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A MATHEMATICAL MODEL TO PREDICT GROUNDWATER CONTAMINATION DUE TO PESTICIDE APPLICATION

D. KUMARAGAMAGE

Department of Soil Science, Faculty of Agriculture, University of Peradeniya.

Mathematical models are often used to describe the transport of agro-chemicals in soils. Such models have been successfully used in many countries to predict the extent of groundwater contamination by various pesticides under certain soil and environmental conditions. The objective of this study was to formulate and validate a mathematical model to describe pesticide transport in soils, which can be used to predict the extent of groundwater contamination.

The classical convective-dispersive transport equation was used considering irreversible removal of pesticide from solution due to adsorption and degradation. Preliminary experiments using carbofuran indicated that adsorption by soil particles is rapid and equilibrium was reached quickly, and that adsorption data in most soils fitted well to linear isotherm. Therefore, when formulating the model, a local equilibrium assumption with linear isotherm was used to characterize pesticide adsorption. The degradation of pesticide was assumed to be a first order kinetic process, and the degradation constants were obtained from literature.

The model was validated using data obtained for carbofuran in a column leaching study, where the soil column was initially saturated with water. Four soils were used, including two ultisols, one alfisol and one inceptisol. A known carbofuran concentration was applied to the surface of the column and was thereafter followed by carbofuran free solution. The leachate samples were analyzed for carbofuran concentrations and leaching was continued until the carbofuran concentration in the leachate is undetectable.

In curve fitting the numerical solution of the transport equation to the observed data, it was assumed that the solution sample represents volume-averaged concentrations. The average pore velocity was calculated by dividing the soil water flux by volumetric moisture content.

In all soils, the model prediction fitted well to the observed data for carbofuran. This model therefore can be used to predict the concentration of carbofuran in moving water at any soil depth, given the soil conditions. However, to use this model for other pesticides, preliminary information regarding adsorption and degradation should be available and the transport model should be modified accordingly.