government among others, that bees can choose to collect pollen from non-treated plants.

Connolly said: "It will be interesting to see if insects become addicted to neonicotinoids over time as humans become addicted to nicotine. Given that the neonicotinoids are commonly found in our farmed environment at these levels, this may have already occurred."

The pesticide industry said even if there was a preference, there was no effect on the bees' health. "What's important is not whether bees show a slight preference for these crops, but that there is no effect on their health when field-realistic amounts of these pesticides are used," said von Westenholz.

Goulson said that even before the new studies were published on Wednesday, "there was already a large body of evidence which very strongly suggested that exposure of bees to neonicotinoids at field-realistic doses did them substantial harm."

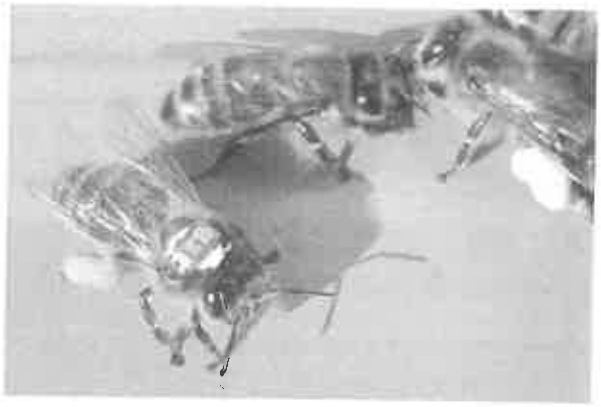
(Source: http://www.theguardian.com/environment/2015/apr/22/bees-may-become-addicted-to-nicotine-like-pesticides-study-finds)

Article 2

Plight of the bumblebee: Pesticides linked to the decline of bee colonies

23:02, 29 March 2012
By Agency staff

Two studies provide some of the strongest evidence yet that pesticides sprayed on farmers' fields threaten bumblebees and honeybees.



Bee side: Tracking device on their backs

Common pesticides could be wiping out bee colonies by causing pollen-gathering insects to lose their way home, research suggests.

Two studies provide some of the strongest evidence yet that pesticides sprayed on farmers' fields threaten bumblebees and honeybees.

One team of British scientists showed that bumblebee colony growth slowed after exposure to one of the chemicals.

Another group of French researchers tracked foraging honeybees and found that another pesticide tripled their chances of dying away from the hive.

The chemical was thought to disrupt the bees' homing systems, causing them to get lost and perish.

Insecticides called neonicotinoids may be partly to blame for Colony Collapse Disorder, the research suggests.

The phenomenon, marked by the abrupt disappearance of honeybee colonies, is a growing problem in northern hemisphere countries. Bumblebees are also at risk.

Professor Dave Goulson, from the University of Stirling in Scotland, who led the British study, said: "Some bumblebee species have declined hugely.

"For example in North America, several bumblebee species, which used to be common, have more or less disappeared from the entire continent. In the UK, three species have gone extinct."

Declining: A bumblebee foraging among flowers

A number of theories have been put forward to explain the declines, including the use of pesticides.

Both research groups focused on neonicotinoids, which were introduced in the early 1990s and are now widely used around the world.

The chemicals are nerve agents that spread to the nectar and pollen of flowering plants.

Doses of the pesticides used on crops are not allowed to be lethal to bees. But the evidence suggests there may be significant indirect effects, such as interfering with an insect's ability to navigate.

The British study exposed developing colonies of bumblebees, Bombus terrestris, to low levels of a neonicotinoid pesticide called imidacloprid.

Colonies were then placed in an enclosed site where the bees could forage naturally for six weeks.

At the start and end of the experiment, researchers weighed the bumblebee nests, including the bees, wax, honey, grubs and pollen.

Exposed colonies were found to gain less weight than untreated colonies, indicating that foraging bees were bringing less food back to the hive.

On average, the treated colonies were 8% to 12% smaller at the end of the study. They also produced 85% fewer queens, the vital founders of future new colonies.

After the winter die-off, the lack of queens could mean 85% fewer nests in the coming year.

"Bumblebees pollinate many of our crops and wild flowers," said Prof Goulson. "The use of neonicotinoid pesticides on flowering crops clearly poses a threat to their health, and urgently needs to be re-evaluated."

Bees are good, bees are good: But three species have gone extinct in the UK

The French team tagged free-ranging honeybees with tiny radio tracking devices glued to their thoraxes.

Some of the bees were then exposed to sub-lethal doses of the pesticide thiamethoxam. They proved to be two to three times more likely to die while away from their nests than untreated bees.

Between 10% and 32% of bees failed to return to their colonies after being released up to a kilometre away and foraging in treated crops.

Bees that were unfamiliar with the foraging site were most likely not to return home. The findings suggested that the pesticide upset their navigation skills.

Data from the tracking experiment was used to predict what might happen to colonies with "lost" worker bees.

The scientists found it was possible for bee populations to decline to a point where they might not recover.

Mickael Henry, from the INRA agricultural research institute in Avignon, said: "Our study raises important issues regarding pesticide authorisation procedures. So far, they mostly require manufacturers to ensure that doses encountered on the field do not kill bees, but they basically ignore the consequences of doses that do not kill them but may cause behavioural difficulties."

Environmental group Friends of the Earth called the findings, published in the journal Science, "very significant".

aul de Zylva, head of the group's Nature and Ecosystems Programme, said: "The bee is a cherished icon of the British countryside and our gardens and is the farmer's friend that helps pollinate our food crops so we cannot afford further decline.

"We now need the Government to look seriously at the emerging evidence from here and other countries and consider whether neonicotinoid pesticides should continue to be used freely in the UK."

(Source: from: http://www.mirror.co.uk/news/uk-news/pesticides-linked-decline-bee-colonies-776567)

Article 3

Sick Bees – Part 18F2: Colony Collapse Revisited – Synthetic Pesticides

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ScientificBeekeeping.com

OK, I hope that since explaining that bees have always had to deal with natural plant toxins, and more recently, with human pollution, that I can finally move on to attempting to answer the original question, "To what extent are manmade pesticides related to colony morbidity, mortality, or sudden collapse?"

Synthetic Pesticides

Not being a toxicologist, I had always assumed that synthetic pesticides were chemically and biologically in a different class than the natural allelochemicals found in nature. How wrong I was!

Synthetic insecticides are essentially nothing more than chemically "tweaked" forms of natural substances, generally modified to make them cheaper, more effective, more or less stable, less toxic to humans, more targeted toward specific pests, and recently, more environmentally friendly. For a good summary of this subject, read John Tierney's "Synthetic v. Natural Pesticides" [1].

Preadaptation

There is nothing new about honey bee exposure to pesticides - bees had by necessity been forced to develop detoxification mechanisms for these classes of chemicals long before humans invented modern pesticides! Prior to that (and still today), bees were exposed to naturally-occurring organochlorides from many natural sources [2], organophosphates produced by cyanobacteria in surface waters [3], carbamates as a natural fermentation byproduct of beebread [4], nicotine (as in neonicotinoids) in a number of plant species [5], pyrethrins (derived from chrysanthemums) [6], insect growth regulators (self-produced hormones), and a host of alkaloids and other toxins in pollen and nectar.

A term used by toxicologists is ***preadaptation***. Honey bees are, by necessity, preadapted to deal with the major classes of synthetic pesticides; the toxicology and metabolism of synthetic insecticides is no different than that for natural toxins (although the synthetics may have a greater degree of toxicity). And despite the widely-cited paucity of detoxification genes in the honey bee genome, Hardstone [7] determined that compared to insects in general, honey bees are not particularly sensitive to insecticides overall, nor even to specific classes of insecticides!

If it hasn't already occurred to you, think on this: there are any number of nectar/honeydew sources that bees concentrate into honey that may be acutely toxic to humans (rhododendron, mountain laurel, tutu, etc.), yet

does not appear to affect the bees to any great extent. The toxins of those named plants (grayanotoxin and tutin) are poisonous to insects, yet bees are able to detoxify them better than humans can!

Cresswell [8] notes that some bees may be better preadapted to toxins than others. Remember that I mentioned earlier that tropical nectars tend to contain more alkaloids? Well, honey bees evolved in the tropics, and are apparently well preadapted to metabolize alkaloids, whereas bumblebees evolved in temperate regions in which there were fewer natural alkaloids in the nectars. It's possible that honeybees may be better preadapted to detoxify alkaloids (such as neonicotinoids) than are bumblebees.

Have you noticed yet that this is a complex subject? And that is one reason why I feel that the single-minded focus by some folk on any one particular class of insecticides may be misguided. Lest I sound critical of my fellow environmentalists, I suspect that many remain under the misassumption that *all* pesticides bioaccumulate or biomagnify as do the "Persistent Organic Pollutants" (DDT, chlordane, PCB's, etc) and heavy metals (mercury, lead). Gold [9] explains:

DDT is unusual with respect to bioconcentration, and because of its chlorine substituents it takes longer to degrade in nature than most chemicals; however, these are properties of relatively few synthetic chemicals. In addition, many thousands of chlorinated chemicals are produced in nature… Natural pesticides can also bioconcentrate if they are fat soluble. Potatoes, for example, naturally contain the fat-soluble neurotoxins solanine and chaconine, which can be detected in the bloodstream of all potato eaters.

Oh no—not only do French fries contain toxic acrylamide, but also additional neurotoxins that bioaccumulate in my body fat!

Reality check: our diet, as well as that of the bees, is chock full of natural plant toxins (many of which have been only recently been introduced into the human diet). The bee immune* system does not differentiate between natural toxins, environmental pollutants, or synthetic pesticides. They must all be taken into consideration when we discuss "chemicals" and bees. Rather than focusing on this pesticide or that, what we beekeepers should be assessing is the total toxin load to which colonies in any particular setting are exposed.

Update 4/27/2013: It's been pointed out to me that I've used the term "immune" too loosely. I should have used the term "detoxification."

Interactions Between Synthetic and Natural Toxins

Bees in agricultural landscapes, as well as in urban and suburban areas, are exposed to a wide variety of manmade toxicants above the background level of natural toxins. Surprisingly, previous exposure to plant allelochemicals may help them to deal with manmade toxicants!

Després [10] found that eating certain natural toxins in a plant may then make an insect more resistant to certain synthetic pesticides. Armyworms fed cowpeas became more tolerant to organophosphates. And those fed xanthotoxin from corn displayed higher tolerance to a pyrethroid insecticide–and appeared to be able to pass that immunity on to their offspring! Don't you just love this stuff!

Biological note: we've barely investigated to what degree the exposure of the previous generation of bees to alleleochemicals or pesticides results in trans-generational epigenetic effects.

On the other hand, Després also found that:

By contrast, exposure to particular plant chemicals can repress the expression of detoxification enzymes involved in insecticide resistance…Finally, it cannot be excluded that an enzyme conferring resistance to a phytotoxin can enhance the toxicity of an insecticide and vice versa. The striking complexity of the repression–induction patterns and substrate specificities of detoxification enzymes has so far represented a major difficulty in the understanding of cross-resistance mechanisms.

"Striking complexity" – well put! Even the type of honey that bees are eating enters into the picture. A study by Mao [11] found that allelochemicals in honey may affect their ability to metabolize pesticides. The researchers also speculate that the practice of wintering bees on sugar syrup may compromise their ability to process environmental toxins!

I hope you are starting to understand why I couldn't just jump into answering the question as to whether pesticides cause CCD! There are a great many contributory variables when we start looking at toxicity, and we just don't yet know that much about a lot of them! But there is one thing that we do know – that there was a major change in honey bee exposure to toxicants starting (in this country) in the 1990's.