CALFED Conference 2008 Abstract

Sorption of chlorpyrifos in vegetated agricultural drainage ditches

Mathew R. Rogers[a,b,c] and William T. Stringfellow[b,c]

[a]Department of Civil and Environmental Engineering, University of California Berkeley, 1 Cyclotron Rd. MS 70A-3317, Berkeley, CA 94720; Phone: (510)486-6555; FAX: (510)486-7152; mrrogers@berkeley.edu
[b]Environmental Engineering Research Program, University of the Pacific, 3601 Pacific Ave., Sears Hall Rm. 117, Stockton, CA 95211
[c]Center for Environmental Biotechnology, Lawrence Berkeley National Laboratory, Berkeley, CA 94720

Constructed wetlands and vegetated agricultural drainage ditches have been proposed as structural best management practices (BMPs) for the control of non-point source chlorpyrifos in agriculturally dominated watersheds. There are currently several pilot projects examining the applicability of natural treatment systems as agricultural pesticide BMPs in the San Joaquin River Valley, but research is needed to enhance removal. Partitioning processes dominate the short-term fate of chlorpyrifos in aquatic ecosystems. Sorption to soil and aquatic plants has been measured as an important sink for chlorpyrifos, however, sorption to soils of the San Joaquin River Valley and plants used in structural BMPs has not been characterized.

Sorption isotherms to three soils and five plants were determined by batch equilibrium technique. Linear partitioning coefficients of whole plant stems (K_d = 571.1 to 1303.4 $L \cdot kg^{-1}$) was more than 10 times higher than for soil (K_d = 40.0 to 71.4 $L \cdot kg^{-1}$). Chopped plant material had K_d values 7.6 to 96.2 percent greater than whole stems. Wetland plants with high internal surface area due to porous tissues had greater linear partitioning coefficients than terrestrial plants with a hollow tubular structure. Chlorpyrifos sorption reached a pseudo-equilibrium in less than 8 hours, more rapidly than the reaction rates for biotic or abiotic degradation reactions.

While sediment-associated chlorpyrifos is a small portion of total chlorpyrifos in the water column, but plant biomass provides greatly increased surface area for enhanced adsorptive removal. Plants with higher adsorptive capacity and growth density should be chosen to optimize chlorpyrifos removal in BMPs. Partitioning to plant surfaces in natural treatment systems is an important mechanism in vegetated agricultural drainage ditches for mitigating peak concentrations of chlorpyrifos in irrigation or stormwater, allowing time for attenuation by slower degradation reactions.

Relevance statement: Measurements of the pesticide adsorptive capacity of soils and plants to be used in structural BMPs aids in the selection of optimal sites and plant communities to achieve removal objectives for improved water quality and reduced stress in zooplankton and insect communities for improved ecosystem health.