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NITROGEN RELEASE AND LOSS, AND KENAF RESPONSE TO CONTROLLED-RELEASE UREA FERTILIZERS APPLIED TO BRIS SOILS

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By

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DEDICATED TO:

Mohd Hafizudin bin Haji Hashim – husband

Halimah binti Awang - mom

Abdullah bin Hassan – dad

Abstract of thesis submitted to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Masters of Science

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Kenaf has been identified to replace tobacco which is widely planted in Beach Ridges Interspersed with Swales (BRIS) soils area. Urea fertilizer had been used widely in agriculture as a major source of nitrogen (N). However, urea fertilizer can be easily leached. Therefore, control release urea (CRU) fertilizers are excellent alternatives for BRIS soil because they release nutrients slowly and plants are able to absorb without waste. The objectives of this study were to determine the nitrogen release, loss and kenaf response to control-released urea (CRU) fertilizers applied on BRIS soils. The specific objectives were to determine of the BRIS soils properties and characteristics of CRU fertilizers, to determine the mineralization of N and ammonia volatilization loss under laboratory condition, and the effect of CRU application on N uptake by kenaf grown on BRIS soil. The investigation consist of Study 1, Study 2, Study 3 using two BRIS soil series viz Rhu Tapai and Rudua. Both of soil series and were treated with four treatments viz Meister-20, Duration type-V, Uber-10, and typical urea as a control. In Study 1, determination of the BRIS soil properties and characteristics of CRU fertilizers were conducted. In Study 2, determinations of

mineralization of N and ammonia volatilization loss under laboratory condition were conducted. In determination of mineralization of N, treated soil samples were analyzed for eight weeks. NH_3-N volatilization was determined for two weeks. In Study 3, effect of CRU application on N uptake by kenaf grown on BRIS soils were conducted. BRIS soils which were mixed with 2 t/ha palm oil mill effluent, was filled into culverts measuring 24 x 55 cm in diameter x height. Kenaf seed was sown at the center of the culvert. Two N rates were used in this study viz 300 and 600 kgN/ha. Determination of mineral N in treated soil was also being carried out monthly for five months. The culverts were arranged in a randomized complete block design. The effectiveness of treatments was determined by analyzing the plant height, yield, and availability of N in the plant tissues and replicated three times. Analysis of variance was used to analyze the data to detect significant differences. Treatments means were compared using Tukey at 5% level of significance. In laboratory condition, CRU released NH_4-N, NO_3-N, and Urea-N lower than typical urea in eight weeks of experiment. CRU also released NH_3-N volatilization lower than typical urea in two weeks of experiment. In field study, typical urea released NH_4-N, NO_3-N, and Urea-N higher at early stage of experiment then decreased rapidly. However, CRU released NH_4-N, NO_3-N, and Urea-N lower at early stage of experiment and maintain over five months. In terms of kenaf performances, the CRU gave significantly higher yield and N uptake. The results showed that the fertilization at rate of 300kg N/ha was enough to give the same results as 600kg N/ha and about 50% of fertilizer can be saved. Therefore, the CRU fertilizers can increase the effectiveness of urea application for plant growth.

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

PEMBEBASAN SERTA KEHILANGAN NITROGEN DAN RESPON KENAF TERHADAP BAJA UREA PERLEPASAN-TERKAWAL TERHADAP KENAF DITANAM PADA TANAH BRIS

Oleh

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Kenaf telah dikenal pasti untuk menggantikan tembakau yang meluas ditanam di kawasan tanah Rabung Pantai berselang dengan Parit Cetek (BRIS). Baja urea telah digunakan secara meluas dalam bidang pertanian sebagai sumber utama nitrogen (N). Walau bagaimanapun, baja urea boleh mudah terlarut lesap. Oleh itu, baja kawalan pelepasan urea (CRU) adalah alternatif yang sangat baik untuk tanah BRIS kerana mereka melepaskan nutrien secara perlahan-lahan dan tumbuh-tumbuhan dapat menyerap tanpa sisa. Objektif kajian ini adalah untuk menentukan pembebasan nitrogen, kehilangan dan tindak balas kenaf terhadap baja mengawal mengeluarkan urea (CRU) yang digunakan pada tanah BRIS. Objektif khusus untuk menentukan sifat tanah BRIS dan ciri-ciri baja CRU, untuk menentukan mineral N dan kehilangan pengewapan ammonia dalam keadaan makmal, dan kesan aplikasi CRU pada pengambilan N oleh kenaf ditanam di tanah BRIS. Penyelidikan terdiri daripada Kajian 1, Kajian 2, Kajian 3 menggunakan dua siri BRIS tanah iaitu Rhu Tapai dan Rudua. Siri tanah ini telah dirawat dengan empat rawatan iaitu Meister-20, Duration jenis-V, Uber-10, dan urea

tipikal sebagai kawalan. Dalam Kajian 1, penentuan sifat-sifat tanah BRIS dan ciri-ciri baja CRU telah dijalankan. Dalam Kajian 2, penentuan mineral N dan kehilangan pemeruapan ammonia dalam keadaan makmal telah dijalankan. Dalam penentuan mineral N, sampel tanah yang dirawat telah dianalisis selama lapan minggu. Pengewapan NH_3-N telah ditentukan selama dua minggu. Dalam Kajian 3, kesan aplikasi CRU pada pengambilan N oleh kenaf yang ditanam di tanah BRIS telah dijalankan. Tanah BRIS yang telah dicampur dengan 2 t/hasisa enap kilang sawit, diisi ke dalam pembetung berukuran 24 x 55 cm ketinggian x diameter. Benih kenaf telah disemai di tengah-tengah pembetung. Dua kadar N telah digunakan dalam kajian ini iaitu 300 dan 600 kgN / ha. Penentuan mineral N dalam tanah yang dirawat juga dijalankan secara bulanan selama lima bulan. Pembentung telah disusun dalam reka bentuk blok lengkap rawak. Keberkesanan rawatan ditentukan dengan menganalisis ketinggian tumbuhan, hasil, dan Ketersediaan N dalam tisu tumbuhan dan direplikasi sebanyak tiga kali. Analisis varians telah digunakan untuk menganalisis data untuk mengesan perbezaan yang ketara. Rawatan dibandingkan menggunakan Tukey pada paras keertian 5%. Dalam keadaan makmal, CRU mengeluarkan NH_4-N, NO_3-N, dan Urea-N lebih rendah daripada urea tipikal dalam lapan minggu eksperimen. CRU juga mengeluarkan NH_3-N pengewapan urea yang lebih rendah daripada urea tipikal dalam dua minggu eksperimen. Dalam kajian lapangan, urea tipikal mengeluarkan NH_4-N, NO_3-N, dan Urea-N yang lebih tinggi pada peringkat awal eksperimen kemudian menurun pesat. Walau bagaimanapun, CRU mengeluarkan NH_4-N, NO_3-N, dan Urea-N lebih rendah pada peringkat awal eksperimen dan mengekalkan lebih lima bulan. Dari segi persembahan kenaf, CRU memberikan hasil dan pengambilan N yang lebih tinggi. Keputusan menunjukkan bahawa aplikasi pada kadar 300kg N/ha adalah cukup untuk memberi keputusan yang sama seperti 600kg N/ha dan kira-kira 50% baja boleh dijimatkan. Oleh itu, baja CRU boleh meningkatkan keberkesanan aplikasi urea untuk pertumbuhan tumbuhan.

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CHAPTER 1

INTRODUCTION

There is a serious effort to replace tobacco, which is mainly grown in the BRIS (Beach Ridges Interspersed with Swales) soils in the east coast of Malaysia. This is due to the government anti-smoking campaign as tobacco is hazardous to health. Kenaf is known as fiber crop and has been identified as a potential crop to replace tobacco. Kenaf produces fibers and can be commercialized into various non-wood fiber products, which tags along current world trend in promoting non-wood based materials. In Malaysia, various studies had been carried out to promote kenaf in local market. Replacement of the lucrative tobacco crop grown on BRIS soils requires careful soil management practices, since it is very sandy with low fertility. The BRIS soil can be found along beaches, 0.2 to 10.0 kilometers from the sea (Faridah and Abdullah, 1991). Total area of BRIS soil in Malaysia is about 155,400 ha and 40,400 ha in Sabah (Aminah *et al.*, 2006).

In agriculture, BRIS soil has been known as problem soil due to low water holding capacity, low cation exchange capacity (CEC), pH ranging 3-5, and very low organic matter content. The total N is also very low in BRIS soils (Roslan *et.al.*, 2010). It also has high surface temperature and becomes very dry during daytime. Nutrients applied to BRIS soils can be easily leached, especially during heavy rain season. Generally crop performances on BRIS soils are poor unless proper crop and soil management are practiced (Abdul Wahab and Mohd Zain, 1991).

1.1 Justification

BRIS soil is not suitable for agriculture due to its physical and chemical properties, which affects the agricultural productivity compared to other mineral soil. It needs proper management and inputs to ensure the high agricultural production. Since BRIS soil is not fertile due to its low availability of N, control release urea (CRU) fertilizer is an alternative to be used in BRIS soils since it can reduce N loss from leaching.

1.2 Objectives

This study was undertaken to determine the nitrogen release, loss and kenaf response to control-released urea fertilizers applied on BRIS soils. The specific objectives were; Study 1: to determine of the BRIS soils properties and characteristics of CRU fertilizers, Study 2: to determine the mineralization of N and ammonia volatilization loss under laboratory condition, and Study 3: to determine the effect of CRU application on N uptake by kenaf grown on BRIS soil.

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