



**UNIVERSITI PUTRA MALAYSIA**

**PREPARATION AND CHARACTERIZATION OF UREA WITH  
COATED-UREA MATERIALS AND THEIR PERFORMANCE TO  
REDUCE AMMONIA VOLATILIZATION AND IMPROVE CROP  
PRODUCTION**

**NASIMA JUNEJO**

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**By**

**NASIMA JUNEJO**

**Thesis Submitted to the School of Graduate Studies, Universiti  
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Urea is a widely used N fertilizer in the world. The rapid hydrolysis process of urea is responsible for high microsite pH and accumulation of  $\text{NH}_4$  in the soil. It caused  $\text{NH}_3$  emission from surface applied urea, resulting in poor N uptake and hazardous environmental effects. Urea can be more effective if an efficient method is devised to reduce  $\text{NH}_3$  losses. One of the approaches is to coat urea with biodegradable materials and urease inhibitors. The objectives of the study were; to prepare and characterize coated urea with biodegradable material and urease inhibitors; to evaluate the effects of the coated urea on  $\text{NH}_3$  losses, nitrogen transformations in soil and crop production. Laboratory, glasshouse and field studies were conducted to evaluate the physical



and chemical properties of coated urea; to quantify the N transformation and ammonia volatilization loss on selected soil series and to determine yield and N uptake by plant from coated and uncoated urea. Six treatments of coated urea were prepared for the study labeled as; uncoated urea; palm stearin and Cu coated urea; agar and Cu coated urea; gelatin and Cu coated urea; Cu coated urea and Cu and Zn coated urea. The urea were coated with agar, gelatin, palm stearin, Cu and Zn by using fluidized bed coating machine. The coated urea was characterized for physical and chemical properties by using elemental analysis, FT-IR, TGA and SEM techniques. The results of study revealed that there were no significant changes were occurred in the properties of urea after coating. Laboratory evaluations of coated urea were carried out to quantify the N transformation and ammonia volatilization loss on three soil series named as; Munchong, Serdang and Holyrood. The urea coated treatments coated with combinations of agar, palm stearin and Cu had 20-23, 30-32 and 40 - 38 % lower microsite pH,  $\text{NH}_4$  and  $\text{NO}_3$  content in soil as compare to uncoated urea, respectively. In glass house study, Munchong soil series was used to grow the maize variety J-58. The plant were harvested after 8 weeks, followed by second planting on the same pots to determine residual effects of coated urea treatments on soil and plant. The coated and uncoated urea treatments, Triple super phosphate and potassium chloride was applied as fertilizer source of N, P and K at the rate of 100, 50, 100 kg ha<sup>-1</sup> before the planting. After first



harvesting, the second planting was done without application of N fertilizer. The results of both experiments revealed that 33- 40 % increase in N uptake and 40 - 60 % in dry matter yield of maize in the pot treated by coated urea with as compared to uncoated urea. However, the highest yield 26.50 and 26.45 g pot<sup>-1</sup> was obtained from micronutrient coated urea at first harvest and from Agar and Cu coated urea at second harvest, respectively. To evaluate the effects of coated urea treatments under field condition, a pasture site (Guinea grass) was selected, harvested and fenced before application of fertilizer treatments. The duration of experiment was six months. During the experiment, the site was fertilized with urea treatments, TSP and KCl treatments at the rate of 217, 100 and 217 kg ha<sup>-1</sup>, respectively. And standardized agronomical operations were performed. The grass was cut two times at flowering stage to record dry matter yield. The soil and plant sample were analyzed for N, Cu and Zn content. The results showed 35 and 30 % improvement in N uptakes and crop production in UCuZn treated plots in at both harvestings, respectively. In addition, amendment of urea with multiple coatings has beneficial residual effects. It was concluded that coated urea can improve N uptake and reduce the ammonia losses. The urea coated with Biodegradable polymer and Cu had increased the residual effects of N.



Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

**PERSEDIAN DAN PENCIRIAN UREA SERTA BAHAN SALUTAN DAN PRESTASINYA BAGI PENGURANGAN PEMERUAPAN AMMONIAI DAN PENINGKALAN HASIL TANAMAN**

Oleh

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Urea adalah baja N yang digunakan dengan meluasnya di serata dunia. Proses hidrolisis urea yang sangat pantas memainkan peranan penting bagi tapak mikro pH yang tinggi dan pengumpulan  $\text{NH}_4$  dalam tanah. Ia menyebabkan emisi  $\text{NH}_3$  yang dari urea yang digunakan di permukaan, justeru menyebabkan pengambilan N yang rendah dan menyebabkan kesan yang bahaya terhadap alam sekitar. Urea boleh menjadi lebih efektif, jika ditemui kaedah yang lebih efisien untuk mengurangkan kehilangan  $\text{NH}_3$ . Salah satu cara ialah dengan menyalutkan urea dengan bahan biodegradasi dan penggunaan inhibitor urease. Maka, objektif kajian adalah seperti berikut; untuk menyediakan dan



mencirikan urea yang disadur dengan bahan biodegradasi dan inhibitor urease; untuk menilai kesan urea yang disalut terhadap kehilangan  $\text{NH}_3$ , transformasi nitrogen dalam tanah dan penghasilan tanaman. Kajian makmal, rumah kaca dan kajian lapangan dijalankan untuk menilai sifat fizikal dan kimia urea yang disalut; untuk menilai transformasi N dan pemeruapan ammonia ke atas siri tanah yang dipilih dan untuk menentukan hasil dan pengambilan N oleh tumbuhan dari urea yang di salut dan tidak disalut. Enam rawatan dengan urea yang disadur disediakan untuk kajian dan dilabelkan sebagai; urea tidak disalut, stearin sawit dan urea yang disalut dengan Cu; agar dan urea yang disalut dengan Cu; gelatin dan urea yang disalut dengan Cu; urea yang disalut dengan Cu dan urea yang disalut dengan Cu dan Zn; Urea disalut dengan agar, gelatine, stearin sawit, Cu dan Zn dengan menggunakan mesin 'fluidized bed coating'. Urea yang disalut dicirikan untuk sifat fizikal dan kimia melalui analisa FT-IR, TGA dan SEM. Keputusan kajian tersebut menunjukkan bahawa tidak terdapat perubahan signifikan yang dikesan terhadap urea selepas penyaduran. Analisa makmal ke atas urea yang disalut dijalankan untuk menentukan jumlah transformasi N dan pemeruapan kehilangan ammonia pada tiga siri tanah iaitu; Munchong, Serdang dan Holyrood. Urea yang dirawat dengan urea yang disalut dengan kombinasi agar, stearin sawit dan Cu mempunyai 20-23, 30-32 dan 40-38% kandungan lebih rendah tapak mikro pH,  $\text{NH}_4$  dan  $\text{NO}_3$  dalam tanah berbanding

urea yang tidak disadur. Dalam kajian di rumah kaca, Siri Munchong digunakan untuk menanam jagung variasi J-58. Pokok tersebut dituai selepas 8 minggu, dan diikuti dengan penanaman kali kedua di tapak yang sama untuk menentukan kesan baki urea yang disadur ke atas tanah dan pokok. Rawatan urea yang disalut dan tidak disadur, 'triple super phosphate' dan kalium klorida digunakan sebagai baja untuk sumber N, P dan K pada kadar 100, 50, 100 kg ha<sup>-1</sup> sebelum penanaman. Selepas tuaian pertama, penanaman kali kedua dilakukan tanpa penambahan baja N. Keputusan kedua-dua eksperimen menunjukkan bahawa 33-40 % peningkatan dalam pengambilan N dan 40-60% dalam hasil tuai jagung dalam pasu yang mempunyai urea yang disalut berbanding urea yang tidak disadur. Walaubagaimanapun, hasil tertinggi 26.50 dan 26.45 g pasu<sup>-1</sup> diperolehi dari mikronutrien yang disadur urea pada tuaian pertama dan dari agar dan Cu yang disadur urea pada tuaian kedua. Untuk menilai kesan rawatan urea yang disadur terhadap eksperimen di lapangan, satu kawasan pastur (rumput Guinea) dipilih, dituai dan dipagar sebelum rawatan baja dilakukan. Tempoh ujikaji adalah enam bulan. Semasa eksperimen dijalankan, tapak kajian dibajakan dengan rawatan urea, TSP dan KCl pada kadar 217, 100 dan 217 kg ha<sup>-1</sup>. Selepas itu, langkah kerja agronomi yang standard dijalankan. Rumput dipotong sebanyak dua kali pada peringkat pembungaan untuk merekodkan hasil kering. Sampel tanah dan pokok dianalisa untuk kandungan N, Cu dan Zn.



Hasil keputusan menunjukkan peningkatan 35 dan 30% dalam pengambilan N dan penghasilan tanaman dalam plot rawatan UCuZn dalam kedua-dua sesi tuaian. Tambahan pula, penggunaan urea dengan pelbagai jenis saduran mempunyai kesan baki yang baik. Adalah dirumuskan, bahawa urea yang disalut boleh meningkatkan kadar pengambilan N dan mengurangkan kehilangan ammonia. Urea yang disalut dengan polimer biodegradasi dan Cu telah meningkatkan kesan baki N.

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I certify that a Thesis Examination Committee has met on 6<sup>th</sup> April 2011 to conduct the final examination of Nasima Junejo on her Doctor of Philosophy thesis entitled “Preparation, characterization and evaluation of coated urea with biodegradable materials to reduce ammonia volatilization loss and enhance crop production” In accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U. (A) 106] 15th March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy. Members of the Thesis Examination 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 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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**NASIMA JUNEJO**

Date: 6 April 2011



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