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COMPARISON OF THE CARBON DIOXIDES FLUXES UNDER PEAT SOIL BETWEEN TEMPERATE AND TROPICAL REGION UNDER INTENSIVE AGRICULTURE PRODUCTION

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SUMMARY

Agriculture production under peat soil (organic soil) is a significant contributor to carbon dioxides (CO_2) emission worldwide. Agriculture activities under organic soil are categorized as one of the anthropogenic activities for global climate change and greenhouse gases (GHG) contributors. Organic soils are used for specialty crops as green vegetables and onions in Canada, pineapple and oil palm in Malaysia. The aim of this study was to compare the two growing environments in terms of CO_2 fluxes emission and potential strategies for management strategy improvements. Thus, in Canada, the gas was manually sampled at 15-min for an hour duration from multiple stationary installed non-steady state chambers (NSS) design. In Malaysia, two different chambers were used namely; NSS and CO_2 Draeger gas detection tube chambers were used to measure the CO_2 fluxes for 30-min duration. In results it was found that the mean CO_2 fluxes under tropical region is higher than in temperate area due to continuous warm and humid climate. This result helps in the understanding of the different factors contributing to the CO_2 flux variation and differences between these two regions. Good management practices should be taken into account to ensure the sustainability of the peat soil under intensive agriculture practices.

Keywords: *Carbon dioxides, non-steady state chamber, organic soil*

INTRODUCTION

Mitigation of GHG *i.e.* CO_2 - from the soil is important in reducing the impact from climate change. Microbial activities in the soil play a vital role in releasing or consuming these three gases, and thus are significant in the global GHG cycle. Modelling techniques of GHG estimation from anthropogenic, terrestrial and aquatic components mark the effects on quantification of flux data. Quantifying spatial and temporal variations of the GHG emission is necessary in accessing the potential impact of different agriculture practices on global warming. Consequently, methods used to calculate fluxes of trace gases directly affect the localized or global scale emission estimation and validation (Asman *et al.,* 1999). Draining the organic soil for agriculture purposes increase potential GHG gases, mainly CO_2 fluxes. Draining process exposed the organic soil layer to the decomposition, which allows more oxygen to enter the soil profile. The estimation of the GHG base on soil physical characteristic in rich organic soil is not new. Howard and Howard (1993) found non-linear relationship between soil moisture and CO_2 flux production using wide range of agriculture soil types, including the peat soil. Intensive cultivation under rich organic soil profoundly increase and decrease certain GHG fluxes and emissions. The mineralization of the organic soil very much depend on the soil moisture and temperature. Increase in climatic temperature, reduced the organic matter content of soils. Conseqently, increase the potential GHG emissions (The Leirós *et al.,* 1999). The actual measurement of the estimated value will be valuable for the IPCC standard and as for now just based on the inaccurate studies and not from a crop specific and too generalized. Direct measurement of the CO_2 fluxes for the temperate and tropical region from cultivated cropland on peat soil is needed. Therefore, the aim of this study is to compare the two growing conditions of temperate versus tropical climates in terms of CO_2 fluxes emission and discuss potential strategies for management strategy improvements under peat soil cultivation.

METHODOLOGY

Study location under organic soil in Canada was located at Sherrington, Quebec, Eastern Canada. This location was intensively cultivated for vegetable production. The growing season begin from late spring (May) until the end of November. The water table below soil surface was about at 1 m depth and due to the crop water requirement, the schedule irrigation is normally took place for 8 mm water for one hour sprinkler irrigation. About 24 NSS gas chambers were installed at three different locations with 4 replicates chambers per location. Each chamber location was geo-referenced using Garmin eTrex Legend handheld GPS (Garmin International Inc., Olathe, KS, USA). The gas measurement was done through the gas extraction from a NSS gas chamber (figure 1) made from a flexi-glass frame with size (W x L x H): 0.556 x 0.556 x 0.140 m, and vented to avoid pressure perturbations. The gas samples were collected at least once per week throughout the growing season. All gas samples were extracted using a 20 ml syringe from the headspace. For each sampling event, five gas samples were taken at 15 minutes intervals, thereby totalling one hour. All samples were then injected into 12 ml vacuumed exetainers (Labco, Wycombe, UK) fitted with an extra 60 mil (60 mil equal to $1/16^{th}$ of an inch or 0.0625 inches) of Teflon-silicon septa (National Scientific, Rockwood, TN, USA). All samples were brought immediately to the Soil Ecology Research Laboratory of Macdonald campus, McGill University, where they were stored in a temperature controlled location, and analyzed for the three main trace GHG gases, N_2O, CH_4 and CO_2 concentrations, using a customized Bruker-Varian 450 gas chromatograph (Bruker, Bremen, Germany). These five gas concentrations allowed the flux to be calculated based on median flux estimated using a simple linear regression method. The median slope of the flux was used during the data processing in the MATLAB is to i) remove bias imposed by outlier data, ii) calculate fluxes of trace gases, and iii) estimate total GHG cumulative diurnal emissions under various agriculture practices. A median slope technique was used to disregard outliers of gas measurements taken in a short sampling period. This approach provided an efficient and integrated method to process large datasets for GHG emission estimation.

While in Malaysia, the study sites were located at Simpang Renggam, Johor, Malaysia in pineapple and oil palm areas. The test sited was about 1 acre each and about 200 m distance to each other. The palm was at 8 years old during the measurement, and 10 months for pineapple. Both areas were established with an open drainage and the water table was about sub meter depth. During the gas sampling at each crop type, a total of 24 CO_2- samples were collected (2 site x 2 replicated chambers x 2 times gas measurement x 3 sampling time of the year). This resulted of 48 gas samples for both sites. The CO2 from the peat was captured using the NSS closed chamber design and the gas was detected using the CO_2 Draeger Gas detection tube (Kitigawa, Japan). The cylinder shape chamber was about 15 cm diameter and 15 cm height. The chamber was deployed at 7.4 cm height from the soil surface. After 30-min a gas fluxes emitted, a 100 mL gas was drawn using a syringe from the headspace and then transferred through an opened CO_2 Draeger gas detection tube for flux level measurement. The CO_2 level was read as in percentage which was indicated by the color change from the purple to pink.

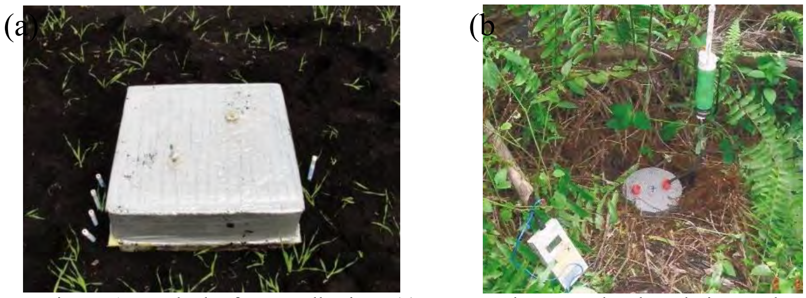

Figure 1: Method of gas collection. (a) Non-steady state chamber design under vegetable production, and (b) Close chamber design under pineapple and oil palm plantation.

RESULTS AND DISCUSSION

The results of the CO_2 fluxes (figure 2) indicated that the emission is higher in tropical organic soil i.e. under oil palm and pineapple rather than under vegetable production. The result indicated that the average CO_2-C fluxes was about 5, 7 and 2.4 g m^{-2} d^{-1} fluxes for pineapple, oil palm and vegetable productions (table 1). Higher CO_2 fluxes in the tropical region compared to the eastern temperate region may be due to the continuously hot and humid weather condition. Since most of the sampling was conducted during the day, the fluxes presented may require more data for statistically robust comparison purposes. Moreover, for the temperate climate area the vegetable production only took place for about a half of the year as compared to the perennial crop.

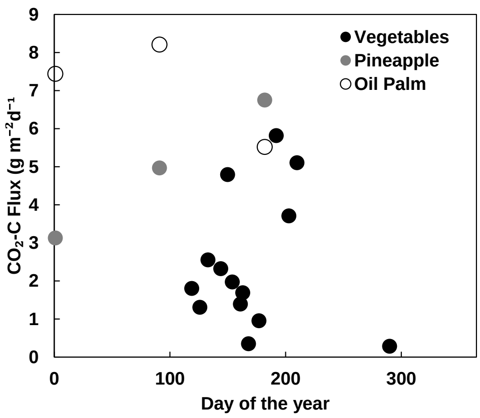

Figure 2: Compare the degree of the CO2 fluxes under different crop, over the number of day in the year.

Table 1: A descriptive statistics of the CO2

Parameter	Pineapple	Oil palm	Vegetable
	CO_2-C (g m^{-2} d^{-1})		
Max	6.8	8.2	5.8
Average	5.0	7.1	2.4
Median	5.0	7.4	1.9
Min	3.1	5.5	0.3

This result presents an initial understanding of the CO_2 fluxes level during the growing season under organic soil production. One of the most important sampling strategies that need to be done is by considering the field heterogeneity. Both locations either in Canada and Malaysia were not based on the field spatial variability consideration upon the sampling location. High root respiration during the gas measurement under pineapple and oil palm is the susceptible factors that may have contributed to the observed high CO_2 fluxes. Thus, more further studies are required to investigate for hot and low spot for the CO_2 emission rather than directly measured at any location. Such an approach can be achieved by mapping the soil electrical conductivity to characterize the field heterogeneity.

SUMMARY

Overall, it was observed that the mean CO_2 fluxes under oil palm cultivation are higher than in other cropping system. However, the cumulative CO_2 fluxes in the tropical region may be higher due to the hot and humid weather as compared to the temperate region. This result helps in the understanding of different factors contributing to CO_2 flux variation and differences between these two regions. Good management practices should be taken into account to ensure the sustainability of the peat soil under intensive agriculture practices

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