UNIVERSITY OF ILLINOIS
College of Agricultural, Consumer and Environmental Sciences

Farm Chemical Toxicity Measured

It was thought that as farm chemicals start degrading in contact with soil they become less toxic, but new research suggests that certain pesticides can actually become more toxic in contact with reduced, iron-bearing clays commonly found in soils.

The long-held theory was that farm chemicals became less harmful in the soil through a process of microbial degradation and sequestration. No one expected, therefore, to discover a chemical reaction with clay particles that increased the toxicity of a compound.

"We expected to see some reaction because other studies we have done showed that reduced clay is more reactive than oxidized clay," said Joe Stucki, University of Illinois professor of soil chemistry. "But we were surprised that the toxicity of one of the compounds increased."

The researchers in this project mixed four different pesticides with reduced or unoxidized ferruginous smectite, a specific group of clay minerals. They compared the toxicity of the pesticide on its own to the toxicity of the pesticide that had reacted with the smectite. They used a widely accepted toxicity test employing mammalian cells of a hamster.

Treatment with reduced smectite, or clay mineral with little or no oxygen attached to it, substantially increased the toxicity of dicamba by as much as 33 percent, decreased the toxicity of oxamyl by 50 percent, slightly decreased the toxicity of alachlor, and for 2,4-D toxicity remained about the same.

Dicamba is one of the most widely used products for controlling broadleaf weeds in corn. Oxamyl is widely used for control of insects, mites, and nematodes on field crops, fruits, and ornamentals. The majority of oxamyl is applied to apples, potatoes, and tomatoes.

Alachlor is a herbicide for control of annual grasses and broadleaf weeds in crops, primarily corn, sorghum, and soybeans. Alachlor was, at one point, the second most widely used herbicide in the United States, with particularly heavy use on corn and soybeans in Illinois, Indiana, Iowa, Minnesota, Nebraska, Ohio, and Wisconsin.

2,4-D is a herbicide for the control of broad-leaf weeds in agriculture and for control of woody plants along roadsides, railways, and utilities rights-of-way. It has been most widely used on such crops as wheat and corn and on pasture and rangelands.

"Virtually every study looking at the effect of soil and clay minerals on the fate of pesticides has ignored oxidation state. That's an omission, because soils are commonly in a reduced condition, and now we have shown that the oxidation state makes a big difference," said Stucki.

"What we're showing here, at least in the case of dicamba, is that the compound became more toxic when it came into contact with the reduced clay, so we can't always assume that when a compound comes into contact with the soil it's a positive environmental outcome," he said.

The pesticide levels tested were comparable to pesticide concentrations commonly found on farms. Also, smectite clays are abundant in many soil profiles. Reduced smectite clay particles are often found near the soil surface due to rainfall events and microbial activity.

Stucki says other degradation products were found in the research, and the research team is currently attempting to identify those compounds and measure their toxicity.

Funding came from the Department of Energy, the National Science Foundation, the U.S.-Israel Binational Agricultural Research Fund, the International Arid Lands Consortium, and the U of I Agricultural Experiment Station.

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Source: Joe Stucki (217-333-9636; jstucki@uiuc.edu)