CHAPTER I
INTRODUCTION

1.1 General statement

Natural geochemical processes and anthropogenic activities are two major causes of releasing hazardous substances such as heavy metals and other toxic substances to environment. There are many possible ways for heavy metals to get into the soil and the soil-plant system and thus all through the food chain. It can happen by air pollution; by natural ways such as volcanic eruptions or dust storms; through anthropogenic activity for example mining and smelting, using of chemical fertilizers, or application of manure and pesticides. They can spread by sewage sludge, smog, or the precipitation of dry and wet sediments from the atmosphere. Among various metals, cadmium and zinc are widespread harmful heavy metals. Cadmium is closely related to zinc and will be found wherever zinc exists in nature. Moreover, cadmium is produced as a by-product of zinc mining activity.

In Mae Sot District, Tak Province, Thailand, the paddy fields receiving irrigation from the Mae Tao and Mae Ku creeks were found to contain markedly elevated cadmium levels. Both creeks passed through a zinc rich area where a zinc mine had been actively operated for more than 20 years. About 69.2% of the sediment samples of the creeks exceeded the maximum permissible level of 3.0 mg/kg (PCD, 2004; NRC-EHWM, 2005; Simmons et al., 2005). It was found that 85.0% of the paddy soil samples receiving irrigation from both creeks contained cadmium above the maximum permissible level (Swaddiwudhipong et al., 2007). Rice grain and soybean grown in the areas were also found to have elevated cadmium content compared with the normal values.

Department of Primary Industries and Mines (2006) reported elevated level of cadmium in paddy soils and rice grain downstream of a zinc mine area in Pratard Phadaeng, Mae Ku and Mae Tao sub-district, Tak province. Over 90% of rice grain sample collected contained cadmium at the concentration exceeding the Codex Committee on Food Additive and Contaminants (CCFAC) draft Maximum Permissible Level for rice grain of 0.2 mg/kg (Tosukhowong, 2007). Remediation of these soils has become very important as they pose severe health risks to humans if the contaminates enter the food chain. To this end, the use of economic efficient non-edible crops such as quick growing trees like Eucalyptus, and ornamental horticulture; Chrysanthemum, Marigold, Globe amaranth are being cultivated in cadmium contaminated areas (Pulford and Watson, 2003; Minhas and Samra, 2004; Srisatit and Surabhukdi, 2007; Khajanchi et al., 2008). Owing to the energy crisis in Thailand and all over the world, the use of biodiesel as an alternative energy has grown dramatically during the last few years. Sugarcane has been interested to using as a raw material for biodiesel or ethanol production. Thus, it leads to an idea in sugarcane cultivation to replace rice farming in these polluted areas. However, fertilization is also necessary for promote sugarcane growth and improve the quality and quantity of sugarcane production.

The demand in increasing agricultural productivity, the decline in land area suitable for agriculture and the deterioration of soil quality in cultivated lands have resulted in a steady increase in the use of chemical fertilizers. Since the 1950s, the application of plant nutrients has increased substantially especially phosphorus fertilizers (Tisdale et al., 1985). Each year, more than 30 million metric tons of phosphate nutrients are consumed worldwide; with more than 99% coming from phosphate rocks (IFA, 2005). Phosphorus is an essential element necessary for plant and is one of the most limiting nutrients for plant growth in soils. Plants need phosphorus for growth, utilization of sugar and starch, photosynthesis, nucleus formation and cell division (McKenzie and Middleton, 1997). However, a possible negative effect of phosphorus fertilizers is the contamination of cultivated lands by trace metals such as cadmium, copper, manganese, nickel, lead and zinc naturally present in the phosphate rocks used to manufacture the fertilizers (Lambert et al., 2007). In USA, Minnesota Department of Agriculture, Pesticide and Fertilizer Management Division (2002-2006) reported high level contamination of heavy metals in various types of fertilizers including phosphorus fertilizers and found that the level of cadmium contained in fertilizers ranged from less than 0.4 to 47 mg/kg. Cadmium contaminated in phosphorus fertilizers is considered as one of the major sources of metal addition in agricultural soils. Moreover, it could be uptake by plants and thus enter the food chains. Many works have studied the interaction between fertilizers application and the accumulation of cadmium concentrations in soils and plants (Williams and David, 1973; He and Singh, 1993).

Some investigators have reported that phosphate appear to be one of the controlling factors in cadmium movement in soil (Waggan et al., 1978). Tu et al. (2000) examined the influence of nitrogen, phosphorus and potassium fertilizers on the speciation distribution of lead and cadmium in a red soil of China. Their findings suggest that applying chemical fertilizers may change the speciation and thus phytoavailability of heavy metals. Therefore, the interaction among phosphates and cadmium is of great interest. However, there is still little information on the transport and accumulation of cadmium and zinc in plants as related to the nutritional level in soil environment. Therefore, the effect of fertilizers application rates on cadmium and zinc accumulation in soils, the availability to plants and the relationship between phosphorus, cadmium and zinc concentrations were examined in this study.

1.2 Objectives

1) To determine the effect of the phosphorus in fertilizer on total cadmium (TCd), total zinc (TZn), total phosphorus and available phosphorus in soil at different of application rates.

2) To determine the relationship between the concentration of cadmium and zinc in sugarcane; total cadmium, total zinc, bioavailable cadmium and zinc in soil.

1.3 Hypothesis

The application of phosphorus in fertilizer into soil may affect cadmium and zinc uptake and accumulation into each part of sugarcane.

1.4 Scope of the study

1.4.1 Field experiment

Soil and sugarcane samples were collected from three location difference in cadmium concentration in Mae Sot district, Tak province. Cadmium contaminated areas have been zoned as to levels by Geographic Information Systems; GIS (NRC-EHWM, 2005) including:

1) Mae Ku (<3 mg Cd/kg) in Mae Ku Noi village, Mae Ku sub-district.
2) Mae Tao 1 (3-20 mg Cd/kg) in Mae Tao Pae village, Mae Tao sub-district.
3) Mae Tao 2 (>20 mg Cd/kg) in Mae Tao Pae village, Mae Tao sub-district.

These three areas received 16-16-8 NPK fertilizer at the rate of 50 kg/rai during the first and the fifth months after sugarcanes were planted.

1.4.2 Pot experiment

1) The soil used in the pot experiment was collected from the areas which contain cadmium concentrations in the range of < 3 mg Cd/kg located in Mae Ku, Mae Sot district, Tak province.
2) Chemical fertilizer used in this study is granular commercial 16-16-8 NPK fertilizer (16% N, 16% P_2O_5 and 8% K_2O). The rates of fertilizers application were 0, 50, 100 and 200 kg/rai. Three replications were carried out for all experiments. The fertilizer was applied to soil in twice, once in the first and again in the fifth months after sugarcane was cultivated. The method for the fertilizer application was imitated the real site customary procedure in Mae Sot district, Tak province.
3) Sugarcane used in the study was LK 92-11 ecotype collected from Kampangpetch province.

1.4.3 Sample collection and analysis

1) Soil and sugarcane samples in both field and pot experiment were collected at the end of the second and the sixth month of the cultivation.
2) Total cadmium and zinc were analyzed in five parts of the sugarcane including underground stems (setts), roots, bagasses, sugarcane juice and leaves. For sample collection in the second month, sugarcane was divided into only four parts because sugarcane juice was not present at that stage of maturity.
3) Soil analysis included total cadmium and zinc, available cadmium and zinc, total phosphorus and available phosphorus.

The summarization for scope of the study is presented in Figure 1.1

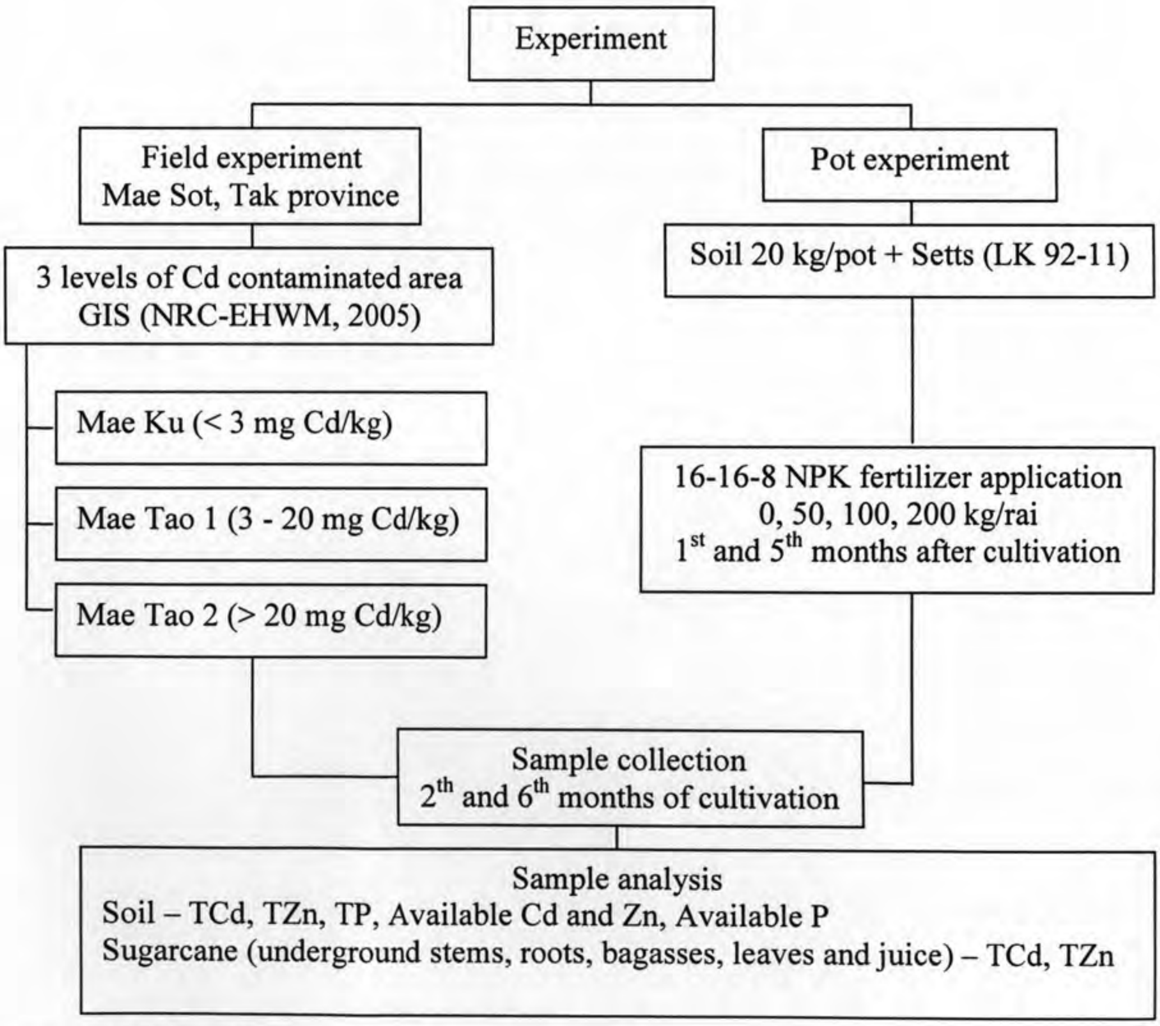

Figure 1.1 Schematic diagram of scope of the study