Selenium impacts honey bee behavior and survival

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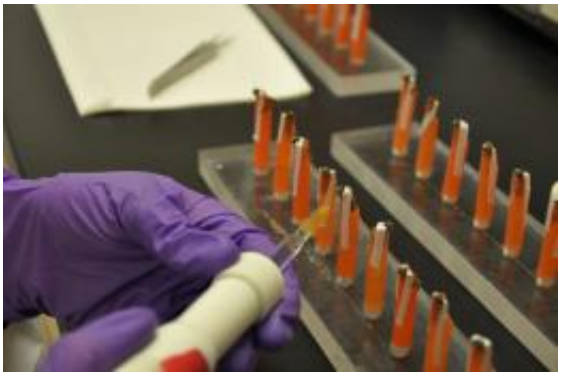

Close-up of the experimental set-up showing a honey bee forager being dosed with a sugar solution containing selenium, a plant-accumulated pollutant. Photo credit: UCR Strategic Communications.

(Phys.org) -- Entomologists at the University of California, Riverside have a “proof of concept” that selenium, a nonmetal chemical element, can disrupt the foraging behavior and survival of honey bees.

Selenium in very low concentrations is necessary for the normal development of insects — and humans — but becomes toxic at only slightly higher concentrations when it replaces sulfur in amino acids. In soils, particularly in Pacific Rim countries and near coal-fired power plants worldwide, it occurs most often in soluble forms, such as selenate.

Wondering what effect selenium concentrations in plants has on honey

bees, John T. Trumble, a professor of entomology, and Kristen R. Hladun, his graduate student, performed controlled greenhouse experiments in which they documented the selenium amounts that three plant species — two kinds of mustards and one weedy radish plant — incorporate into their nectar and pollen after the plants had been irrigated with low to moderate levels of the trace mineral.

They then allowed honey bees to visit the plants. They found that the bees fed on food sources, such as flowers that contained selenium at even very high concentrations.

“Nature has not equipped bees to avoid selenium,” Trumble said. “Unless the rates of concentrations of selenium were extremely high in our experiments, the bees did not appear to respond to its presence.”

Two of the rates of irrigation water Trumble and Hladun tested had selenium concentrations — 0.5 and 0.7 parts per million — that were well below concentrations considered by the US government to be of concern.

“We found, however, that in weedy radish plants even these low rates produced selenium amounts of 60 parts per million in the nectar and 400 to 800 parts per million in the pollen,” Hladun said. “But despite these high amounts, the bees would not avoid the selenium.”

The researchers also found that bees that had been fed selenate in the lab were less responsive to sugar (as sucrose).

“The selenium interfered with their sucrose response,” Hladun explained. “Such bees would be less likely to recruit bees to forage because they wouldn’t be stimulated to communicate information about sucrose availability to the sister bees.”

Trumble and Hladun also measured the mortality of forager bees that were fed selenium chronically (moderate selenium amounts over a few days). They found that these bees died at a significantly younger age.

Study results appear this month in PLoS ONE.

The researchers note that their work, performed in the laboratory, needs to be done next in the field because the bees' reduced response to sugar could diminish floral resources needed to support coworker bees and larvae in the field.

In preliminary studies they conducted in the field, the researchers found that some foragers leaving radish plants were carrying pollen with high concentrations of selenium. Further, they noted that plants with high concentrations of selenium were being visited by foragers just as frequently as were plants with no selenium, suggesting that the bees do not avoid feeding on selenium.

"The consequences of their inability to avoid selenium could be substantial," Trumble said. "We must emphasize that our data do not show that large losses of honey bees are currently occurring or that there is any relationship with Colony Collapse Disorder. Field studies need to be conducted to determine if honey bees collect enough selenium from contaminated plants to cause significant effects on learning, behavior and adult or larval survival."

The researchers already have received a three-year 480,000 grant from USDA-NIFA to take their research from the lab to the field. The grant, which will support Hladun's postdoctoral work at UCR, will allow the researchers also to investigate other elements, such as cadmium and lead, which have been found in urban honeybee hives.

"In our lab experiments, we focused on individual bees," said Hladun,

who will graduate with a Ph.D. this summer. “But bees are social insects. In our future work, we plan also to focus on whole colony health.”

Provided by University of California - Riverside