CHAPTER I

INTRODUCTION

The rice production systems in Laos can be classified into three main ecosystems: irrigated lowland, rainfed lowland, and rainfed upland. The rainfed lowland rice ecosystems can be divided into four main sub-ecosystems, namely good (10%), drought-prone (60%), drought and submergence-prone (20%) and submergence prone (10%) (Inthapanya *et al.*, 1995; Linguist *et al.,* 2006). Lowland environments predominate in central and southern agricultural areas during wet season, while during dry season it predominates in the provinces along the Mekong River. The rainfed lowland ecosystem accounts for about 78.8% of the total area, having 81% production with an average yield of 3.6 t/ha. The rainfed upland ecosystem accounts for13.4% of the total area and 8.4% of production with a yield of 1.8 t/ha. Irrigated environment accounts for 7.8% of the area and 10.6% of the production with a yield of 4.4 t/ha. The dependence on the rainfed cultivation makes national production very susceptible to drought. On the others hand, the rice production are reduced by low soil fertility. Soil fertility difficulty is caused by nutrient deficiency, nutrient toxicity and others. Iron (Fe) toxicity is a reason of the soil fertility difficulty. Rice suffers from Fe toxicity when soil minerals are rich in iron. The appearance of toxicity symptoms in leaf tissues and a reduction in rice yield, however, occur only when the soil is flooded and microbial activities reduces insoluble Fe(III) into soluble, and potentially toxic Fe(II) (*Ponnamperuma*, 1972).

Iron (Fe) toxicity is a condition related with large concentration of ferrous ions (Fe^{2+}) in the soil solution. Rice is especially prone to Fe toxicity because it is grown in soil usually submerged for 1 month or longer during the growing season. The Fe^{2+} concentrations in the soil solution that reportedly affect lowland-rice yields can range from 10 to>2000 mg L^{-1}. A wide range of soil types can be iron-toxic, including acid sulfate soils (Tinh, 1999), acid clay soils (Alaily, 1998), peat soils (Deturck, 1994), and valley-bottom soils getting interflow water from nearby slopes (Sahrawat and De Datta, 1995). When soils are flooded non-soluble Fe^{+3} is reduced to soluble and therefore potentially toxic Fe^{+2}. In addition, Fe induced yield reduction is often associated with a poor nutrient status of the soil (Benckiser et al., 1983). From this reason, the effects of iron toxicity may also increasing conditions of P, K, and Zn deficiency and H_2S toxicity (Ottow et al., 1982).

High uptake of Fe^{2+} by roots can result in accumulation of Fe and appearance of Fe toxicity symptoms. Inside the leaf, excess amounts of Fe^{2+} cause production of oxygen radicals which can cause internal damage to cells and tissues (Thompson and Ledge, 1987). This may then lead to an accumulation of oxidized polyphenols (Yamauchi and Peng, 1993). The characteristic visual symptom associated with those processes is the “bronzing” of the rice leaves (Howeler, 1973). Rice yield losses are associated with the appearance of bronzing symptoms that range from 10% to 100% (WARDA, 2001). Overcoming rice-yield reductions caused by Fe toxicity requires both adapted and tolerant varieties as well as suitable management interventions.

Iron toxicity is a major problem in wetland rice in Laos**.** A preliminary survey in Vientiane Plain in 2007 found rusty colour water in 72.2% of the fields examined and *Xyris indica* L., an indicator plant for Fe toxic soils, in 38.8% of the fields.

Symptoms of Fe toxicity were observed in almost 90% of the rice crops examined, 51.8% with moderate symptom (leaf bronzing but regular panicles) and 37.5% with severe symptoms (leaf bronzing with arrested panicle emergence). Therefore, this study will be conducted to evaluate Lao rice varieties for tolerance to Fe toxicity. A preliminary study has found strong positive response to an application zinc (Zn) in rice growing on Fe toxic soil in Vientiane (Nattinee Phattarakul, unpublished). I will also examine how Fe toxicity in rice may be alleviated by Zn fertilizer. Findings of this study is expected to help solve the problem of Fe toxicity in farmers' wetland rice in Lao PDR and perhaps other places in Southeast Asia and Africa where Fe toxicity is a major stress in wetland rice. This study will be conducted at Chiang Mai University, Thailand and in Vientiane, Lao PDR.

The objectives of this study are as follows:

1. To evaluate Lao rice varieties for their tolerance to Fe toxicity
2. To examine how Fe toxicity sensitive and tolerant rice varieties response to rate of external Fe
3. To investigate the effect of Zn on Lao rice varieties growing in Fe toxic soil