Pesticide build-up could lead to poor honey bee health

Honey bees industriously bring pollen and nectar to the hive, but along with the bounty comes a wide variety of pesticides, according to Penn State researchers. Add the outside assault to the pesticides already in the waxy structure of the hive, and bee researchers see a problem difficult to evaluate and correct. However, an innovative approach may mitigate at least some beeswax contamination.

The researchers present their analysis of pollen, brood, adult bees and wax samples today (Aug 18) at the 236th national American Chemical Society meeting in Philadelphia. Those results show unprecedented levels of fluvalinate and coumaphos -- pesticides used in the hives to combat varroa mites -- in all comb and foundation wax samples. They also found lower levels of 70 other pesticides and metabolites of those pesticides in pollen and bees.

"Everyone figured that the acaricides (anti-varroa mite chemicals) would be present in the wax because the wax is reprocessed to form the structure of the hives," says Maryann Frazier, senior extension associate. "It was a bit of a shock to see the levels and the widespread presence of these pesticides."

While the researchers expected the presence of the chemicals available to treat varroa mites in the hives, the other pesticides' levels were also surprising. All of the bees tested showed at least one pesticide and pollen averaged six pesticides with as many as 31 in a sample.

"We already had in place ways to test for viruses, bacteria and fungi, but it was difficult to find an analytical laboratory that could analyze for unknown pesticides," says Christopher A. Mullin, professor of entomology. "We needed them to take a comprehensive look at all pesticides, not just those associated with beekeeping."

They eventually turned to the National Science Laboratory of the U.S. Department of Agricultural Marketing Service that already tests commodities such as milk and fruits and vegetables to allow them to meet national and international standards.

"When we began doing this work, honey was not regularly analyzed, and bee pollen was not a commodity and so was not analyzed," says Mullin. "We decided to go with the types of screening the lab does for milk and apples which look at over 170 pesticides. Now, honey is included in the commodities to be analyzed."

The researchers, including Roger Simonds, a chemist at the National Science Laboratory decided on a modified QuEChERS (Quick, Easy, Cheap, Effective, Rugged, and Safe) method because it uses smaller samples. They coupled this with gas and liquid chromatography to develop methods of analyzing pollen, bees and wax.

"Simplicity was important because there were many people across the country sampling for us," says Maryann Frazier. "Now rather than having them collect 15 grams of pollen they need only collect 3 grams."

The researchers note that this method also uses less solvent and generates data in the parts per billion range.

While beekeepers will have a difficult time controlling pesticide exposure outside the hive, the researchers tested a method for reducing the acaricide load in beeswax. Using gamma radiation from a cobalt 60 source housed at Penn State's Breazeale Reactor, they irradiated the sheets of beeswax that beekeepers use as the structural foundation for the bees to build their combs. They used radiation levels at the high end of that used to irradiate foods. Irradiation broke down about 50 percent of the acaricides in the wax.

"Gamma radiation is often used to kill viruses and other disease causing agents," says James L. Frazier, professor of entomology, Penn State. "Commercial irradiation firms usually decontaminate medical instruments or foods."

The researchers tried irradiation at a commercial plant and though some modifications were necessary to irradiate the wax sheets, it is possible. Some beekeepers already irradiate their equipment to get rid of any disease causing agents. However, it might be more efficient if the wax sheet supplier irradiated their product before sale to the beekeepers.

Beekeepers cannot manage the environmental pesticide contamination as easily as the wax contamination. The U. S. Environmental Protection Agency does regulate and monitor pesticides, but they do not have the ability to monitor the interaction of these chemicals. With the large number of pesticides found in bees and pollen, interactions are likely.

"We are finding fungicides that function by inhibiting the steroid metabolism in the fungal diseases they target, but these chemicals also affect similar enzymes in other organisms," says James Frazier. "These fungicides, in combination with pyrethroids and/or neonicotinoids can sometimes have a synergistic effect 100s of times more toxic than any of the pesticides individually."

For CCD, bees are not dying in their hives, but are not returning to their hives. James Frazier notes it is difficult to observe bees outside the hive. The U.S. EPA only looks at acute exposure to individual pesticides, but chronic exposure may cause behavioral changes that are unmonitored.

"We do not know that these chemicals have anything to do with Colony Collapse Disorder, but they are definitely stressors in the home and in the food sources," says Dr. Frazier. "Pesticides alone have not shown they are the cause of CCD. We believe that it is a combination of a variety of factors, possibly including mites, viruses and pesticides."

The researchers, who also include Sara Ashcraft, research assistant, have a team uniquely suited to looking at the honey bee pesticide problem because they combine a toxicologist in Mullin, a physiologist in James Frazier and someone with connections to beekeepers across the country in Maryann Frazier.

"We now want to look at small versus large operations and organic versus nonorganic operations to see if there are differences," says Maryann Frazier.

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