UNIVERSITI PUTRA MALAYSIA

GLUFOSINATE AMMONIUM RESIDUES IN DIFFERENT SOILS AND WATER OF OIL PALM ECOSYSTEM

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By

SITI JARIANI BINTI MOHD JANI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

October 2010

DEDICATION

This thesis is dedicated to my lovely parents, siblings and friends

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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Chairperson: Associate Professor Datin Rosenani binti Abu Bakar, PhD

Faculty: Agriculture

In Malaysia, the herbicide glufosinate ammonium (GLUF) is widely used in oil palm plantations mainly for the control of weeds and grasses, thus making it easier for collection of palm oil fruits and to ensure safety of workers against wild animals. Currently, lifecycle assessment of environmental impacts is a requirement particularly for products that are exported such as palm oil and there is lack of documented data on the residues of GLUF in the oil palm ecosystem to support the lifecycle assessment. Therefore, it is important for the industry to have a relevant data to prove that there is no environmental impact on the herbicide practices especially for oil palm which is exported to countries that requires high environmental safety standards. Hence, the main objective of this study is to investigate the behavior and possible residues of GLUF in soil and water of oil palm ecosystem through three specific objectives: 1) To determine the adsorption and desorption of GLUF in different soils under oil palm cultivation, 2) to

determine the degradation of GLUF in different soils under oil palm cultivation and 3) to determine the residues of GLUF in soil and water of oil palm plantation.

In order to achieve the first objective, adsorption and desorption study were conducted on four mineral soils, Inceptisol (Selangor), Oxisol (Munchong) and Ultisols (Serdang and Rengam) series and a peat soil (Histosol) collected under oil palm cultivation from 0-15 cm and 15-30 cm depths using batch equilibrium technique. The concentrations of GLUF used were 0, 0.25, 0.5, 1, 1.5, 3, 5 and 10 µg/mL. The adsorption and desorption isotherms were fitted to the linear and Freundlich equations. Adsorption of GLUF was in the following increasing order: Selangor > Rengam> Munchong> peat > Serdang. The results indicated that the adsorption of GLUF was positively correlated only with clay content. The high sorption of the Selangor series soil could be explained by the high clay content in this soil series compared to the other soil series. In contrast, the order of GLUF desorption was in the following order: Serdang> peat> Munchong> Rengam> Selangor. Results indicate that adsorption of GLUF was mainly on the clay fraction of the soil and the binding strength of adsorbed GLUF was high as indicated by low amount of GLUF desorbed from the soils.

The second objective was achieved through a degradation study in the laboratory using incubation technique. The effects of microbial activity on GLUF were studied in three soil series (Selangor, Serdang and peat) collected at 0-15 cm depth. The soils were either sterilized or non-sterilized and both were treated with either a recommended field dose (3.333 L/ha) of GLUF or double recommended field dose. Each soil treatment was done in triplicates. Samples were analyzed at 0, 2, 4, 8, 12, 16, 24, 35, 42 and 60 days after

treatment. Sterile soil showed no significant changes in all 3 types of soil compared to the non-sterile soil. This can be explained by the lack or no microbial activity in the sterile soil. The results indicate that microbial activity played an important role in the degradation of GLUF. In non-sterile soil for both dosage of GLUF application, the shortest half-life was observed in peat soil with 4.61 and 15.5 days for the recommended and double recommended dose, respectively. Selangor Series Soil (clay) exhibited the longest half-life of 10.02 and 37.45 days in the recommended and double recommended field dose, respectively.

A field experiment was conducted to achieve the third objective. The type of soil at the site was clay soil. The study plots were arranged in Completely Randomized Design (CRD) and the study was conducted at two different seasons, the rainy and dry season. In this study, GLUF was applied at a recommended dose and double recommended dose. During the rainy season, the GLUF residues were still detected in the soil at day 3 after application of the recommended field dose and day 7 for application of double recommended field dose. There were no detected residues in the water collected from PVC tube installed in the field and sub stream for both doses. Residues of GLUF remained longer in the soil during the dry season. The residues were still detected at day 21 and 42 for the recommended and double recommended field dose, respectively. No water sample was collected during the dry season because the sub stream and PVC tube were all dried up. This is due to the low rainfall at that time of the season.

From all the results obtained, it can be concluded that GLUF is safe to be used in oil palm plantation as it has a very short half-life and low potential of GLUF to be

transported or leached to the groundwater if used as recommended. However, the impact of the herbicide on the environment depends on more factors than these, for examples, its impact to soil microorganism, non-target organism and aquatic environment. The use of this herbicide in agriculture environment might lead to their occurrence in non-agricultural environment. Herbicides that have a high leaching potential can result in the contamination of ground water supplies.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

SISA BAKI GLUFOSINATE AMMONIUM DALAM TANAH BERLAINAN DAN AIR BAGI EKOSISTEM KELAPA SAWIT

Oleh

SITI JARIANI BINTI MOHD JANI
Oktober 2010

Pengerusi: **Profesor Madya Datin Rosenani binti Abu Bakar, PhD**

Fakulti: **Pertanian**

Di Malaysia, racun herba glufosinate ammonium (GLUF) digunakan secara meluas di ladang-ladang kelapa sawit terutamanya bagi mengawal pelbagai rumpai dan rumput, seterusnya memudahkan kerja-kerja pengumpulan buah sawit dan bagi memastikan keselamatan pekerja dari haiwan-haiwan liar. Di masa ini, penilaian kitar hidup bagi kesan persekitaran adalah kemestian terutama bagi produk yang diekspot seperti minyak sawit dan kurangnya data yang didokumentasikan berkaitan sisa baki GLUF dalam ekosistem kelapa sawit untuk menyokong penilaian kitar hidup tersebut. Oleh itu, adalah sangat penting bagi industri ini memiliki data yang relevan untuk membuktikan bahawa tiada kesan persekitaran diatas penggunaan GLUF terutama bagi kelapa sawit yang mana dieksport ke negara-negara yang memerlukan tahap keselamatan alam sekitar yang tinggi. Dengan itu, objektif utama kajian ini adalah untuk menyiasat perilaku dan kemungkinhadiran sisa baki GLUF dalam tanah dan air di ekosistem kelapa sawit melalui tiga objektif spesifik: 1) Mengenalpasti kadar jerapan dan penyahjerapan GLUF

dalam tanah-tanah yang berlainan di kawasan tanaman kelapa sawit, 2) mengenalpasti tempoh penguraian GLUF dalam tanah-tanah yang berlainan di kawasan tanaman kelapa sawit dan 3) mengenalpasti sisa-baki GLUF dalam tanah dan air bagi ladang kelapa sawit.

Bagi mencapai objektif pertama, kajian jerapan dan nyahjerapan telah dijalankan keatas empat tanah mineral, Inseptisol (Selangor), Oksisol (Munchong) and Ultisol (Serdang dan Rengam) dan sejenis tanah gambut (Histosol) yang diambil dari kawasan tanaman kelapa sawit pada kedalaman 0-15cm dan 15-30cm menggunakan teknik keseimbangan berperingkat. Kepekatan GLUF yang digunakan adalah 0, 0.25, 0.5, 1, 1.5, 3, 5 dan 10 µg/mL. Isoterma bagi jerapan dan nyahjerapan disesuaikan menggunakan persamaan garis lurus dan Freundlich. Jerapan GLUF adalah mengikut turutan menaik berikut: Selangor > Rengam> Munchong> gambut > Serdang. Keputusan ini menunjukkan bahawa jerapan bagi GLUF adalah berhubungkait secara positif dengan kandungan liat. Jerapan yang tinggi pada tanah Siri Selangor dapat dijelaskan dengan kandungan liat yang tinggi dalam tanah ini berbanding tanah-tanah lain. Walaubagaimanapun, turutan bagi penyahjerapan GLUF adalah berlawanan seperti berikut: Serdang> gambut> Munchong> Rengam> Selangor. Keputusan ini menunjukkan bahawa jerapan bagi GLUF adalah tertumpu pada pecahan liat tanah dan kekuatan ikatan jerapan GLUF adalah tinggi yang mengakibatkan kadar penyahjerapan GLUF dari tanah rendah.

Objektif kedua dicapai melalui kajian penguraian di dalam makmal menggunakan teknik inkubasi. Kesan aktiviti mikrob pada penguraian GLUF telah dikaji dalam tiga siri tanah iaitu (Selangor, Serdang dan tanah gambut) pada kedalaman 0-15 cm. Bagi setiap jenis

tanah, sampel bagi kedua-dua tanah steril dan tidak steril dirawat dengan GLUF pada kadar disyorkan ladang (3.333 L/ha) dan dua kali ganda kadar disyorkan ladang. Setiap tanah yang telah dirawat disediakan dalam tiga replikasi. Sampel dianalisis pada 0, 2, 4, 8, 12, 16, 24, 35, 42 dan 60 hari selepas rawatan. Tanah steril menunjukkan tiada perubahan yang nyata dalam kesemua tiga jenis tanah berbanding tanah tidak steril. Ini dapat dijelaskan bahawa ianya adalah disebabkan kurang atau tiada aktiviti mikrob di dalam tanah steril. Keputusan ini menunjukkan bahawa aktiviti mikrob memainkan peranan penting dalam penguraian GLUF. Di dalam tanah tidak steril bagi kedua-dua kadar disyorkan ladang yang digunakan, jangka hayat separa yang paling singkat dapat diperhatikan pada tanah gambut dengan masing-masing 4.61 dan 15.5 hari. Tanah Siri Selangor (tanah liat) menunjukkan jangkahayat separa yang paling lama dengan masing-masing 10.02 dan 37.45 hari pada kadar disyorkan dan dua kali ganda kadar disyorkan.

Eksperimen ladang telah dijalankan bagi mencapai objektif ketiga. Jenis tanah di ladang eksperimen adalah tanah liat. Plot kajian disusun secara rawak lengkap (CRD). Kajian telah dijalankan pada dua musim berbeza iaitu musim hujan dan musim kering. Dalam kajian ini, applikasi GLUF dijalankan pada kadar disyorkan dan dua kali ganda kadar disyorkan. Semasa musim hujan, sisa-baki bahan yang dikesan hanyalah sehingga hari ketiga bagi kadar disyorkan dan 7 hari bagi dua kali ganda kadar disyorkan. Tiada sisa-baki dikesan dalam air yang diambil dari tiub air yang dipasang di ladang dan parit bagi kedua-dua kadar. Sisa baki GLUF berada lebih lama dalam tanah pada musim kering. Sisa-baki bagi bahan itu dapat dikesan sehingga hari ke-21dan ke-42 bagi kadar disyorkan dan dua kali ganda kadar disyorkan. Tiada sampel air diambil sepanjang

musim kering ini kerana tiub air dan parit semuanya kering. Ini adalah kerana kadar taburan hujan yang rendah pada musim ini.

Dari semua keputusan yang diperolehi, dapat diputuskan bahawa GLUF adalah selamat untuk digunakan kerana ia mempunyai jangka hayat separa yang sangat pendek dan potensi yang rendah untuk racun herba ini dipindahkan atau meluntur ke dalam air bawah tanah sekiranya diguna sebagaimana yang disyorkan. Namun begitu, kesan racun herba ini keatas persekitaran bergantung kepada lebih dari hanya faktor-faktor ini sebagai contoh, kesannya tehadap mikroorganisma tanah, organisma bukan sasaran dan persekitaran akuatik. Penggunaan racun herba ini pada persekitaran yang berbeza mungkin membawa kepada kehadirannya dalam persekitaran bukan pertanian. Racun herba yang mempunyai potensi pelunturan yang tinggi boleh mengakibatkan pencemaran pada bekalan air bawah tanah.

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I certify that an Examination Committee has met on **October 2010** to conduct the final examination of **Siti Jariani Mohd Jani** on her thesis entitled **"Glufosinate Ammonium Residues in Different Soils and Water of Oil Palm Ecosystem"** in accordance with the Universities and University College Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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This thesis was submitted to Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of **Master of Science**. The members of the supervisory committee were as follows:

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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledge. I also declare that it has not been previously, or concurrently, submitted for any other degree at Universiti Putra Malaysia or other institutions.

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SITI JARIANI MOHD JANI

Date: 14 October 2010

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