UNIVERSITI PUTRA MALAYSIA

DECOMPOSITION RATE OF PULVERIZED OIL PALM TRUNK MULCH WITHIN THIRTEEN MONTHS

NURUL HIDAYAH ISMAIL

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NURUL HIDAYAH BINTI ISMAIL

FACULTY OF AGRICULTURE

UNIVERSITI PUTRA MALAYSIA

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CERTIFICATION

This project report entitled "**Decomposition Rate of Pulverized Oil Palm Trunk Mulch Within Thirteen Months"** was prepared by Nurul Hidayah Binti Ismail and submitted to Faculty of Agriculture in fulfillment of the requirement PRT 4999 (Final Year Project) for Bachelor Agriculture Science course.

Student's name: Student's signature:

(NURUL HIDAYAH BINTI ISMAIL) …….

Matric number: 164246

Certified by:

……..

(DR. CHRISTOPHER TEH BOON SUNG)

Project Supervisor,

Department of Land Management

Faculty of Agriculture

University Putra Malaysia

Serdang, Selangor

Date:

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ABSTRACT

Oil Palm Trunk (OPT) is one of the main waste products from the palm oil industry. After 20-25 years of oil palm growth, the replanting of old oil palm need to be conducted. This is to enhance the yield of oil palm as the yield decreases with age. There are several ways to conduct the oil palm that are felled. Before the banning of open burning under Malaysian Environmental Air Quality Regulation in 1978, the most common method of clearing old oil palms for replanting in Malaysia was the "chip and burn" method. This method can contribute to global warming and air pollution. With the ban on open burning, new alternative method management known as "chip and windrowed" was introduced. But this method can lead to a problem such as breeding of the *Oryctes rhinoceros* beetle. Apart from that, it is also as source of rat and *Ganoderma boninense* disease development cause by low sanitation.

This project was conducted to investigate the decomposition rate of the pulverized OPT mulch, nutrient content and rate of nutrient release to the soil using pulverized machine. This research was continued from the previous project which had started from May (2013) and continued from January until September (2014). This decomposition process of pulverized oil palm trunk mulch took about 16 months. This project was conducted at UPM palm oil area (GPS: N 2 ° 58.826 E 101 ° 43.699) near the UPM Stadium. OPT sample which was about 7 kg was taken from Ladang Kota Bharu which is under the management of Trunkbuster Company at Kota Bharu, Gopeng, Perak (GPS : N 4 ° 23.352 E 101 ° 04.606) and was placed on soil in a tray. Munchong soil series were used, Completely Randomized Design (CRD) plot with 8 experimental units was used (4

replication X 2 treatment). T1 treatment was the pulverized oil palm trunk mulch while T2 treatment (without use of pulverized oil palm trunk mulch) as a control. Only T1 treatment was be focused on this experiment because the need to measure of the characteristics and rate of decomposition of oil palm trunk mulch. For every month, samples were taken and nutrient content were analyzed by wet ashing method. The percentage of total nutrient remaining for Nitrogen are (80.9%), Calcium (19.54), Carbon (17.6%), Phosphorus (16.8%), Magnesium (7.8%), and Potassium (3.75%). The rate of decomposition are slow which was 0.109 (percentage remaining per month).

ABSTRAK

Batang kelapa sawit merupakan salah satu hasil buangan utama dari industri kelapa sawit. Penanaman semula kelapa sawit perlu dilakukan ketika usia kelapa sawit mencapai di antara 20-25 tahun. Ini adalah untuk meningkatkan hasil kelapa sawit pada penanaman seterusnya kerana hasil akan berkurangan apabila umur pokok meningkat. Terdapat beberapa cara untuk mengendalikan batang kelapa sawit yang ditebang. Sebelum larangan pembakaran terbuka dikuatkuasakan di bawah Akta Peraturan Kualiti Alam Sekeliling Malaysia 1978, kaedah yang biasa digunakan untuk pembersihan bagi projek penanaman semula ladang adalah kaedah 'chip and burn'. Kaedah ini dapat menyumbang kepada masalah pemanasan global dan pencemaran udara. Bagi mengelakkan masalah ini, kaedah terkini yang dijalankan adalah 'chip and windrow'. Tetapi kaedah ini boleh menimbulkan masalah pembiakan serangga seperti kumbang badak, *Oryctes Rhinoceros*. Selain itu, juga menyebabkan masalah kehadiran tikus dan penyakit *Ganoderma boninense* disebabkan faktor sanitasi yang kurang berkesan. Tujuan kajian ini dijalankan adalah untuk mengkaji kadar penguraian dalam sungkupan penghancuran dari batang kelapa sawit, kandungan nutrien dan kadar nutrien pelepasan ke tanah dengan menggunakan mesin pulverized. Kajian ini merupakan sambungan projek yang dimulakan pada bulan Mei (2013) dan disambung pada bulan Januari sehingga bulan Ogos (2014). Proses penguraian sungkupan batang kelapa sawit merangkumi masa selama 16 bulan. Projek ini dijalankan di kawasan ladang sawit UPM (GPS: N 2 ° 58.826 E 101 ° 43.699) berhampiran Stadium UPM. Sampel batang kelapa sawit diambil dari Ladang Kota Bharu yang diuruskan oleh syarikat Trunkbusters di Kota Bharu, Gopeng, Perak (GPS: N 4 ° 23.352 E 101 ° 04.606) diambil sebanyak 7 kg

dan diletakkan di atas tanah di dalam dulang. Reka bentuk rambang sepenuhnya (CRD) plot telah digunakan iaitu 8 unit uji kaji (4 replikasi X 2 rawatan). Rawatan T1 menggunakan sungkupan penghancuran batang kelapa sawit manakala rawatan T2 sebagai kawalan (tidak menggunakan sungkupan penghancuran batang kelapa sawit. Hanya rawatan T1 sahaja yang akan difokuskan dalam eksperimen ini kerana lebih tertumpu kepada sifat dan kadar perubahan pada sungkupan penghancuran batang kelapa sawit. Pada setiap bulan, sampel akan diambil dan kandungan nutrien akan dianalisis menggunakan kaedah 'wet ashing'. Peratus nutrien yang tinggal pada sungkupan penghancuran OPT adalah bagi Nitrogen (80.9%), Kalsium (19.38%), Karbon (17.6%), Fosforus (16.8%), Magnesium (7.8%) dan Kalium (3.75%). Kadar pereputan adalah perlahan iaitu 0.109 (peratus yang tinggal per bulan).

CHAPTER 1

1.1 INTRODUCTION

The past few decades have seen rapid growth of oil palm industry in Malaysia in terms of cultivated area and volume of production. It is reported that Malaysia produced about 13.9 million tonnes (dry weight) of oil palm biomass, including trunks, fronds and empty fruit bunches annually (Anis *et al.,* 2007). This figure is expected to increase substantially when the total planted hectare of oil palm in Malaysia reached 5.10 million hectares in 2020 (Hashim *et al*., 2004). A recent figure indicated that oil palm plantation areas in Malaysia have expanded from 3.37 million hectares in year 2002 to 4.17 million hectares in year 2006. The use of oil palm trunk and oil palm biomass for various products have been extensively explored. The alternative biomass is comparatively cheaper, sustainable, as well as, environment friendly.

Treated palm trunks can be made into furniture (Darnoko 2002 cited in Simorangkir 2007). Other experimental items made from byproducts include paper (Wanrosli *et al*., 2007), fibre board and fillers (Wahid *et al*., 2005), activated carbon (Ahmad *et al*., 2007), fish food (Bahurmiz and Ng, 2007), compost for growing mushrooms, and enzymes, vitamins and antibiotics (Ramachandran *et al*., 2007).

In this studies, it will be focused on one of the uses of Oil Palm Trunk (OPT) which is mulching. This procedure is a common practice especially in oil palm plantations for conserve the soil conserve as to keep the good moisture condition in the soil. The pulverized OPT can be used as the source for energy and the nutrients needed for plant growth. The energy release in a form of Carbon (C) and nutrient source in the elements

of Nitrogen (N), Phosphorus (P), Potassium (K), Magnesium (Mg) and Calcium (Ca). This is all of the macro elements that needed by plant.

There are many of advantages in using pulverized oil palm trunk (OPT) for mulching process. Some of that can increase profits and reduce waste which there has been considerable research on these opportunities. With a combination of reuse, recycling, using solid and liquid wastes, and appropriate energy management, the crude palm oil (CPO) industry can achieve almost zero pollution discharge, making it an environmentally friendly industry (Chavalparit *et al*., 2006).

But the pulverized OPT mulch also can cause some problem that can reduce plant productivity. The OPT that undergo processes using pulverized machine will be windrowed in the line between two rows of replanting oil palm plants into heaps. The problem is not all of the soil surface will be covered by this OPT, so some area of soil will cannot absorb the nutrients from the mulch.

The condition of heaps pulverized OPT mulch give a suitable conditions for pests like rodents, snakes and *Oryctes rhinoceros* beetle. These pests will disturb the growing process of replanting oil palm plants. Besides, if the sanitation are not in properly well clean it can lead the *Ganoderma Boninense* disease in plant. This disease has become the most serious pest in immature and young mature palms in Malaysia currently.

Besides, the decomposition rate of this mulching are slow. The organic matter takes time for decompose. More than 50% of the pulverized palm biomass decomposed at 24th weeks after pulverization, which increased to 80% by the 56th week. Then, the uptake of nutrients and energy for soil and plants will be slow.

Objectives

1) To determine the decomposition rate of dry matter of the pulverized oil palm trunk mulch at the end of 13 months.
2) To determine the changes in the nutrient content and nutrient release of the pulverized oil palm trunk mulch at the end of 13 months.

BIBLIOGRAPHY

Abas, R., Kamarudin M. F., Nordin A.A.B., and Simeh, M. A. 2011. A study on the Malaysian oil palm biomass sector - supply and perception of palm oil millers. Oil Palm Industry Economic Journal, 11 (1), 28-41.

Abdullah, S.A. and Nakagoshi, N. 2007. Forest fragmentation and its correlation to human land use change in the state of Selangor, peninsular Malaysia. Forest Ecology and Management 241: 39–48.

Agboola, A., and Unamma, A. 1991. Maintenance of soil fertility under traditional farming systems. In: Lombin KG, Adeoye BK, Chude OV, Torunana AMJ, Agbede OO, Nwaka MG, Omueti IAJ, Olayiwola OS (eds) Organic fertilizer in the Nigerian agriculture: present and future. Federal Ministry of Agriculture, Abuja, 7–10.

Ahmad, A.L., Loh, M.M., and Aziz, J.A. 2007. Preparation and characterization of activated carbon from oil palm wood and its evaluation on methylene blue adsorption. Dyes and Pigments 75: 263–272.

Anderson, J.M., Proctor, J., and Vallack, H.W. 1983. 1. Ecological studies in four contrasting lowland rain forest in Gunung Mulu National Park, Sarawak. III. Decomposition processes and nutrient losses from leaf litter. Journal of Ecology, 71:503-527.

Anderson, J. M and Ingram, J.S. 1993. Tropical Soil Biology and Fertility, A Handbook of Methods (second edition). Commonwealth Agricultural Bureau, Oxon, 22.

Asma, W.I., Rasidah, W.K., Rosenani, A.B., Aminuddin, H. & Rozita, A. 2011. Effects of mulching and fertilizer on nutrient dynamics of sand tailings grown with *Acacia* hybrid seedlings. Journal of Tropical Forest Science 23 (4), 440-452.

Basiron, Y. & Weng, C. K. 2004. The oil palm and its sustainability. Journal of Oil Palm Research, 16 (1).

Blanchar, R., Rehm, G., & Caldwell, A. 1965. Sulphur in plant materials by digestion with nitric and perchloric acid. Soil Science Society of America Journal, 29(1), 71-72.

Bahurmiz, O.M. and Ng, W.K. 2007. Effects of dietary palm oil source on growth, tissue fatty acid composition and nutrient digestibility of red hybrid tilapia, Oreochromis sp., raised from stocking to marketable size. Aquaculture 262: 382–392.

Chan, K.W., Watson, I., and Lim KC. 1980. Use of oil palm waste material for increased production. In: Proc. Conf. On Soil Sc. and Agric. Dev. in Malaysia. Malaysian Soil Science Soc, KL. 213-242.

Chavalparit, O., Rulkens, W.H., Mol, A.P.J. and Khaodhair, S. 2006. Options for environmental sustainability of the crude palm oil industry in Thailand through enhancement of industrial ecosystems. Environment, Development and Sustainability 8: 271–287.

Chung, G., Sim, S., & Balasubramaniam, R. 1999. Effects of pest damage during immature phase on the early yields of oil palm. Proceedings 1999 PORIM Internatioal Palm Oil Congree, Emerging Technologies and Opportunities in the Next Millenium-Agriculture Conference, 454-476.

Crawford, D. L., Barder, M.J., Pometto III, A. L., & Crawford, R. L. 1982. Chemistry of softwood lignin degradation by Streptomyces viridosporus. Archives of Microbiology, 131(2), 140-145.

Feller C, Bernoux M (2008) Historical advances in the study of global terrestrial soil organic carbon sequestration. Waste Manag 28:734–740.

Germer, J., & Sauerborn, J. (2008). Estimation of the impact of oil palm plantation establishment on greenhouse gas balance. Environment, Development and Sustainability, 10(6), 697-716.

Hansen, T.S. 2005. Spatio-temporal aspects of land use and land cover changes in the Niah catchment, Sarawak, Malaysia. Singapore Journal of Tropical Geography 26: 170–190.

Kaye, J. P., & Hart, S. C.1997. Competition for nitrogen between plants and soil microorganisms. Trend in Ecology & Evolution, 12 (4), 139-143.

Khalid, H., Zin, Z., & Anderson, J. 1999. Quantification of oil palm biomass and nutrient value in a mature plantation. I. above-ground biomass. Journal of Oil Palm Research, 11(1), 23-32.

Khalid H, Zakaria Z, Anderson JM 1999. Effects of oil palm residues management at replanting on soil nutrient dynamics and oil palm growth. In: Proceedings of the 1999 PORIM international palm oil congress (Agriculture). Palm Oil Research Institute of Malaysia, Bangi, 235–246.

Khalid, H., Zin, Z., & Anderson, J. 2000. Decomposition processes and nutrient release patterns of oil palm residues. Journal of Oil Palm Research, 12(1), 46-63.

Lim, SC., and Khoo, KC 1986. Characteristics of the oil palm trunk and its potential utilization. The Malaysian Forester 49 (1): 3-22.

Mansor H and Ahmad AR. 1991. Chemical composition of the oil palm trunk. In: Proc. Nat. Seminar on oil palm trunk and other palmwood utilization. Min. Primary Industries, Malaysia, 335-342.

Makinde, AE., Oluwatoyinbo, IF.,, Ayoola, TO. 2006 Intercropping and crop residue incorporation: effects on soil nutrient status. J Plant Nutr 29:235–244.

Tajuddin, Hashim.,Teoh, C,H., Kamaruzaman Aribi and Mohd Ali .1993. Zero burning - an environmentally friendly replanting technique. In Jalani Sukaimi et al. (eds.). Proc. of PORIM International Palm Oil Congress 'Update and Vision' – Agriculture Module, Palm Oil Research Institute of Malaysia, Bangi. p. 185-194.

Ooi, L. H., & Heriansyah. 2005. Palm Pulverization in sustainable oil palm replanting (diversified cropping systems for asia, proceedings of the fifth asian crop science conference). Plant Production Science, 8(3), 345-348.

Ramachandran, S., Singh, S.K., Larroche, C., Soccol, C.R. and Pandey, A. 2007 Oil cakes and their biotechnological applications—a review. Bioresource Technology 98: 2000–2009.

Ratnasingam, J., Ma, T. P., Manikam, M. ad Farrokhpayam, S.R. (2008). Evaluating the machining characteristics of oil palm lumber, Asian J. Applied Science, 1: 334-340.

Rosenani, A.B., & Hoe, S. F. (1996). Decomposition of oil palm empty fruit bunches in the field and mineralization of nitrogen. In O. Cleemput, G. Hofman & A. Vermoesen (Eds.), (pp. 127-132) Springer Netherlands. doi :10.1007/978-94-011-5450-5_20.

Rosenani, AB., & Wingkis R (1999) Empty fruit bunch application to newly transplanted oil palm: its decomposition and nutrient release. In: Zauyah S, Rosenani AB, SaudHM (Eds), Proceedings of the soil science conference of Malaysia 1999. Malaysian Soil Science Society, pp 112–129

Kamaruddin, Taqwan.2013. Decomposition Rate of Pulverized Oil Palm Trunk Mulch. FYP Thesis.Universiti Putra Malaysia.

Unger, P.N.1997. Tillage and research management in rain fed agriculture: present and future trends. In: Renard C (ed) Crop residues in sustainable mixed crop/livestock farming systems. ICRISAT, Patancheru, 307–340.

Zulkifli, H. and Khalid, H. (2008). The effect of incorporating palm residues at replanting on phosphate dynamics in an inland soil in Malaysia. Journal of Oil Palm Research, 20, 559-570.