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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

Dynamics of Soil Micronutrients under Frond Heaps at Oil Palm Fields in Malaysia
（マレーシア国アブラヤシ農園内の切除葉堆積区画における土壌中微量栄養素の動態）

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Oil palm (*Elaeis guineensis*) cultivation has been providing employment, income, and business opportunities for several millions of people in Malaysia. However, ongoing expansion of oil palm cultivation has caused the environmental degradation such as deforestation, biodiversity loss, and greenhouse gas emissions. As one of the methods for sustainable management of the plantation, oil palm growers have implemented the site-specific agronomic management practice in existing oil palm cultivation. Generally, each oil palm field can typically be considered as three micro sites under different agronomic management: 1) weeded circle to which fertilizers are applied under the palm canopy and the undergrowth is clear-slashed; 2) frond heap where pruned palm fronds are heaped up, usually between palm trees; and 3) harvest path along which workers move to harvest and transport fruit bunches.

To date, many studies have investigated how fertilization at the weeded circle affects the soil physicochemical properties and the status of soil macronutrients. However, the effects of heaped fronds at the frond heap on dynamics of soil micronutrients in oil palm cultivation remain poorly understood. Existing studies regarding to micronutrients focused only on deficiency symptoms in the palm trees, and no attention has been paid to the changes in status and dynamics of soil micronutrients affected by frond heaping. Therefore, there is a need to evaluate dynamics of soil micronutrients (Mn, Fe, Cu, and Zn) under the frond heap in order to develop more appropriate and effective recycling system for pruned fronds in oil palm cultivation.

In the first study, the status of soil micronutrients was compared among the micro

sites at an 18-year-old oil palm field. In the surface soils, total Mn at the frond heap was significantly higher than at the weeded circle and the harvest path, and total Zn was highest at the weeded circle. Amounts of DTPA-extractable (available) Mn, Fe, Cu, and Zn at the frond heap were higher than at the harvest path. Results of sequential fractionation of soil micronutrients indicated that Mn in the acid soluble, Mn oxide-occluded, and organically bound fractions were higher at the frond heap than at the harvest path. These results suggest that release of Mn during decomposition of heaped fronds could increase the amounts of Mn in the above mentioned fractions, which in turn contributed to the increment of total and available Mn at the frond heap. In addition, frond heaping practice also affected the distribution of Fe, Cu, and Zn.

In the second study, the status of soil micronutrients was compared among oil palm fields with different planting ages of 5 years (OP5), 10 years (OP10), and 18 years (OP18). In the surface soil, total Mn at the frond heap and the weeded circle increased with planting age due to long-term practice of frond heaping and turnover of oil palm roots over time, respectively. Available Mn, Fe, Cu, and Zn in the surface soil at the frond heap tended to be higher in OP18 than in OP5 and OP10. The Mn in the acid soluble, Mn oxide-occluded, and organically bound fractions in the surface soil at the frond heap increased with planting age, suggesting that incorporated Mn in these fractions increased total and available Mn at the frond heap during decomposition of fronds.

In the third study, the amounts of micronutrients in heaped fronds were examined, and possible inputs of the micronutrients into the underlying soil were estimated, assuming that heaped fronds were completely decomposed. Among the examined micronutrients, the amounts of Mn in the frond heap and the estimated inputs into the underlying soil were the highest and increased with planting age.

From these studies, it was clarified that long-term practice of frond heaping increases the availability of micronutrients in the surface soil at the frond heap, especially for Mn. Since oil palm trees have adventitious root system which can reach to the frond heaping area, the increased available micronutrients are supposed to be utilized by the tree. Therefore, it was concluded that the frond heaping practice plays a significant role in the internal recycling of soil micronutrients at the oil palm plantation.