////Title: Exposure to Commonly Used Pesticides May Harm Health

////Standfirst:

Conventional agricultural practices have greatly increased the yield and efficiency of modern farming, allowing us to better feed a growing population. To protect crops from pests and disease, we rely heavily on chemical pesticides. However, the impacts of pesticide use are not localised to plants – there is growing awareness that pesticides can negatively affect many other organisms, including humans. Professor Kathleen Susman [Suhs-min] of Vassar College in New York, along with her colleagues, assessed whether a commonly used class of pesticides, neonicotinoids [nee-oh-nick-atin-oids], have the potential to cause damaging effects in non-target organisms. Her findings also have implications for human health.

////Main text:

There are hundreds of pesticides readily available for commercial use. As a result of our heavy reliance on pesticides, low concentrations of these chemicals can be found in our drinking water, in rivers and lakes, non-agricultural soils, and even the air. Although we are all exposed to some pesticides over our lifetimes, agricultural workers are at particularly high risk to being exposed to potentially harmful concentrations of these chemicals.

Pesticides are used to protect crops from insects that eat them or spread plant diseases. Most of these chemicals work by targeting the neural control of muscle contraction in the insect, leading to paralysis and death. Among the five major types of pesticides, neonicotinoids are the most common. This is in large part because they are designed to selectively bind to a specific amino-acid sequence found only in insects. Consequently, they have long been advertised as being harmless to humans and other animals.

However, recent studies have suggested that unintended exposure to neonicotinoids can negatively impact the physiology and behaviour of non-target insects, such as bees, which are important pollinators, and many vertebrate animals including birds, frogs, fish, and mammals.

Given that pesticides have unintended effects and long-term consequences that vary with exposure type and length, many researchers are beginning to explore behavioural effects of pesticides. Measuring behavioural effects is more sensitive than simply measuring lethality, allowing researchers to determine the long-term effects of various pesticides. A number of behavioural tests that measure animals' movement, reproductive behaviour and aggression, have been developed for assessing the toxicity of various pesticides.

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In a 2020 paper published by PLOS One, Professor Kathleen Susman at Vassar College, with colleagues at neighbouring Marist College, reported that a pesticide containing imidacloprid [ih-mid-uh-kloh-prid], the most commonly used neonicotinoid worldwide, causes physiological and behavioural changes in the nematode, *Caenorhabditis elegans* [say-nor-ab-die-tuss ell-uh-ganz]. This established model organism is used by researchers to determine toxin exposure levels in mammals.

This study was the first to examine the effects of commercially available imidacloprid-containing pesticides on non-target organisms. Using the 'Tree and Shrub' pesticide, produced by Bayer, the researchers exposed nematodes, which are important soil organisms, to various concentrations of the pesticide and with varying exposure times. In line with other studies examining the behavioural effects of pesticides, the researchers assessed how Tree and Shrub affected the nematodes' growth, movement, egg-laying behaviour, and neural health. Given how similar the nematode genome is to the human genome, particularly in terms of genes targeted by toxins, these findings have implications for human health.

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Professor Susman and her colleagues found that nematodes that were exposed to Tree and Shrub grew to be smaller than the control nematodes, which were not exposed to the pesticide. A third group, which was exposed to both heat stress and the pesticide, showed the most stunted growth. These findings suggest that the pesticide causes stress that diverts energy away from growth during development, explaining the smaller size of the nematodes exposed to the pesticide.

The researchers then performed another series of tests to assess the impacts of pesticide exposure on the worms' movement – or 'locomotion'. They found that locomotion was decreased in nematodes exposed to Tree and Shrub, but only when chronically exposed from the egg state to adulthood. Nematodes that were only exposed for 24 hours, starting in the young adult stage, were not affected. The team suggests that this difference is likely because locomotive development happens during very early development, meaning only very young nematodes would be vulnerable to these effects.

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The researchers were particularly interested in the impacts of the pesticide on the reproductive behaviour and physiology of the nematodes.

They found that the pesticide reduced the numbers of egg-laying nematodes in two separate groups. One group was raised with pesticide exposure and transferred to a pesticide-free area to lay their eggs. The other group was given the reverse treatment: the worms were not exposed to the chemical during growth, but were moved to an area with pesticide treatment to lay their eggs.

These results show that the pesticide can impact egg-laying in two ways. In this case, Tree and Shrub both inhibited egg development in young nematodes exposed to the pesticide, and signalled to adult nematodes that the pesticide-containing environment was not favourable for egg-laying.

The researchers also documented poor fertility in nematodes exposed to Tree and Shrub. Based on their results, the team suspects that the pesticide also impedes egg formation in the worms.

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Along with changes to behaviour, nematodes raised with pesticide exposure showed signs of neural degeneration. Specifically, the cell bodies of neurons in exposed worms were swollen. This is a sign of degeneration that usually does not appear until a nematode's post-reproductive life. However, the team's nematodes that showed these signs of degradation had not yet reached adulthood. The researchers speculate that this neural damage could be the main cause of the observed behavioural effects, though this is still unknown.

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The findings of this study suggest that imidacloprid, the active ingredient in Tree and Shrub, can cause a myriad of issues in non-insect animals, impairing their development, locomotion, egg-laying, and neural health. This research is a clear warning sign – the results warrant further studies investigating how imidacloprid and other commercially available neonicotinoids can have negative health impacts on animals, including humans.

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This SciPod is a summary of the paper 'Neonicotinoid-containing insecticide disruption of growth, locomotion, and fertility in *Caenorhabditis elegans'* from PLOS One https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0238637

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