CHAPTER I

INTRODUCTION

1.1 Introduction

Progressive increase worldwide of production and application of chemicals for agriculture as well as for plant protection has become an environmental concern when these chemicals has been polluted in soil, sediment, groundwater and surface water (Plimmer, 1990). Because of their chronic toxicity, and their long-lasting sorption by soil and sediment, the contamination of the persistent pollutants leads to a serious risk to the environment, to animals and human when directly exposed to their residues (Wania and Mackay, 1996). One of the main herbicides widely used in Thailand is phenylurea and substituted phenylurea herbicides, for example isoproturon, linuron, and diuron, etc. The phenyl urea herbicides are extensively used for long-term pre-emergence and post-emergence control of annual grasses and broad-leaved weeds in both non-crop and crops areas (Giacomazzi and Cochet, 2004).

Diuron (1-(3,4-dichlorophenyl)-3,3-dimethylurea) largely used since 1960 in Europe and United State, is mainly used as pre-emergence herbicide for general weed control on non-crop lands as well as along railroad (Aspelin, 1997). In Thailand, diuron is the sixth highest imported herbicide (Table 1.1). It is widely applied as an herbicide that inhibits photosynthesis and is mainly used for weed control before and during the land preparation for plantation of several economically important crops in Thailand such as cassava, sugarcane, and pineapple (Agriculture, 1999).

Table 1.1 Main herbicides imported in Thailand in 1999 (tons)

Rank	Name	quantity
1	Glyphosate	6,187
2	2,4-D	2,665
3	Atrazine	1,640
4	Ametryn	990
5	Paraquat	766
6	Diuron	562
7	Alachlor	584
8	Butachlor	561
9	Bromacil	196
10	Thiobencarb	179

Representative booster biocides were surveyed in sediment from Thailand. The range of Diuron concentrations in sediment (0.07–25 μg kg^{-1} dry wt.) was the highest among the booster biocides detected (Harino et al., 2006). Ecotoxicological reports suggest that the phenylurea herbicides are harmful to aquatic invertebrates (Mansour et al., 1999), freshwater algae (Peres et al., 1996), and suspected of being carcinogenic (Behera and Bhunya, 1990). This group of herbicides is known for high persistence in soil with the half-lives greater than 100 days; nonetheless the half-lives from 90-180 days and the extrapolated values of greater than 3,000 days have been reported (Madhun and Freed, 1987). The high persistence in soil and the extensive use of the phenylurea herbicides result in a risk of pollution of the subsoil and consequently contamination of domestic water resources. The fate of herbicides is dependent on various mechanisms such as wind erosion, volatilization, run-off,

sorption to soil, leaching, photo and chemical degradation, absorption by plants, but microbial degradation is considered to be the primary mechanism for its dissipation from soil (Sheets, 1964; Giacomazzi and Cochet, 2004).

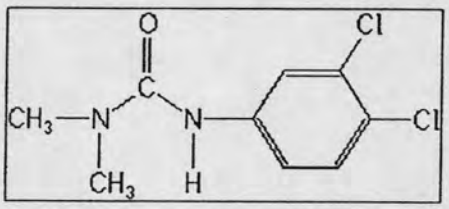

Figure 1.1 Chemical structure of diuron

To remedy the soil contaminated with herbicide, several treatment techniques including acid extraction, bioremediation, thermal desorption, and the slurry-phase treatment can be applied. However, these processes have been found to be successful only for the removal of specific groups of contaminants from soils; either metals, volatile organic compounds, or pesticide and herbicides, and are not effective for the removal of mixed pollutants which can include a combination of these contaminants (Semer and Reddy, 1996). As a result, pretreatment of the contaminated soil including soil fractionation and soil washing is often necessary to remove materials that are not compatible with these treatments and to enhance the leaching of the contaminated compound from soil, respectively (Chu and Chan, 2003). Pesticide sorption affects other processes like transport, degradation, volatilization, bioaccumulation, which influence the final fate of these compounds in the soil environment (Gao et al., 1998). All these processes influence the extent of surface water and ground water contaminations. Moreover, soils are a heterogeneous mixture of several components, many of which are organic and inorganic compounds of varying composition and

surface activity. They can bind pesticides and reduce the bioavailability (Torrents and Jayasundera, 1997). The surfactant-aided soil remediation of ground water and washing of soil are technologies used to enhance the removal of organic contaminants (Abdul et al., 1992), and cleaning of hydrophobic organic compounds (HOCs) from contaminated soil or sediment (Jafvert et al., 1995). In addition to surfactant, organic solvents are also widely used in extracting hydrophobic pollutants from contaminated soils, sediments and waters, so solvent-aided and surfactant-aided soil-washing processes are used to improve the performance of the conventional surfactant-aided soil remediation for the contaminant leaching and increase the pollutant degradation by the photo oxidation or the accessibility of microorganism to the solubilized hydrophobic contaminant, therefore increase the bioavailability for biodegradation (Eweis et al., 1998).

Accordingly, the aim of this research project is mainly to investigate types and concentrations of organic solvents as well as those of surfactants to enhance leaching of diuron from soil. Two treatment conditions, including the static condition (soil column) and mixing condition (shaking-flask) in order to increase solubility of diuron, were compared. The information obtained from this investigation will be useful in order to increase the accessibility of microorganism to diuron in the contaminated site. This knowledge will be advantageous for further study of the biodegradation of diuron as an alternative bioremediation treatment of site contaminated with diuron and related phenylurea herbicides.

1.2 Hypothesis and Objectives

In order to enhance the bioavailability of microorganism for diuron biodegradation and increase solubility of diuron for further treatment, leaching of

diuron from soil samples collected in agricultural area in Thailand will be investigated.

Hypothesis: Since the adsorption process is reported to involve in the persistence and inaccessibility of further degradation of this compound, the leaching of diuron from soil particles using organic solvents and surfactants will be examined. These following conditions will be mainly focused:

1. Type and concentration of organic solvents
2. Type and concentration of surfactants
3. The combinations of organic solvent-surfactant
4. Aging period of contaminated soil
5. Two types of contaminated-soil treatment conditions will be tested
6. Suitable solubilization conditions of diuron including pH and ionic strength
7. Photodegradation of leachate of organic solvent/surfactant-aided soil washing.

1.3 Research Output

This research project involves in the investigaton of the suitable conditions for leaching of diuron, a representative of the phenylurea herbicides, from soil sample. The information obtained from this research project will be useful in order to increase the bioavailability of microorganism able to degrade to the contaminant as well as increase solubility of diuron for further treatment, i. e. photodegradation. The knowledge of leaching condition will be advantageous for further study and application of either photodegradation or bioremediation treatment to site contaminated with diuron and related phenylurea herbicides, which is widely used in Thailand