



UNIVERSITI PUTRA MALAYSIA

***EFFECTIVENESS OF SULFUR- COATED AND UNCOATED UREA
FERTILIZERS AS NITROGEN SOURCES FOR RICE***

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By

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DEDICATED TO

Mohamad Bin Jena - husband

Said Bin Daud - father

Saadiah Binti Jusoh- mother

and all my beloved sibling

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

EFFICACY OF SULFUR- COATED AND UNCOATED UREA FERTILIZERS AS NITROGEN SOURCES FOR RICE

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Chairman : Professor Mohd Khanif Yusop, PhD

Faculty : Agriculture

The efficiency of urea N in rice culture is usually as low in Malaysian soil. The low N use efficiency is attributed mainly to ammonia volatilization, denitrification, leaching, and runoff losses. Various methods have been developed in order to improve urea-N consumption by rice. The concurrent use of physical methods such as coating with sulfur, using urease inhibitor and the additive of soluble salts were used in order to increase the urea-N utilization in rice. The objective of this study is to determine the efficacy of sulfur coated urea (SCU) as N source for rice. The following are the specific objective to conduct in this study (i) To evaluate physical and chemical properties of the sulfur coated urea, ii) To quantify N transformation, ammonia volatilization and pH changes in soil of SCU on three selected paddy soils and (iii) To determine the effect of SCU on rice yield in the field

Laboratory experiments were conducted to evaluate physical and chemical properties of the SCU's fertilizers. Urea (control), wax sulfur coated urea and polymer coated sulfur coated urea were determined for total N and S content, coating thickness and percentage of coating. Laboratory studies were also conducted to determine the effect of SCU on urea transformation, ammonia volatilization and pH change in three selected rice soils; Chempaka Series (Typic Paleudult), Lubok Itek Series (Typic Fluvaquent) and Tok Yong Series (Typic Paleudult). Two types of SCU fertilizers were used (i) Polymer coated sulfur coated urea (PCSCU) and (ii) Wax sulfur coated urea (WSCU). Urea, urea + Sulfur (6%) and urea + sulfur (17%) fertilizer were used as control treatments. Data were determined every week during 12 weeks incubation.

Rice variety MR220 was selected to evaluate the efficacy of selected SCU. This study was conducted at Kampung Mahligai, Kelantan (05°56.770 N 102°17.684 E). The experimental design used was Factorial Randomize Complete Block Design (RCBD). Different treatments consisting of selected SCU were applied. The treatments were T1: Urea 120 kg/ha at split application (control treatment), T2: PCSCU 60 kg/ha at basal application, T3: PCSCU 60 kg/ha at split application, T4: PCSCU 120 kg/ha at basal application, T5: PCSCU 120 kg/ha at split application T6: WSCU 60 kg/ha at basal application T7: WSCU 60 kg/ha at split application T8: WSCU 120 kg/ha at basal application T9: WSCU 120 kg/ha at split application, T10: Urea + sulfur (6%) without coating 120 kg/ha at split application and T11: Urea + sulfur (17%) without coating 120 kg/ha at split application. Soil samples were collected at day 14, day 28, day 44, day 64, day 78 and day 94 after planting for determination of plant height, pH in soil and ammonium content. At maturity, plant was determined for N and S content, nutrients N and S uptake, yield and parameter at harvest

stage (length and number of panicle and tiller). Soil also was determined for N and S concentration and nutrient uptake.

The coating thickness and the percentage of coating of the WSCU were thicker than the PCSCU. The thickness of fertilizer coatings was in the range of 30.3 μm -49.3 μm depending on the coating type. WSCU showed higher value (49.3 μm) of coating among the fertilizers. PCSCU has a lower value (30.3 μm) of coating. Laboratory study showed that WSCU treatment had the lowest NH_3 volatilization loss among the treatments for the three selected soils. Ammonia volatilization losses became 20 to 35% less in three selected soils. The NH_4^+ -N released from the fertilizer was affected by the types of fertilizer where WSCU had the lowest NH_4^+ -N release for three selected soils. When urea was applied to soil, hydrolysis occurs rapidly to form NH_4^+ -N in soil. The pH increased rapidly after the treatments applied to the soil for three selected soils in week one. The uncoated urea showed higher pH compared to coated urea treatments.

Field study using Lubok Itek series and rice variety MR220 were conducted. Results showed significant differences ($P \leq 0.05$) on grain yield. The highest grain yield is 5.4 t/ha was recorded from treatment WSCU 120 kg/ha at split application (T9). Treatment PCSCU at 60 kg/ha with basal application showed the lowest grain yield (3.3 t/ha) among the treatments. The highest straw yield was 9.83 t/ha recorded from treatment PCSCU 120 kg/ha at split application and U+S 17% 120 kg/ha without coating at split application (T11) while treatment PCSCU 60kg/ha as basal application (T2) showed the lowest straw yield (7.67 t/ha). Furthermore, there were significant differences ($P \leq 0.05$) on pH and ammonium content in soil, plant height, 1000 grain weight, number of tiller, number panicles, panicles length, plant length, N uptakes (plant, grain and straw), S uptakes (plant, grain and straw), N and S

concentration in (grain and straw) and S concentration in soil. No significant different occurred in N concentration in soil.

Under control condition tested on three selected paddy soils showed that coated urea fertilizer give the best results compared to uncoated urea fertilizer. Wax sulfur coated urea fertilizer showed the capability to reduced ammonia volatilization loss effectively compared to uncoated urea fertilizer. The different results were obtained when the field trial carried out.

As a conclusion, uncoated urea fertilizer is an excellent fertilizer when applied to Lubok Itek Series soil (flooded soil) which gives similar result with sulfur coated urea fertilizer. Sulfur coated urea fertilizer did not increased rice yield as compared to control treatment. The use of sulfur coated urea fertilizer at half the recommended nitrogen rate did not produce higher rice yield. Uncoated urea fertilizer is more economical relatively compared to coated urea in terms of price which is cheaper and easily available in markets.

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

**KEBERKESANAN BAJA-BAJA UREA BERSALUT DAN TIDAK BERSALUT
SULFUR SEBAGAI SUMBER-SUMBER NITROGEN PADA PADI**

Oleh

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Mac 2012

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Kecekapan urea N pada kultura padi biasanya adalah rendah pada tanah Malaysia. Kecekapan penggunaan N rendah terutamanya adalah disebabkan oleh pengewapan ammonia, dinitrifikasi, kehilangan melalui larut lesap dan larian permukaan. Pelbagai kaedah telah dibangunkan untuk meningkatkan penggunaan urea-N oleh padi. Penggunaan serentak kaedah fizikal seperti salutan dengan sulfur, menggunakan perencat urease dan penambahan garam larut telah digunakan untuk meningkatkan penggunaan urea-N pada padi. Objektif kajian ini adalah untuk menentukan keberkesanan sulfur urea bersalut (SCU) sebagai sumber N pada padi. Berikut adalah objektif khusus untuk menjalankan kajian ini (i) Untuk menilai sifat-sifat fizikal dan kimia urea bersalut sulfur, ii) Untuk mengukur transformasi N, pengewapan ammonia dan perubahan pH tanah oleh SCU pada tiga tanah padi terpilih dan (iii) Untuk menentukan kesan SCU pada hasil padi di lapangan.

Ujian makmal telah dijalankan untuk menentukan ciri-ciri fizikal dan kimia baja SCU. Urea (kawalan), Wax-urea sulfur bersalut dan polimer bersalut urea bersalut sulfur telah ditentukan untuk menentukan jumlah kandungan N dan S, ketebalan salutan dan peratusan salutan. Kajian makmal juga telah dijalankan untuk menentukan kesan SCU terhadap transformasi urea, pengewapan ammonia dan perubahan pH pada tiga jenis tanah padi terpilih; Tok Yong Series (Typic Paleudult), Lubok Itek Series (Typic Fluvaquent) dan Chempaka Series (Typic Paleudult). Dua jenis baja SCU yang digunakan ialah (i) urea bersalut polimer bersalut sulfur (PCSCU) dan (ii) Wax urea bersalut sulfur (WSCU). Baja urea, urea + Sulfur (6%) dan urea + sulfur (17%) telah digunakan sebagai rawatan kawalan. Data ditentukan setiap minggu selama 12 minggu inkubasi.

Varieti padi MR220 telah dipilih untuk menilai keberkesanan baja SCU yang dipilih. Kajian ini dijalankan di Kampung Mahligai, Kelantan (05° 56,770 N 102° 17, 684 E). Reka bentuk uji kaji yang digunakan adalah Rekabentuk Blok Rawak Lengkap (RCBD). Rawatan yang berbeza yang terdiri daripada SCU yang terpilih telah digunakan. Rawatan-rawatan adalah seperti T1: Urea 120 kg/ha pada aplikasi split (rawatan kawalan), T2: PCSCU 60 kg/ha pada aplikasi basal, T3: PCSCU 60 kg/ha pada aplikasi split, T4: PCSCU 120 kg/ha pada aplikasi basal, T5: PCSCU 120 kg/ha aplikasi split, T6: WSCU 60 kg/ha pada aplikasi basal, T7: WSCU 60 kg/ha pada aplikasi split, T8: WSCU 120 kg/ha pada aplikasi basal T9: WSCU 120 kg/ha pada aplikasi split, T10: Urea + sulfur (6%) tanpa salutan 120 kg/ha pada aplikasi split dan T11: Urea + sulfur (17%) tanpa salutan 120 kg/ha pada aplikasi split. Sampel tanah telah diambil pada hari ke 14, 28 hari, 44 hari, 64 hari, 78 hari dan 94 hari selepas penanaman untuk menentukan kehilangan N dan pengambilan N, pH pada tanah dan kandungan ammonium. Pada tahap matang, kandungan N dan S tanaman telah ditentukan, hasil tanaman dan pengambilan nutrien N dan S.

Ketebalan dan peratus salutan pada WSCU adalah lebih tebal berbanding PCSCU. Ketebalan salutan baja adalah dalam julat 30.3 μm -49.3 μm bergantung kepada jenis salutan. Baja WSCU menunjukkan nilai yang lebih tinggi (49.3 μm) salutan berbanding baja lain. Baja PCSCU mempunyai nilai salutan ketebalan yang lebih rendah (30.3 μm). Kajian makmal menunjukkan bahawa rawatan WSCU mempunyai kehilangan pengewapan NH_3 terendah di kalangan rawatan untuk tiga tanah terpilih. Kehilangan pengewapan ammonia menjadi 20 hingga 35% kurang pada tiga tanah terpilih. $\text{NH}_4^+ \text{-N}$ yang dibebaskan daripada baja telah dipengaruhi oleh jenis baja di mana WSCU mempunyai pelepasan $\text{NH}_4^+ \text{-N}$ terendah pada tiga tanah terpilih. Apabila urea telah diletakkan pada tanah, hidrolisis berlaku sangat cepat untuk membentuk $\text{NH}_4^+ \text{-N}$ dalam tanah. pH meningkat secara mendadak selepas rawatan diletakkan pada tanah pada minggu pertama bagi ketiga-tiga tanah yang dipilih. Urea tidak bersalut menunjukkan pH yang lebih tinggi berbanding dengan rawatan urea bersalut.

Kajian lapangan menggunakan Siri Lubok Itek dan varieti padi MR220 telah dijalankan. Hasil kajian lapangan menunjukkan bahawa terdapat perbezaan yang signifikan ($P \leq 0.05$) pada hasil biji padi. Hasil biji padi tertinggi (5.4 t/ha) dicatatkan daripada rawatan WSCU 120 kg pada aplikasi split (T9). Rawatan PCSCU 60kg pada aplikasi basal menunjukkan hasil biji padi yang paling rendah (3.33 t/ha) pada rawatan lain. Walaupun WSCU rawatan 120kg pada aplikasi berbeza dan Urea + Sulfur 120 kg 17% tanpa salutan pada aplikasi berbeza yang menghasilkan butiran padi tertinggi tetapi kenaikan itu tidak ketara secara statistik. Hasil jerami tertinggi adalah 9.83 t/ha dicatatkan daripada rawatan PCSCU 120 kg/ha pada aplikasi split (T5) dan Urea + Sulfur 17% tanpa salutan pada aplikasi split (T11) manakala rawatan PCSCU 60kg pada aplikasi basal menunjukkan hasil jerami yang paling rendah (7.67 t/ha). Selain itu, terdapat perbezaan yang signifikan ($P \leq 0.05$) pada pH dan kandungan ammonia di dalam tanah, ketinggian tanaman, berat 1000 biji padi, bilangan tiller, bilangan

tangkai, panjang tangkai, panjang tanaman, pengambilan N (tanaman, bijian dan jerami), Pengambilan S oleh (tanaman, biji padi dan jerami) dan kepekatan N dan S pada (biji padi dan jerami) dan kepekatan S dalam tanah. Tiada perbezaan yang significant pada kepekatan N dalam tanah.

Ujian pada persekitaran terkawal terhadap tiga jenis tanah sawah telah menunjukkan bahawa baja urea bersalut memberikan hasil terbaik berbanding baja yang tidak disalut. Baja wax sulfur coated menunjukkan keupayaannya dalam mengurangkan kehilangan ammonia secara berkesan berbanding dengan baja urea yang tidak bersalut. Walaubagaimanapun, keputusan yang berbeza telah diperolehi apabila ujian dijalankan di kawasan lapangan.

Sebagai kesimpulan, baja urea tidak bersalut adalah baja yang bagus apabila digunakan ke atas Lubok Itek Siri tanah (tanah banjir) yang mana memberikan hasil yang sama dengan baja urea bersalut sulfur. Selain itu, baja urea bersalut sulfur tidak meningkatkan hasil padi berbanding dengan rawatan kawalan. Penggunaan baja urea bersalut sulfur pada separuh daripada kadar nitrogen yang disyorkan yang dihasilkan tidak menghasilkan hasil padi yang lebih tinggi. Baja urea tidak bersalut adalah lebih jimat secara relatif berbanding dengan baja urea bersalut dari segi harga di mana adalah sangat murah dan mudah didapati di pasaran.

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I certify that a Thesis Examination Committee has met on 19th June 2012 to conduct the final examination of Nur Fazlina Binti Said on her thesis entitled “Effectiveness of Sulfur- coated and Uncoated Urea Fertilizers as Nitrogen Sources for Rice” in accordance with the Universities and University Colleges 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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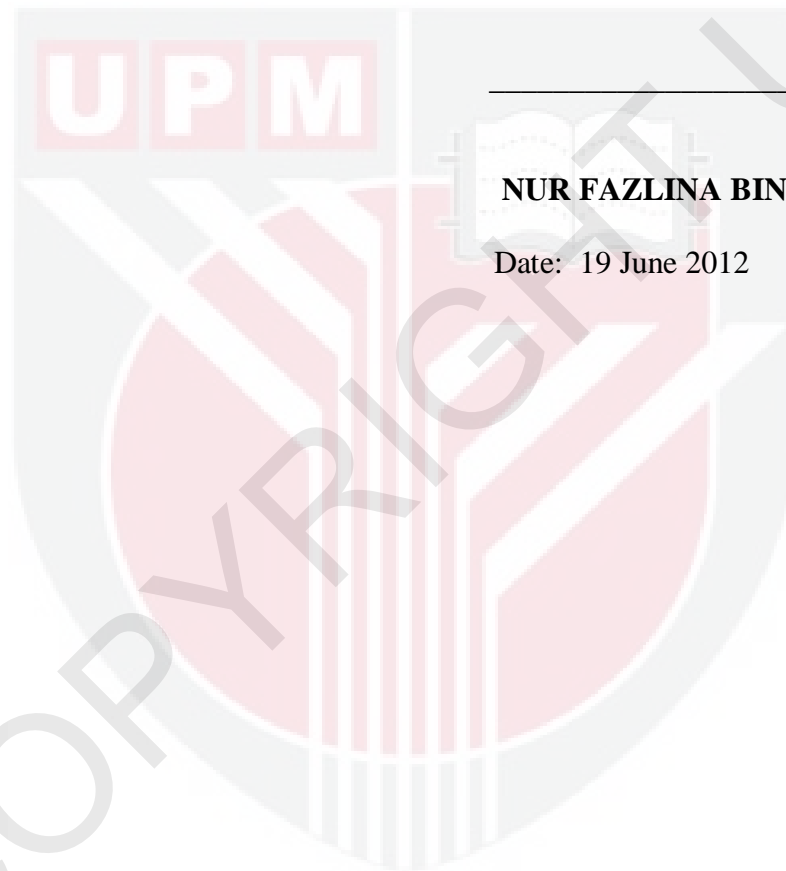
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DECLARATION

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



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Date: 19 June 2012

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