GENERAL INTRODUCTION

At the present, atmospheric carbon dioxide (CO_2) concentrations have been rapidly increasing from 280 to 381 ppm in about a hundred years (IPCC, 2007) and it is expected to increase global surface temperature and altered rainfall frequency and amount. Predicted change in the amount and frequency of rainfall at both season and annual scales will affect the variation in soil moisture and the plant and soil processes In recent report, increases in rainfall variability could rapidly alter key carbon cycling processes, which impact on carbon exchange such as soil CO_2 flux, CO_2 uptake and aboveground net primary productivity, and plant community composition (Davidson *et al.,* 2000; Knapp *et al.,* 2002). These carbon fluxes represent a large portion of global carbon budget and contribute significantly to an increasing atmospheric CO_2 concentration. Therefore, understanding the underlying processes of uptake and release of carbon in the terrestrial ecosystems must be established if it is to predict the future trends of global CO_2 in the atmosphere and to mitigate CO_2 emission from the regions.

Soil CO_2 efflux or soil respiration from the soil surface is one of main flux of the C cycle in terrestrial ecosystems. Soils are now to be significant source of CO_2 because soils are hold approximately twice as much carbon (1500 Pg) as the atmosphere (780 Pg) and releasing about 68 Pg year^{-1} (Raich and Schlesinger, 1992). Thus, changes in soil CO_2 efflux across large areas will lead to a great effect on net exchange of CO_2 between terrestrial ecosystem and the atmospheric. Soil CO_2 efflux is the release of CO_2 produced by autotrophic (plant root) and heterotrophic (microbes and soil fungi) respiration and sum of degases (Hanson *et al.*, 1993). Soil CO_2 efflux is related to many ecological processes such as photosysthesis, root respiration, organic matter decomposition and microbial activity (Bunnell *et al.,* 1977; HÖgberg *et al.,* 2001). Several factors may affect those processes. Therefore, the autotrophic and heterotrophic respirations may respond and adapt to environmental variables differently and thus lead to difference carbon flux pattern under global climate change.

Soil temperature and soil water content are strong factors responsible for variation in soil CO_2 efflux. Soil moisture and soil temperature influence soil CO_2 efflux directly though physiological activity of vegetation and soil microorganism (Qi and Xu, 2001). Rainfall variability (including pattern, amount and timing) was proposed as a key mechanism controlling soil CO_2 efflux in many forest soils (Lee *et al.,* 2002; Lee *et al.,* 2004; Tang *et al.,* 2005; Jarvis *et al.,* 2007) and grassland soils (Liu *et al.,* 2002; Chen *et al.,* 2008). However, there is still uncertainty about the mechanisms responsible for producing soil CO_2 efflux by rainfall. In agricultural field, where rainfall event and supplemental irrigation are infrequent and soil is dry for few weeks, the effect of rainfall may contribute a significant proportion of the total annual soil CO_2 efflux from surface soil. Several researchers have proposed a model to predict soil CO_2 flux from more readily temperature, moisture and other variables (Lloyd and Taylor 1994; Davidson *et al.,* 1998; Tang *et al.,* 2005; Vincent *et al.,* 2006). The few models have incorporated rainfall effects in estimating the variation of soil CO_2 efflux.

Soil CO_2 efflux has been measured using a variety of chamber and micrometeorological methods (such as eddy covariance). There is no standardized approach that is suitable for accurate soil CO_2 efflux during and following rain. Alternatively, the soil CO_2 vertical gradient measurements method and soil automated chamber can continuously measure soil CO_2 efflux following rainfall and it offered in situ observations with minimal disturbance to the soil. Since total soil CO_2 efflux is combined of autotrophic and heterotrophic respiration. In recent year, many attempts have been made to separate the total soil CO_2 efflux in its autotrophic and heterotrophic components (Hanson *et al.,* 2000). The separation of heterotrophic respiration from total soil CO_2 efflux under field condition is still difficult because there are no effective methods for separating them without disturbing the activities of roots and microbial organisms (Buchmann, 2000; Wang and Yang, 2007). Thus, the ability to separation soil CO_2 efflux is essential for understanding the dynamic processes and environmental controlling factors of these components in agricultural soil.

Micrometeorological measurements of the net exchange of carbon dioxide, water vapour, and energy between terrestrial ecosystems and the atmosphere are now being made routinely at sites worldwide to determine the contribution of various ecosystems to the global carbon cycle. Although most study of CO_2 exchange in terrestrial ecosystems have been focused on forest because of their potential to sequester large amount of atmospheric CO_2 (Foken and Wischura, 1996; Baldocchi, 2003). Agricultural land play an important role in the global carbon cycle because agricultural land represents about 12% of the earth's surface, and can have the potential to sequester large amounts of carbon (C) in the soil (Smith, 2004). In many parts of the world, wheat and peanut are grown under rainfed conditions. Amount and distribution of rain and supplemental irrigation can determine the time pattern of water availability of plant used and the ensuing crop biomass and yield. The variable rainfall patterns, along with the variation in timing and magnitude can produce unexpected plant growth responses such as respiration, photosynthesis and productivity and can provide insights into climate change impacts on the ecosystem. Change in rainfall may impact on ecosystem CO_2 exchange through photosynthesis and respiration processes.

Exchange of CO_2 between ecosystems and the atmosphere as an integration of CO_2 uptake during photosynthesis and CO_2 emission via plant and soil CO_2 efflux. The previous measurements were conducted using eddy-covariance technique. Fluxes measured using this technique represent net values between photosynthesis and respiration or net exchange of carbon (NEE) and examine the role of climate on those processes. NEE is controlled by the complex interaction of environmental and biotic factors such as temperature, soil moisture, biomass and leaf are index (Carrara *et al.,* 2004; Xu *et al.,* 2004; Xu and Baldocchi, 2004; Flanagan and Johnson, 2005; Jaksic *et al.,* 2006). It has been exerted strong influence on the biophysical processes resulting in soil CO_2 efflux (Ryan, 1991). Photosynthetic uptake and respiration are separate processes, with different responses to environmental changes. It is essential to investigate separately the responses of plant photosynthesis and ecosystem respiration on environmental factors. Moreover, seasonal changes in ecosystem CO_2 exchanges are closely related to the changes in phenological stage of plant growth and development (Hanan *et al.,* 2005), the soil water balance and rainfall regime (Huxman *et al.,* 2004; Patrick *et al.,* 2007) and occur in response to meteorological condition.

Thus, developing a clear understanding of the relationship between rainfall variation and ecosystem CO_2 exchange processes in the terrestrial ecosystem is required to increase our confidence in modeling future CO_2 cycling-climate scenarios and improve our understanding of how the crop behaves in current climate conditions that controlled by changes in rainfall variability.

This research work consists of two experiments. The experiment 1 deals with the response of soil CO_2 efflux to rainfall variability and the response of net CO_2 exchange to biophysical properties, environmental factors and rainfall. The research work was conducted at winter wheat field. The soil gradient systems combined with root exclusion method were used to measure soil CO_2 efflux. The eddy covariance system and supporting measurements were used to measure net CO_2 exchange between wheat canopy and the atmosphere. The experiment 2 deals with the effect of rainfall events on soil CO_2 efflux and the effect of environmental factors on net CO_2 exchange. The research work was investigated at summer peanut field. The eddy covariance system and supporting measurements were conducted during May 2007 to September 2007. Along with eddy-covariance system and soil automated chamber were monitored to measure soil CO_2 efflux.

The main objectives were 1) to investigate the influence of rainfall events on soil CO_2 efflux, 2) to determine the seasonal patterns of soil CO_2 efflux and its controlling factors as influence by rainfall variability, 3) to quantify the seasonal distribution of net ecosystem exchange in wheat and peanut fields during growing season, and 4) to examine how key environmental controls influence those carbon exchange.