USGS

WATER RESOURCES RESEARCH GRANT PROPOSAL

Project ID: 2003CA57G

Title: Distribution and toxicity of sediment-associated pesticides in the Sacramento River watershed.

Project Type: Research

Focus Categories: Agriculture, Non Point Pollution, Sediments

Keywords: Sediment, Pyrethroid Insecticides, Non-point Source Pollution

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Abstract: Due to increased regulatory scutiny of organophosphate (OP) pesticide use in agriculture and the outright banning of some of the most popular OPs in consumer home and garden products, there is an emerging reliance on pyrethroid pesticides as a replacement for the OPs. This transition is being encouraged with little knowledge on environmental fate and effects of this pesticide class. Pyrethroids are far more particle-associated than the OPs, and we run the risk of trading a known and well monitored water column toxicity problem for an unknown and poorly monitored sediment toxicity problem. This study is intended to gather information on aquatic effects of pyrethroid use, and thereby promote environmentally sensitive selection of pest control agents and application methods. In our previous work we have demonstrated the analytical feasibility of pyrethroid analysis in sediments, and have shown toxicity of field-collected sediments having elevated pyrethroid concentrations. In a companion state-funded study to that proposed here, we are extending these investigations into the Sacramento River watershed, giving particular attention to pyrethroid presence and toxicity in 303(d) listed water bodies. The proposed study is designed to complement the state-funded work, but focus on more fundamental questions of pyrethroid aquatic toxicology in order to better interpret these field data. The proposed work includes:

1. Bioaccumulation and toxicokinetic studies – We will examine metabolism and depuration processes in two invertebrate species, in order to determine if invertebrate prey could be a route of pyrethroid exposure to predators. While fish are capable of metabolizing pyrethroids in a matter of days, these processes are likely to be much slower in some invertebrates.

2. Enhancement of toxicity by PBO – Piperonyl butoxide (PBO) is included in many pyrethroid pesticide formulations because it inhibits enzymatic detoxification, thereby enhancing toxicity of the pyrethroid. Recent evidence has shown residual PBO to be present in surface waters as well, suggesting there is a need to examine its unintended role in enhancing pyrethroid toxicity to aquatic organisms.

3. Pesticide interactions – As both pyrethroids and organochlorines are strongly particle-associated, both would be expected to occur in agriculture-affected sediments, and both have the same mode of neurotoxic action, there is a need to examine the extent of toxicological interaction when concurrently exposed to both compound classes.

4. Chronic toxicity – Dr. Chris Ingersoll of USGS is participating in this project. His role, in part, will be to test for chronic toxicity of pyrethroid-contaminated sediments in order to evaluate whether the more commonly used acute tests are adequately protective.

5. Changes in bioavailability over time – Soils on farms on which pyrethroids have been used will be studied for up to nine months post-application to examine whether pyrethroid residues, while chemically measurable, may be less bioavailable and less desorbable as particle contact time increases. These experiments will help better evaluate the risk when those particles are introduced into aquatic systems, which is likely to occur only after several months in the terrestial environment.

The aquatic risks of OP pesticides are well documented so it is understandable that users are being encouraged to switch to pyrethroids, but this is occurring with minimal data on the aquatic toxicology of pyrethroid pesticides. We believe both environmental managers and pesticide user groups would benefit by obtaining this type of environmental data as pyrethroid use is emerging, rather than playing “catch-up” after their use has become widespread and application practices have become entrenched.
