Chlorpyrifos Contamination in Soil and Water: Method Development and the Application of Environmental Models

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ABSTRACT

The work presented here focuses on the extract clean-up since this step is usually time-consuming, requires large quantities of organic solvents, and contributes significant amount of errors. Several clean-up techniques based on solid-phase extraction used in the analysis of chlorpyrifos residue in soil and water were evaluated. Recoveries of chlorpyrifos residue in soil via PS-1 filter paper, C_8 and silica cartridges were in the range of 97.1%, 95.7% and 109.2% with standard deviation (SD) of 0.8%, 4.8% and 10.1%, respectively. The use of PS-1 filter paper was recommended based on the good reproducibility, faster analysis and low cost. For the clean-up of water sample, the performance of C_8 and C_{18} cartridges with variation of pH and methanol volume were compared and the recoveries of chlorpyrifos were in the range of 52% to 102% with SD of 2.1% to 13.3%. The use of C_8 with 1% methanol and pH adjusted to 2.0 was recommended. The chosen methods were used to analyse chlorpyrifos content in water and soil samples collected from Tanjung Karang paddy field for 2 paddy planting seasons. In the effort to predict the amount of this compound in the environment, the applicability of chemical fate models was investigated. Two environmental models, EQC level III and ChemCAN 4 were evaluated by comparing the actual amount of chlorpyrifos with the value predicted by the models. The values from the EQC level III model was found to be of the same order as the actual values, while those predicted by ChemCAN 4 model is 100 times smaller than the actual values.

CHAPTER 1

INTRODUCTION

Pesticides are an important but often controversial component of today's integrated pest management systems (Harrison 1998). Organophosphorous pesticides are currently the major types used on a worldwide scale. They have replaced organochlorine pesticides that have been withdrawn from use because of their toxicity, persistence and bioaccumulation in the environment. Chlorpyrifos, an organophosphorous pesticide, is sold under various trade names such as Lorsban™ and Dursban™ are widely used to eliminate or control the population of flies, household pests, mosquitoes, ectoparasites on cattle and sheep and various crop pests in soil. It has a broad range of insecticidal activity and is effective by contact, ingestion and vapour action but not systemic (Worthing 1987).

Pesticide residue analyses are usually costly and time consuming because these analyses usually involve two major steps: extraction of target analytes from the bulk matrix and clean-up of the analyte from matrix co-extractives (Obana et al. 1999). Therefore, the development of a fast and efficient method for the analysis of a specific pesticide has become an area of great interest amongst the environmental chemists.

Several methods have been developed for the analysis of chlorpyrifos in the environment. The traditional approach involving solvent partition is time consuming and expensive because of the high consumption of solvents. The standard method of