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Are Pesticides from Plants Dangerous to Humans?

It remains unclear how the pesticides from plants known as pyrethroids affect human health

By Ferris Jabr and Environmental Health News | Friday, February 26, 2010 | 9

Chemicals derived from flowers may sound harmless, but new research raises concerns about compounds synthesized from chrysanthemums that are used in virtually every household pesticide.

For at least a decade, pyrethroids have been the insecticide of choice for consumers, replacing organophosphate pesticides, which are far more toxic to people and wildlife. But evidence is mounting that the switch to less-toxic pyrethroids has brought its own set of new ecological and human health risks.

About 70 percent of people in the United States have been exposed to pyrethroids, with children facing the highest exposure, according to a study published this month. Although the human health threats are unknown, animal studies have found evidence of damage to neurological, immune and reproductive systems.

In addition, pyrethroids are flowing off yards and gardens, contaminating some streams and rivers at concentrations that can kill small creatures vital to the survival of fish and other aquatic life. Both California and the U.S. Environmental Protection Agency are reevaluating the chemicals because of safety concerns.

“Pyrethroids are obviously a safer alternative to organophosphates, but just because they are safer doesn’t mean they are safe,” said Dana Boyd Barr, a research professor of environmental health at Emory University’s Rollins School of Public Health in Atlanta, Georgia. Barr authored a study that for the first time has measured pyrethroid exposure in the U.S. population.

Pyrethroids are found in more than 3,500 products used inside homes and on crops, yards, and gardens - including lice shampoos, indoor foggers, flea sprays for pets and pesticides to fight ants, wasps, mosquitoes, aphids and spiders. Consumers can identify pyrethroids in products by checking labels for compounds that end in “thrin,” such as bifenthrin, permethrin and cypermethrin.

The compounds are synthetic versions of naturally occurring insecticides called pyrethrins harvested from chrysanthemum flowers. Chemists alter the structure of the pyrethrin molecule to make it more stable in sunlight and to increase its toxicity. The chemicals kill insects by interfering with basic nerve cell functioning. Insects and other invertebrates are highly susceptible to them, while birds and mammals are better able to counteract their effects.

In the new study, 5,046 urine samples collected from U.S. adults and children between 1999 and 2002 were tested for five metabolites of pyrethroid insecticides. Metabolites are the result of the body breaking down a chemical.

Traces of at least one pyrethroid metabolite were found in 75 percent of the people tested in 2001-2002, up from 66 percent in 1999-2000. Children’s concentrations were more than 50 percent higher than the amounts found in adolescents and adults, according to the study by Barr and colleagues published online in *Environmental Health Perspectives* on Feb. 3.

Children are more highly exposed to pyrethroids because “they spend a lot more time on the floor and have much more hand to mouth activity,” Barr said. “Pyrethroids tend to accumulate in dust or on surface areas in homes because they don’t evaporate easily into the air.” A 2008 study found pyrethroids and their metabolites in vacuum cleaner dust collected from homes and daycare centers in North Carolina and Ohio.

In addition to inhaling or absorbing pyrethroids that linger in households, people ingest traces of pyrethroids in their food, since the

chemicals are used on some vegetable, fruit and grain crops.

A 2006 EPA review found that the risk of exposure through diet was at or below the agency's level of concern for most people. But the study also found that infants and toddlers are highly exposed in some foods, especially bananas, pineapple and dried-oat baby food.

"Now that we know people are exposed to pyrethroids widely, we need to determine what the exact health effects are," said Barr.

So far, there is little scientific data evaluating the potential threat to human health.

Studies with lab animals have linked pyrethroid exposure to damage of the thyroid, liver and nervous system, as well as impairment of behavioral development, changes in the immune system and disruption of reproductive hormones, according to the 2006 EPA review. These animal studies are relevant to human health because pyrethroids act on functions of the nervous system common to all animals, according to the EPA.

Some pyrethroids imitate the hormone estrogen and can increase levels of estrogen in breast cancer cells, and some are suspected carcinogens. Other data suggest that people using the chemicals are at risk of aggravated allergies or asthma, although the EPA concluded last year that there is no clear link.

Pesticide manufacturers say that pyrethroids are safe and that they are vital to agriculture and to combating mosquitoes that carry West Nile Virus and other diseases.

"Pyrethroids are an extremely important class of insecticidal compounds with major public health and agricultural uses," Rex Runyon, a vice president at CropLife America, a trade group that represents pesticide companies, said in an email. Runyon added that pyrethroids "do not pose unreasonable effects to human health or the environment" when used according to the directions on the label.

Although little data exist about human health concerns, evidence is growing that pyrethroids might be harming aquatic ecosystems. Studies of streams and rivers in California, Texas and Illinois suggest that the pesticides might be wiping out small organisms that live in the waterways and form the base of the food chain.

A 2009 study found the pesticides in urban stream sediments in central Texas, where they are widely used to control fire ant and grub worm infestations. The concentrations are lethal to a small, shrimp-like crustacean called *Hyalella azteca* - a species commonly used in laboratories to investigate the effects of pesticides on invertebrates necessary for healthy rivers.

"All of our sampling sites were very close to neighborhoods with manicured lawns," said Jason Belden, an Oklahoma State University zoologist and author of the study published in the journal *Environmental Pollution*. "Some people are not following the best management practices. They're not being careful enough with pesticides. We all need to make an effort to only use pesticides when we need them."

Pyrethroids are showing up not only in sediments, but also in the currents of California rivers, at levels toxic to insects and aquatic invertebrates that fish and other animals feed on.

Biologist Donald Weston of the University of California, Berkeley, looked for the insecticides in urban runoff, sewage treatment plant effluent, and agricultural drains in California's Sacramento-San Joaquin River Delta. In the laboratory, Weston tested the toxicity of these samples on the shrimp-like *Hyalella azteca*.

"Virtually every drop of runoff from urban communities was toxic to *Hyalella* because of pyrethroids," Weston said.

For the first time ever, Weston and his team documented pyrethroids in the outflow of sewage treatment plants, which was surprising.

"About half of the waste water treatment plants we sampled were toxic," Weston said. "Most people wouldn't have expected pyrethroids to get through the system. People figured they would be captured by the slush at the bottom - and probably many of them are - but there is enough getting through the system to make the runoff toxic."

Agricultural drains, on the other hand, were only an occasional source of pyrethroids, according to the study, published this month in *Environmental Science and Technology*.

"When you say 'pesticides,' I think the average person on the street tends to think of agriculture," Weston said. "They don't tend to think of the suburban homes, whereas it turns out the suburban home was a constant source of pyrethroid toxicity."

The study demonstrated toxicity in two urban creeks and in a 30-kilometer stretch of the American River, considered one of the cleanest rivers in the Delta region.

"The water is totally clear - as clear as the water that comes out of your bathroom faucet," said Weston. "But the last 30 or 40 miles of the river, once you start getting into Sacramento, are very heavily urbanized. All these communities are dumping their storm water into the American River and it's enough to cause toxicity."

Weston said that finding the chemical in the water itself - not just in the sediments - is cause for concern.

"Pyrethroids are very sticky and they don't like to be dissolved in the water, so most of them are in the sediments," Weston said. "But it takes so little in the water to be toxic - only two parts per trillion. The state of California now knows not only do they have to worry about the sediment particles, they have to worry about the water as well. And the water travels much farther downstream."

The levels of toxicity Weston recorded were more than enough to kill a whole host of insects and other invertebrates necessary for healthy river ecology. The researchers have not documented that creatures in the streams have died. But if the water and sediment samples are toxic to the crustacean in the lab, it is a sign they will be toxic to similar creatures in the waterways.

"Bottom dwelling invertebrates and things like stoneflies and mayflies are basically the bottom of the food chain. The concern is whether these insecticides are cutting out this lower rung that the fish depend upon," Weston said. "This would have not only ecological consequences, but recreational and commercial consequences."

In response to toxicity concerns raised by Weston's work, California's Department of Pesticide Regulation began reevaluating regulation of pyrethroids in 2006. The state has requested additional data from manufacturers on the safety of pyrethroids and is analyzing at least 700 products used in households and on farms.

When mounting the review, Mary-Ann Warmerdam, director of the state's pesticide agency, told the Los Angeles Times that the state's evaluation "is a shot across the bow to the manufacturers that we found a reason for concern and you need to provide us with data to either eliminate the concern, reformulate your products or consider taking them off the market."

California, Weston said, doesn't want to return to using organophosphates such as chlorpyrifos, which was banned from household use because of human health concerns, "but they want to control the use of pyrethroids to minimize the environmental effects we document."

"The state of California has the power to ban a product based on the outcome of the reevaluation," Weston said, "but I don't think anyone is expecting that to occur. More likely there will be further regulations pertaining to the use of pyrethroids."

Also, the EPA this year is reevaluating pyrethroids as part of its 2010 pesticide review. The EPA systematically evaluates all registered pesticides every 15 years. Potential outcomes include banning pyrethroids in certain areas, tightening policies or no change to the regulations. However, the EPA process will take another six to eight years.

In the meantime, there are some alternatives for consumers. Barr suggests products extracted from vegetables and herbs or planting chrysanthemums around the garden. Natural pyrethrins found in chrysanthemum plants do not persist in the environment like the synthetic versions do. Another option for killing some pests is boric acid.

Also, an insecticide called fipronil has partially replaced pyrethroids for controlling termite and ant infestations in some areas. Like pyrethroids, fipronil is far less toxic to birds and mammals than other insecticides, but can still kill small aquatic life.

Weston says switching to another chemical is not the solution: he believes people need to fundamentally change how they use pesticides. Many people apply so much to their yards and gardens that the chemicals flow into waterways.

“I think it’s a good idea to minimize pesticide exposure of any sort, not only because of what we know, but because of what we don’t know,” Weston said. “I don’t think a lot of those products are needed. The less you can use them, the better.”

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