Royal pain. Bumble bee hives produce fewer queens (*top*) when exposed to pesticides.

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AGRICULTURE

Field Research on Bees Raises Concern About Low-Dose Pesticides

Five years ago, bees made headlines when a mysterious condition called colony collapse disorder decimated honey bee colonies in parts of the United States (*Science*, 18 May 2007, p. 970). Now bees are poised to be in the news again, this time because of evidence that systemic insecticides, a common way to protect crops, indirectly harm these important pollinators. Two field studies reported online this week in *Science* document problems (http://scim.ag/MHenry, http://scim.ag/Whitehorn). In bumble bees, exposure to one such chemical leads to a dramatic loss of queens and could help explain the insects' decline. In honey bees, another insecticide interferes with the foragers' ability to find their way back to the hive.

Researchers say these findings are cause for concern and will increase pressure to improve pesticide testing and regulation. "It's going to cause an absolute firestorm," predicts James Cresswell, an ecotoxicologist at the University of Exeter in the United Kingdom, who was not involved in the research. Bayer CropScience, the main producer of systemic pesticides, maintains that its products are not a culprit in honey bee declines, and many independent experts aren't convinced by the evidence against pesticides, adding that pathogens and parasites are the main problem.

In the United States alone, 59 million hectares of crops are protected by systemic pesticides. Seeds are treated with these neurotoxins before planting, and the poison suffuses the tissues, pollen, and nectar. Typical levels of imidacloprid, the most common of a family of widely used pesticides called neonicotinoids, are not lethal to bees, according to a meta-analysis by Cresswell published in *Ecotoxicology* last year. But there is growing evidence from laboratory experiments that neonicotinoids can harm memory and navigation in bees. However, realistic field tests were lacking.

David Goulson, a bumble bee biologist at the University of Stirling in the United Kingdom, and colleagues have now studied the bumble bee *Bombus terrestris* under seminatural conditions. Mimicking the bees' exposure to imidacloprid in canola, they fed bumble bees a controlled diet in the laboratory. Twenty-five colonies received pollen treated with six parts per billion of the pesticide. Another 25 colonies got double that dose, and 25 more served as a control. After 2 weeks, the blooming period for canola, the researchers placed the colonies in a field for 6 weeks to forage on gardens, wildflowers, and a variety of crops.

At the end of the experiment, the hives with the bees that had eaten the imidacloprid in the lab weighed 8% to 12% less than the 25 untreated hives—an indication that the bees had gathered less food and produced fewer workers. The most important difference was the number of queens produced; the control hives averaged 13 queens, compared with 2 and 1.4 in the treated hives. "That is quite dramatic," Dennis vanEngelsdorp of the University of Maryland, College Park, says. It suggests that pesticides may be contributing to the decline of bumble bees, which are already suffering from habitat loss.

Tjeerd Blacquière of Plant Research International in Wageningen, the Netherlands, who was not involved in the study, says Goulson's results are probably a worst case scenario because the affected bumble bees were forced to consume only one kind of pollen—pesticide tainted—in the lab, whereas they would probably have a choice in the wild, thus lowering the dose.

Why the hives produced fewer queens isn't clear, but Goulson says that if imidacloprid hinders the navigation ability of the foragers, they might not have gathered enough food for the queen to reproduce more queens.

Foraging problems are exactly what Axel Decourtye of the Association for Technical Coordination in Agriculture in Avignon, France, and his colleagues found in a field study of honey bees. Decourtye's team glued tiny radio-frequency tags to the backs of 653 honey bees. Up to 43.2% of the bees given a sublethal dose of thiamethoxam didn't return to the hive, depending on how far away the bees were released and how unfamiliar the terrain, compared with 16.9% of untreated bees. "We were quite surprised by the magnitude of the effect," co-author Mickaël Henry of the French National Institute for Agricultural Research in Avignon says.

The team plugged the mortality rates into a model of honey bee population dynamics and found that many colonies would dwindle. Jeffrey Pettis of the U.S. Department of Agriculture in Beltsville, Maryland, doubts that the mortality rates would cause colony collapse disorder or other loss of hives, but says that he is a co-author of a study nearing publication that will strengthen the case that neonicotinoids can harm hives. Other unpublished work shows an impact on native, solitary bees, he says.

David Fischer, an ecotoxicologist at Bayer CropScience in Research Triangle Park, North Carolina, says both studies used doses that were higher than what he thinks is present in crops. Nailing down the actual levels should be a priority, Cresswell says.

The findings reinforce the recommendations of a major report, issued last September under the auspices of the Society of Environmental Toxicology and Chemistry and written by scientists from universities, industry, and regulatory agencies. They called for more sensitive tests, such as feeding pesticides to larvae and immature bees, and including bumble bees and native bees as well.

Regulatory agencies are starting to move, if slowly. The European Food Safety Authority is considering new guidelines for risk assessments of pesticides for bees. For its part, the U.S. Environmental Protection Agency will convene a scientific advisory panel to address similar questions in the fall. **–ERIK STOKSTAD**