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Impact of nitrogen fertilizer application on nitrous oxide emission in oil palm plantation

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Abstract

This study investigates the impact of N-fertilizer application on the emission of nitrous oxide (N_2O) in oil palm plantations. The soil sampling was undertaken at three different oil palm plantations of different land use, i.e. transformed land use (large and small-scale) and a logged-over forest. The soil samples were analysed for N, P and K contents and soil organic carbon. It was found that despite different amount of N-fertilizer applied at the plantations (in the range of 99-155 kg N/ha), immature palm development seems to release relatively higher amount of N_2O compared to mature stage. However, further estimation of carbon equivalent emission (CO_2-eq) would be a more useful means for estimating the impact of N-fertilizer on greenhouse gas emission.

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Keywords: Greenhouse gas; N-fertilizer; nitrous oxide; oil palm plantation

1. Introduction

One of the factors that contribute to the increased nitrous oxide (N_2O) concentration includes fertilized soil in

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agricultural area. Emissions from fertilizer application represent more than 51% of the overall plantation emission [1,8]. The use of fertilizer, coupled with land use and climate changes are the main controlling factors on greenhouse gas emissions from agricultural lands [2]. However, the use fertilizer has often been associated with water deterioration, e.g. eutrophication, but less attention has been given on its contribution to greenhouse gas emissions. In fact, nitrous oxide has been seen as the main contributor of greenhouse gases during agricultural-stage of palm oil plantation development [7,11]. Therefore, this study will provide information on the changes in N_2O emission at different land uses associated with palm oil plantation, and for future mitigation to reduce climate change.

2. Methodology

2.1 Sampling sites

The soil samples were collected from three different sites. The first site is located in Kempas Estate, Melaka (N 2° 19' and 2° 11' and E 102° 26´ and 102° 30´) which is a transformed land use from other crops, i.e. rubber and cocoa and also represents a large-scale plantation area of 1700 ha. The second site is the UPM oil palm plantation (N 05° 00‟ 52.2" and 05° 06‟ 04.6"; E 100° 56‟ 39.1" and 101° 00‟ 45.3") which is also a transformed land use but a small-scale plantation of 40 ha. The UPM oil palm plantation belongs to UPM Holdings and is managed by Taman Pertanian Universiti (TPU). The third site is Chepor Estate (N 02° 58‟ 54.653" and 02° 59‟ 17.815"; E 101° 43‟ 17.141" and 101° 43‟ 42.574") which is a logged-over forest of about 982 ha.

2.2 Data collection and analysis

The soil sampling was conducted for the three estates according to the age of the palms. Soil samples were collected for analysis of N, P, K contents and soil organic carbon (and organic matter) and were taken using schematic triangular method [6] (Fig. 1). The soil samples were collected as triplicates to a depth of 25 cm due to the accumulation of major nutrients on the surface soil. The samples were kept cool during transportation and brought back to laboratory for further analysis. All samples were stored in the refrigerator to prevent moisture loss and to reduce composition changes from biological activity that is slower at low temperature. Then the soil samples were left air dried in a dust and fume-free location. The soil clods and aggregates are pulverized by means of wooden mortar and pestle or by a soil mill to reduce particle size. Soil samples were screened through a 0.25 mm sieve. After screening, soil is thoroughly mixed and put in a plastic pot till analysis. Extraction of soil samples were carried out using 0.01M $CaCl_2$ solution. 10 grams of air dried soil samples were shaken for two hours at 2˚C with 100 ml of $CaCl_2$ solution. Then, the suspension was centrifuged in the supernatant liquid and the nutrient contents (N,P,K) were analyzed using Auto-Analyzer instrument.

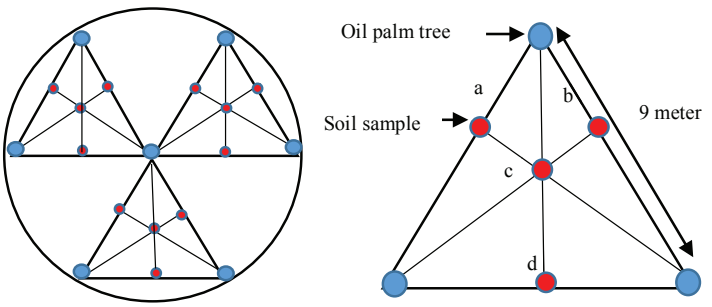

Fig. 1. Schematic triangular sampling of soil