Weed Diversity, Biomass and Micronutrient Assessments on Peat Land Oil Palm Cultivation by Smallholders

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Weed Diversity, Biomass and Micronutrient Assessments on Peat Land Oil Palm Cultivation by Smallholders

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A thesis submitted
In fulfillment of the requirements for the degree of Master of Science (Soil Science)

Faculty of Resource Science and Technology
UNIVERSITI MALAYSIA SARAWAK
2017
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This declaration is made on the 6th day of June 2017.

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ABSTRACT

The relationship of crops, weed and micronutrients in soil is essentially well understood in order to achieve good management and satisfactory crop production. The nutrients, soil and weeds composition in the two, four, and seven year old oil palm plantation by smallholders were studied at Melur Gemilang Plantation in Gedong, Samarahan area. The diversity index and dominance of weed species were calculated using Shannon-Wiener Diversity Index (H') and Summed Dominance Ratio (SDR) respectively. The biomass and carbon stock estimation of weed species were also being assessed. Inductively coupled plasma mass spectroscopy (ICP-MS) technique was used to obtain the micronutrients status of peat soil and weed samples. A total of 48 weed diversity was recorded in the two year – old planting area, followed by 23 and 13 weed species in the four and seven year – old oil palm cultivated area respectively. The selected species of Asystasia intrusa and Nephrolepis bisserata were analyzed for its micronutrients content while the distribution of micronutrients deficit of oil palm were recorded using GPS device. H' value of 2.34 was recorded with the highest estimated carbon stock amount of 5.00 tons/ha in two years old oil palm planted area. There were no significant differences showed between the variables of micronutrients with different depth of peat soil. Boron, zinc and copper were able to be detected in weed species while none in peat soil samples. The oil palm trees distribution of nutrients deficiency were greater at the younger oil palm than the older oil palm with generally deficient in copper, boron and zinc. Poor maintenance activities, peat soil micronutrient problems and low organic material decomposition rate in which different area of soil samples collected act as barriers for optimum oil palm yield. In order to provide valuable material for smallholder planters of oil palm plantations, efficient alternative is hopefully achieved through this study to supply required micronutrients content for maximizing yield production cultivated on peat land.
proper micronutrients application schedule and awareness of precautions on cultivation on peatland is important to prevent concern over disruption of peatland ecosystem.

**Keywords:** Oil palm, weed diversity, micronutrient content, micronutrient deficiency distribution
Penilaian Kepelbagaian Rumpai, Biomas dan Mikronutrien di Ladang Kelapa Sawit Peniaga Kecil Dalam Kawasan Tanah Gambut

ABSTRAK

Kebanyakan pokok-pokok kelapa sawit di kawasan tanaman empat tahun mempunyai kekurangan mikronutrien seperti kuprum, boron dan zink berbanding di kawasan tanaman kelapa sawit yang lebih matang. Penyelenggaraan yang tidak memuaskan, masalah mikronutrien dalam tanah gambut dan kadar bahan penguraian organik yang rendah merupakan halangan untuk penghasilan kelapa sawit yang optimum. Untuk penyediaan material yang berkualiti bagi pengusaha kecil ladang kelapa sawit, tindakan alternatif lain yang ingin dicapai melalui kajian ini adalah untuk membekalkan kandungan mikronutrien yang mencukupi untuk memaksimunkan pengeluaran hasil tanaman di kawasan tanah gambut. Penjadualan aplikasi mikronutrien yang berpatutan dan kesedaran mengenai penanaman di kawasan tanah gambut adalah penting untuk mengelakkan masalah dalam gangguan ekosistem tanah gambut.

**Kata kunci:** Kelapa sawit, kepelbagaian rumpai, kandungan mikronutrien, taburan kekurangan mikronutrien
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CHAPTER 1

INTRODUCTION

1.1 Background of Study

Oil palm (*Elaeis guineensis* Jacq.) plantation in Sarawak is mostly cultivated on peat land area which is most known for nutrient deficiencies and difficulty in practices management for planting purposes. Nowadays, less sustainable practices on conserving soil condition make land that is practicable for oil palm cultivation become less available. In Malaysia, around 20% of land signifies oil palm cultivation on peatland, while Sarawak recorded practically 19% of peat soil area (Andriesse, 1998). Department of Irrigation and Drainage Sarawak (2013) detailed that peat soil in Sarawak region consists of 1.7 million hectares of fresh water peat and 154,000 hectares of mangrove area.

Nutrient deficiencies have become one of the major problems in oil palm cultivation development in Sarawak. As most of this major crop cultivated on peat land areas, this limitation has cost high application rate of nutrients and severe loss to oil palm yield whereby some of the fertilizers applied is likely to be leached due to peat soil inability to retain nutrients and these can be flushed out of the forest if they are not taken up by the trees or crop vegetation. Oil palm trees will show severe signs and symptoms for macronutrients and micronutrients deficiencies which eventually can lead to death of the trees (Sugandi, 2003).
1.2 Problem Statement

Recently, oil palm industry market competitiveness has become increasing and because of this reason, most countries that established oil palm cultivation on peatland planned to secure and control their own palm oil resources because many of these peatlands are inherently infertile and the application of nutrients is required to ensure the healthy growth and development of plantations on these sites. For example, countries such as Indonesia, Columbia, Thailand and China maintain their resources in order to produce their own desired outcome (Gerendas & Heng, 2010). In Sarawak, oil palm yield produced on mostly peatland area has decrease slightly in the recent year of 2012 (Bo, 2013). In order to increase and maintain optimum oil palm production, smallholders that initiate oil palm cultivation on peatland in Sarawak are trying to establish further improvement on soil and micronutrients management to solve the issue.

Uncontrollable weed infestation will affect the oil palm trees growth and development during early establishment due to the nutrients and plant growth sources competition process. The presence of weeds can reduce the optimum efficiency of soil practice and desirable maintenance for the oil palm planters. Oil palm plantation which is commonly cultivated in large scale area might be having maintenance difficulties if planters did not take early precautions to avoid serious weed infestation in the future.

Undisturbed peat soil can contain numerous micronutrients content but appropriate fertilizer and nutrients management of peat soil also plays an important role to provide desirable nutrition for the crops grown. Peat soils are known for its high composition storage of biomass, dead organisms and carbon which are known as carbon stock. Peat soils are
mainly conserved because of its important source of carbon stock which is related to forestry and usage of land.

The result of this research will be useful to show the effectiveness of oil palm cultivation on peat soil areas. In order to increase yield of oil palm production and ensure optimum percentage of growth development, effective strategy of weed control and management of micronutrients application can be determined by proper techniques. This research can provide additional information on improving the effectiveness of different fertilization schedule for micronutrients and to provide awareness about problem of yield production for oil palm cultivation on peat soil.

1.3 Objectives of Study

The objectives of the research are as follow:

i. To determine species richness and diversity of weeds from different stages of oil palm plantation on peat land areas.

ii. To determine biomass and carbon stock of weeds from different ages of oil palm planting established on peat land areas.

iii. To determine micronutrient status, distribution of oil palm deficiency and copper, zinc and boron accumulation in peat soil and selected weed species.
CHAPTER 2

LITERATURE REVIEW

2.1 Peat land

Sarawak is widely known for its great source of availability of peat soils. Despite its various types and characteristics, peat soils do not guarantee consistent yield production of crops cultivation on it without strict soil managements and maintenance application. According to Wetlands International (2010), Sarawak surmounts 69.1% of total peatland in Malaysia, while the other 26.1% and 4.76% was hold by West Malaysia and Sabah respectively. In a recent report, Abdullah (2012) stated that in Sarawak there are around 1.6 million hectares of peatland and over 1.2 million hectares of arable land area. Peat soils contain high source of carbon, where the incomplete decomposition of vegetable organic matter occur due to low level of oxygen needed for the process to finish.

Oil palm cultivations in Sarawak have used many ways to maintain productive yield of oil palm on peat soil. Peat soils are commonly known for its low bulk density, high deficiency of macro and micronutrients and high acidity and water retention (Lim et al., 2012). Examples of oil palm issues are trunk leaning and lodging due to the structure of peat soil.

Various properties of peat soils does not abstain the increasing cultivation of oil palm on peat land in Sarawak. These constraints need continuous and detailed management in order to produce an optimum level of agricultural production. An adequate amount of fertilizers
need to be applied according to different growth stage of plants to supply sufficient amount of nutrients. In addition, the physical limitation of peat soils such as high water table must be managed with proper actions so that the planting schedules can be proceed without much difficulties. Under oil palm cultivation, waterlogged on peat land can inhibit maintenance activities involving mechanization and transportation (Kheong et al., 2010).

2.1.1 Peat soil characteristics

The three classes of peat taxonomy are shallow peat, moderate deep peat and lastly is deep peat (Lim et al., 2012). The depth measurements are less than one meter deep, one to two meter deep and beyond two meter deep respectively. Peat soil initial development occurs at location of lowland and deprived drainage system, and as the middle part of peat soil area develops thicker over time, it can produce leaching condition. Leaching that takes place on peat soil can reduce oil palm productivity as it losing its nutrients content and become less fertile.

Deep peat or fibric (L. Fibra) has the least decomposition rate of organic materials that is least favorable for oil palm cultivation to produce desirable yield. The soil mostly encompasses woody parts of plants that are slow in their decomposition process, which is also has the highest peat maturity level compared to other types of peat soil. On the other hand, moderately deep peat or hemic (Gk. Hemi) consists of moderately decomposed organic matter and shallow peat or also known as sapric (Gk. Sapros) has the highest compositions of decomposed materials that make sapric one of the preferable types of peat soil for oil palm cultivation compared to fibric peat (Wahyunto et al., 2010).
Leaching process of potassium and phosphorus can happen rigorously on deep peat area which will lead to drawback on growth and development of oil palm trees, especially during rainy season. Besides that, the rate of organic matter decomposition will be slower because of high rainfall amount and poor drainage management that eventually cause a formation of fibric peat. In terms of fertility rate, shallow peat is more fertile compared to other types of peat. On the other hand, moderately deep and deep peat soils have low water retention and this can negatively affect oil palm trees’ growth and development. Schwarzel et al. (2002) stated that among problematic type of peat soils are deep peat and shallow peat that are involved in oil palm cultivation.

2.1.2 Management of peat soil

Large company and smallholders farmers tend to utilize available soil area for crops planting which lead to conversion of peat forest for agricultural purposes. These purposes on the peat forest land will disturb the original ecosystem and the diversity of life within the area (Schrier-Uijl et al., 2013). Effective maintenance and management of peat soils must be seriously being taken care of to produce optimum level of productivity in desired period. Therefore, the characteristics of each type of peat soil are important to provide an operational management process. The main difference between types of peat soil is their morphological structure such as the porosity, woodiness, water retention capacity, chemical properties and hydraulic conductivity (Melling et al., 2011).

One of the great concerns for farmers is to maintain optimum yield of crops planted on peat land, for example managing proper water management system. The most effective way to
produce high yield and uphold healthy growth of crops is by maintaining water level of peat soil for about 50 to 70 centimeters below the soil surface (Lim et al., 2012). Oil palm cultivation on peat land is notably for its high contribution to greenhouse gas emissions. Therefore essential water table management of peat soils can diminish greenhouse gas emissions, soil subsidence and peat ignition (Schrier-Uijl et al., 2013).

Peat soil is highly deficient of nutrients content, fertilizer and nutrients management of peat soil also plays an important role to provide adequate nutrition for the crops grown on it. Due to the structure of the peat soil, leaching of fertilizer must be avoided as the soil has high porosity and infiltration rate. Fertilization schedule need to be done periodically and not to be applied during rainy season because that can lead to high leaching rate of fertilization which will only produce costly management system, especially for boron and potassium fertilizers which are highly leachable. Excessive drainage must be avoided because it can change most of the physical properties of peat soils and eventually result in irreversible drying (Schrier-Uijl et al., 2013).

The peat can also be managed by conserving or rehabilitating the peat area. Peat soil is somewhat susceptible to high temperature because this can develop fire burning the peat soil. Peat deposits ignition can cause smoldering fires that is likely to produce high greenhouse gas emissions and create environment issues. Fire risk of peat will affect soil stability, nutrients loss and development of invasive plant species (Certini, 2005). Therefore, caution must be applied to prevent any fire burning within or near the peat soil region.