Insect Armageddon: Low doses of the insecticide, Imidacloprid, cause blindness in insects

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Dr Felipe Martelli says studies have shown that low doses of insecticides can affect insect behaviour but have not uncovered how insecticides trigger changes at the cellular and molecular levels. Credit: Florienne Loder, Bio21 Institute, the University of Melbourne

New research has identified a mechanism by which low levels of insecticides such as, the neonicotinoid Imidacloprid, could harm the nervous, metabolic and immune system of insects, including those that are not pests, such as our leading pollinators, bees.

A study published today in the *Proceedings of the National Academy of Sciences*, led by researchers at the University of Melbourne and Baylor College of Medicine, shows that low doses of Imidacloprid trigger neurodegeneration and disrupt vital body-wide functions, including energy production, vision, movement and the immune system, in the vinegar fly, *Drosophila melanogaster*.

With insect populations declining around the world and intense use of insecticides suspected to play a role, the findings provide important evidence that even small doses of insecticides reduce the capacity of insects to survive, even those that are not pests.

"Our research was conducted on one insecticide, but there is evidence that other insecticides cause oxidative stress, so they may have similar impacts," Professor Philip Batterham, from the School of BioSciences and Bio21 Institute, at the University of Melbourne, said.

"Our findings emphasize the importance of better understanding the mechanisms of action of insecticides, in particular on beneficial insects. Without further research we do not know if other insecticides are any safer."

Imidacloprid, has been banned from agricultural use by the European Union because of concerns about impacts on honeybees, but remains one of the top selling insecticides in the world. Attacking the central nervous systems of the insects, it increases the transmission of stimuli in the insect nervous system, activating receptors resulting in the insect's paralysis and eventual death.

The researchers arrived at the findings by studying the effects of Imidacloprid in vinegar fly larvae. In the field, the insecticide is generally used at concentrations of up to 2,800 parts per million (ppm). In the lab, researchers tested lower doses, identifying that the very small dose 2.5 ppm was enough to reduce the movement of fly larvae by 50 percent after just two hours of exposure.

"That's an indication of the impact of the insecticide on the function of the brain," said Dr. Felipe Martelli, whose Ph.D. work conducted at the University of Melbourne and the Baylor College of Medicine in the laboratory of Professor Hugo Bellen led to the current research paper.

"From there, the accumulation of massive amounts of reactive oxygen species (ROS) or free radicals inside the brain triggers a cascade of damaging events that spread to many other tissues."

Researchers also tested the insecticide on adult flies, finding that flies exposed to very low doses (4 ppm) over 25 days became blind and developed movement problems that affected their ability to climb, symptomatic of neurodegeneration in other parts of the brain.

"Although many studies have shown that low doses of insecticides can affect insect behavior, they have not uncovered how insecticides trigger changes at the cellular and molecular levels," Dr. Martelli, now a research fellow in the School of Biological Sciences at Monash University, said.

More information: Felipe Martelli el al., "Low doses of the neonicotinoid insecticide imidacloprid induce ROS triggering neurological and metabolic impairments in Drosophila," *PNAS* (2020). www.pnas.org/cgi/doi/10.1073/pnas.2011828117

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