Chapter 1

Introduction

People have grown legumes for a longtime and for many proposes: for food, as green manure crops and to feed livestock. This is because legumes are rich in protein, they can supplement diets of carbohydrate rich cereal grains for humans and grass fed animals. Moreover the symbiotic nitrogen (N) fixation between legume and nodule bacteria is well known as the key process to transform N_2 from the atmosphere to NH_3 that is readily utilized by plants. Besides producing economic yield, legumes can also add significant amounts of N in to soil. Roger and Watanabe (1986); Ladha *et al*. (1988) found that growing legume crops such as *Sesbania aculaeta, Sesbania rostrata* and *Aeschynomene afraspera* added more than 100 kg N/ha to soil in 50-60 days. A major limiting factor of legume growth and nitrogen fixation is soil acidity (Craswell and Pushparajah, 1989). Dry weight of soybean can be depressed by more than 50% when soil pH decreased from 6.7 to 4.7 (Cline and Kaul, 1990). Munns (1964) found that soil acidity significantly depressed yield of lucerne in 7 areas in New South Wales.   Legume growth is likely to be limited by soil acidity because it is a world-wide problem. Thirty percent of the world's total lands areas are acidic and around 40% of the world's potentially arable lands are acidic (von Uexku¨ ll and Mutert, 1995). In acid soil, legume growth can be inhibited by combination of factors, including toxicity of some cations such as aluminum, manganese and hydrogen ion and deficiency of essential elements such as calcium, magnesium, phosphorus and molybdenum (Marschner, 1995). There were many pieces of evidence showing that soil acidity is a major limiting factor of legume growth in many regions around the world (Munns, 1964; Brauer *et al*., 2002, Paulino *et al*., 1987). A lot of lime and chemical fertilizer especially P are used to solve acid soil problem (Maddox and Soileau, 1991). But in some situations liming and chemical fertilizer application are not suitable solutions. The cost may be prohibitive or subsoil acidity can not be corrected by surface application (Parkpian *et al*.,1991).

Yimyam *et al*. (2001) reported that in Huai Teecha village, Sop Moei district, Mae Hong Son province local farmers can get good yield from their upland rice and other crops on acidic low P soils. High densities of *Macaranga denticulata*, a fallow enriching tree has been shown to be associated with accumulation of nutrients and higher yield of upland rice (Yimyam *et al*, 2003). The *M. denticulata*, on the other hand, has been found to be highly dependent on arbuscular mycorrhizal fungi (AMF) for growth on acidic low P soil (Youpensuk *et al*., 2004). The local population of AMF associated with *M. denticulata* at Huai Teecha is especially diverse and abundant (Youpensuk *et al*., 2004). Moreover they are effective in improving growth of many crop species, including rubber (Kanyasone, 2009), coffee (Yimyam, 2006) and tangerine (Youpensuk *et al*., 2008). Food crops of shifting cultivation at Huai Teecha including upland rice, job’s tears and sorghum have also been shown to benefit from association with the AMF (Wongmo, 2008). Since legume crops are important in supplementing the rice diet of people who live on shifting cultivation in the mountains as well as helping to improve soil fertility with fixed N, knowing how they may benefit from association with the AMF should be useful for farmers growing the legumes on acidic low P soils.

There are many reports showing that AMF can enhance plant growth in stress conditions (Marschner, 1995). Mycorrhiza may be the new choice for solving acid soil problem in legume. Normally the major adverse effects in acid soil for legume are Al toxicity and P deficiency (Marschner, 1995). Cuenca1 *et al* (2001) reported that AMF can retain the Al in their structure. This led to a suggestion that the process probably reduces Al reaching the host plant and reducing toxicity. Moreover the ability of AMF in enhancing P uptake in the host plants (Clark *et al*, 1999) would be advantageous in plants growing in acidic soils with limited P availability. From this evidence mycorrhiza has the potential to alleviate the key adverse effects of acid soil. Nevertheless, in some situations AMF may have no benefit or even negative effect on plant growth (Jonas, 2007). The benefit of AMF depends on many factors such as plant genotype, AMF species and soil condition, especially the P status of the soil. Difference legume species may have difference response to AMF (Jonas, 2007). However, in the same species there are variations between legume cultivar for the response to AMF (Rajapakse *et al*., 1989). Difference AMF species may have difference effectiveness to enhance plant growth (Boddington and Dodd, 1998). Soil pH is an important factor that determines AMF effectiveness. Clark *et al*. (1999) found that Glomus *clarum* was the most effective AMF species to enhance growth of *Panicum virgatum* in soil pH 4 but *G. diaphanum* became the most effective species when pH change to 5. Therefore the success of using AMF symbiosis to solve acid soil problem in legumes requires suitable management. Answers to questions “Do different legumes have the same response to AMF in acid soil?” and ”Which AMF species are effective in acid soil?”, would be useful in attempts to benefit from AMF as a bio-fertilizer to improve legume growth in acid soil. The objectives of this study are as follows.

1. To evaluate the AMF status of legumes in the swidden upland farming that normally faces of acid soil problem.
2. To evaluate the effectiveness of arbuscular AMF for solving acid soil problem in legumes.
3. To compare the benefit of AMF in different legumes when they are grown in acid soil.
4. To find out how AMF alleviate acid soil problem in legumes.