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学 位 論 文 要 旨
Dissertation Abstract

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学位論文題目：
Title of Dissertation Soil Characteristics and Nutrients Dynamics of An Oil Palm Plantation in Central Pahang, Malaysia
(マレーシア国パハン州のアブラヤシ農園における土壌特性と養分動態)

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Oil palm (*Elaeis guineensis*) is one of the most rapidly expanding oil crops in the world. Its cultivation in South East Asia especially Malaysia and Indonesia has been a major driving force to the countries' social and economic development. However, there has been much concern placed by environmentalists on the uncontrolled expansion of oil palm cultivation that resulted deforestation, lost of biodiversity and excessive CO_2 emission. To address these problems, environmentalists suggested that management of oil palm cultivation should be sustainable and future expansion should be restricted to pre-existing crop land.

During the 20-25 years of economic age of oil palm cultivation, two pathways are important to supply nutrient to soils through usual field management practices; one is the use of chemical fertilizer around the palm tree circle (called as weeded circle), while the other is the placement of pruned fronds upon harvesting at the inter rows of the palm trees (frond heap). To date, many soils studies (experimental trials) focused on the use of fertilizer and organic matter on yield performance. In contrast, comprehensive information on the process and mechanisms related to the soils nutrient dynamics as affected by field managements and palm age is scarce, which is crucial for better management of soil nutrients in a productive, sustainable and eco-friendly oil palm environment.

Therefore, to clarify the heterogeneity of soils system in oil palm plantation, three studies were set up; 1) to characterize the soils within a typical oil palm plantation as affected by field managements and slope positions, 2) to evaluate the soil organic matter status within an oil palm plantation in more detail, and 3) to evaluate the distribution of soil phosphorus influenced by chemical fertilizer application and frond heaping

practices.

In study 1, the soils were classified as Typic Hapludox belonging to the Oxisols in the USDA classification system; the soils are clayey kaolinitic, highly weathered, acidic and low in cations. Soil properties were significantly or tended to be different at the depth of 0-5 cm and 5-10 cm within an oil palm field; total carbon (T-C), total nitrogen (T-N), exchangeable magnesium (Mg) and exchangeable calcium (Ca) contents were higher at the frond heap. Higher amounts of available phosphorus were accumulated at the weeded circle due to fertilizer application. Meanwhile, between different slope positions, non-distinct soil particles movement was observed and no evidence of soil erosion was found.

In study 2, at 0-3 cm depth, T-C, T-N and soil microbial C and N content were higher at the frond heap and weeded circle than the harvest path. This can be attributed to the decomposition of pruned fronds placed on soils and the decomposition of root biomass at the weeded circle. Meanwhile, the application of ammonium fertilizers increased the NH_4^+-N content in the soils. Comparison between fields with different planting age showed the tendencies of T-C, soil microbial biomass C and N contents at the weeded circle tended to increase with planting age.

In study 3, the levels of total P and Bray II P, inorganic $NaHCO_3$ P and NaOH P, and HCl P at 0-3 cm were the highest at the weeded circle due to continuous P fertilization through which a significant portion of the applied phosphate rocks remained undissolved and was gradually accumulated in soils. Such P accumulation tended to be more obvious in the old planting fields (18 years). Meanwhile, the levels of organic P fractions at the frond heap were lower than those at the weeded circle, indicating that the stock of organic P was not built up through frond placement practice.

In conclusion, the soil fertility levels are widely differentiated even within a field as influenced by plantation management and planting age. Frond heaping practices should be continued to maintain the level of soil organic matter as well as to recycle plant nutrients to the soils. For fertilizer application, application of finer grain/reactive phosphate rocks should be more concentrated at the early planting stage to promote saturation of P adsorption by Al and Fe oxide in soils in order to increase the fraction of avail. P; and at the later stages the P fertilizer application rate can be reduced. Because vehicle road will affect the nutrient distribution along a slope, such factor should be included in the planning of fertilizer application. Upon replanting stage, the large variation of nutrient distribution at the micro sites during the previous planting should be taken into consideration in order to efficiently use the available nutrients in the soils.