UNIVERSITI PUTRA MALAYSIA

EFFECTS OF AMENDING UREA WITH HUMIC ACID AND ACID SULPHATE SOIL IN REDUCING AMMONIA LOSS AND NITROGEN UPTAKE BY MAIZE PLANT

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By

MOHD TAUFIK BIN MOHD YUSUFF

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirements for the degree of Master of Science

EFFECTS OF AMENDING UREA WITH HUMIC ACID AND ACID SULPHATE SOIL IN REDUCING AMMONIA LOSS AND NITROGEN UPTAKE BY MAIZE PLANT

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March, 2010

Chairman : Associate professor Osumanu Haruna Ahmed, PhD

Faculty : Faculty of Agriculture and Food Sciences (Bintulu)

The need to reduce ammonia (NH_3) loss from nitrogen based fertilizers such as urea has been recognized. Amending urea with humic acid (HA) and acid sulphate soil could control urea hydrolysis and reduce NH_3 volatilization. This approach may contribute to urea-N use efficiency. The objectives of this study were to: 1) evaluate the effect of mixing urea with HA and acid sulphuric soil on NH_3 loss, and 2) investigate the effect of the selected urea-ASS-HA mixture on N uptake by maize plant. In this study, peat soil was used because it contains about 40% HA, while ASS is abundant in Malaysia. Both acid sulphate soil and HA used were oven dried and ground to pass a 250 µm sieve before being thoroughly mixed with urea based on treatment ratios. The mixtures were mixed thoroughly on a reciprocal mechanical shaker at 200 rpm. All the 14 treatments including 2 controls, mainly soil without fertilizers (T1) and urea without additives (T2) were evaluated in a laboratory study to determine their effect on NH_3 loss, soil exchangeable ammonium (NH_4^+) and soil available nitrate (NO_3^-) using a closed dynamic air

flow system. Out of the 12 mixtures studied, 3 treatments, 2.02 g urea + 0.75 g HA + 0.75 g ASS (T5), 2.02 g urea + 0.75 g HA (T9) and 2.02 g urea + 1.00 g HA (T10) significantly reduced NH_3 volatilization compared with T2 (urea alone). The treatments selected based on their performance in controlling NH_3 loss (T5, T9 and T10) were further investigated in a pot experiment (greenhouse) together with T1 and T2 (controls). Again the mixtures improved soil pH and retention of soil exchangeable ammonium. However, in terms of dry matter production and nutrient uptake (N, P, and K) on *Zea mays* L. (test crop; variety Masmadu) the effect was statistically similar to that of urea alone. Three to five cropping cycles may be required to confirm this finding on Nyalau Series and also reducing the effect of ammonia volatilization with efficient application of urea based fertilizers.

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

KESAN MENAMBAH ASID HUMIK DAN TANAH ASID SULFURIK KEPADA UREA DI DALAM MENGURANGKAN KEHILANGAN AMONIA DAN SERAPAN NITROGEN TERHADAP POKOK JAGUNG

Oleh

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Keperluan untuk mengurangkan kehilangan amonia (NH_3) daripada baja berasaskan nitrogen seperti urea telah diakui. Penambahan urea bersama asid humik (AH) dan tanah asid sulfuric (TAS) boleh mengawal hidrolisis urea dan berupaya mengurangkan pemeruapan amonia. Pendekatan ini boleh menyumbang kepada kecekapan penggunaan urea-N. Objektif kajian ini adalah untuk: 1) menilai kesan campuran urea bersama asid humik dan tanah asid sulfirik terhadap kehilangan NH_3, dan 2) mengkaji kesan campuran urea-TAS-AH terhadap serapan N pada pokok jagung. Dalam kajian ini, tanah gambut digunakan kerana mengandungi AH sekitar 40% manakala TAS terdapat banyak di Malaysia. Kedua-dua TAS dan AH yang digunakan dikeringkan secara ketuhar dan dihancurkan untuk melepasi pengayak bersaiz 250 μm sebelum ianya dicampurkan mengikut nisbah rawatan yang dikaji dalam penyelidikan ini. Campuran tersebut digoncangkan secara rata dengan menggunakan mesin timbal balik pada kelajuan 200 rpm. Kesemua 14 rawatan termasuk 2 kawalan, iaitu tanah

tanpa baja (T1) dan urea tanpa campuran(T2) dinilai di dalam kajian makmal untuk mengkaji kesannya terhadap kesan kehilangan NH_3, amonium (NH_4^+) tukarganti tanah dan nitrat (NO_3^-) tersedia tanah dengan menggunakan sistem tertutup dinamik. Daripada 12 rawatan yang dikaji, 3 rawatan, 2.02 g urea + 0.75 g AH + 0.75 g TAS (T5), 2.02 g urea + 0.75 g AH (T9) dan 2.02 g urea + 1.00 g AH (T10) terbukti dapat menggurangkan pemeruapan NH_3 jika dibandingkan dengan T2 (urea sahaja). Kajian lanjutan dijalankan ke atas rawatan (T5, T9, dan T10) yang dipilih bedasarkan prestasi di dalam mengawal kehilangan NH_3 beserta T1 dan T2 (kawalan). Sekali lagi campuran tersebut berupaya memperbaiki pH tanah dan mengekalkan NH_4^+ tukarganti tanah. Namun dalam penghasilan bahan kering dan penyerapan nutrien (N, P, dan K) pada *Zea mays* L. (tanaman ujikaji; variati Masmadu) kesannya adalah sama jika dibandingkan dengan urea sahaja. Tiga hingga lima kitaran tanaman di tanah Siri Nyalau mungkin diperlukan bagi memastikan hasil kajian ini benar dan dapat membantu mengurangkan kesan pemeruapan ammonia dan pengunaan baja berasaskan urea yang lebih cekap.

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I certify that a Thesis Examination Committee has met on 23 March2011 to conduct the final examination of Mohd Taufik bin Mohd Yusuff on his thesis entitled “Effects of Amending Urea with Humic Acid and Acid Sulphate Soil in Reducing Ammonia Loss and Nitrogen Uptake by Maize Plant” 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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DECLARATION

I declare that this 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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MOHD TAUFIK BIN MOHD YUSUFF

Date: 23 March 2011

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LIST OF ABBREVIATIONS

FAO	Food and Agriculture Organization
FIAM	Fertilizer Industry Association of Malaysia
IFA	International Fertilizers Association
MARDI	Malaysian Agriculture Research and Development Institute
MOA	Ministry of Agriculture
TSP	Triplesuperphosphate
MOP	Muriate of potash
HAs	Humic acids
HA	Humic acid
C/N	Carbon/Nitrogen
ASS	Acid sulphate soil
AAS	Atomic Absorption Spectrophotometry

CHAPTER 1

INTRODUCTION

The improvement in the Malaysian agriculture landscape recently has had a significant impact on Malaysia economy, as this sector has become the third engine of Malaysia's economic growth (MOA, 2008). The development of this sector has brought many opportunities in many agriculture based research and development including fertilizers research in order to increase and sustain crop production as well as reducing fertilizers price (Mohamed Ali, 2009; Lægreid *et al.,* 1999). Nitrogenous fertilizers are one of the essential sources of nitrogen in sustaining the productivity of crops, as they have most rapid-reacting nutrient such as nitrogen with obvious visual effect (Havlin *et al.,* 2005; Lægreid *et al.,* 1999).

Urea is one of the common sources of nitrogen (N) fertilizers used in Malaysia. This fertilizer is imported or produced locally for use (Mohamed Ali, 2009; FAO, 2004). Usage of urea however is still limited despite the possible advantage of having high N content and low unit N cost. The main reason for the restricted use of this fertilizer is due to significant volatilization losses upon its surface application (Jones *et al.*, 2007; Khanif, 1992).

Studies on improving urea fertilizers quality have been carried out in many years in order to increase the efficiency of fertilization as well reducing environmental pollution (Regis *et al.,* 2009; Damodar Reddy and Sharma, 2000). One of the approaches of reducing ammonia volatilization from urea is

by reducing the microsite pH with acidic materials which helps to control urea hydrolysis and dissolution process (Ahmad *et al.,* 2006; Siva *et al.,* 1999). The cost and the availability of the acidic materials however must be considered before these materials can be used as amendment materials.

An approach of using little amount of acid sulphate soil and humic acids from peat in this study was based on their potential acidity (usually less than 3.5) that could reduce soil microsite pH when these materials are used to amend urea before application. Use of acid sulphate soils in amending urea could give an additional value of this soil. Acid sulphate soils is readily available (0.5 million ha) in Malaysia (Shamsuddin, 2006). Iron in acid sulphate soils is an added advantage as the iron might also reduce nitrate (NO_3^-) to ammonium (NH_4^+) form in soil solution (Thomas *et al.,* 2003). This is important because nitrate ions are mobile and susceptible to leaching losses.

Peat soil on the other hand is one of the good sources of HA. There are available in about 2.5 million ha of peat soil in Malaysia (Andriesse, 1988). Recent research in reducing the laboratory work in isolating HA (Susilawati *et al.,* 2007; Ahmed *et al.,* 2004) could give benefit to this country to produce humic acids locally at low cost besides reducing the import bill of HA based fertilizers from China and Australia. The high cation exchange capacity (CEC) of HA (more than 650 cmol/kg soil) could be used to improve NH_4^+ retention and yet ensuring the timely release of NH_4^+.

The approach of using above mention materials could be useful in reducing the cost of amending urea with the aim of reducing NH_3 loss from urea at the same time increasing N use efficiency in agriculture. Thus, the objectives of this study were to: 1) evaluate the affect of mixing urea with HA and acid sulphate soil on NH_3 loss, and 2) investigate the effect of the selected urea-acid sulphate soil-humic acid mixture on N uptake by maize plant.

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BIODATA OF STUDENT

Mohd Taufik Mohd Yusuff was born on August 3, 1984 at Batu Pahat, Johor, Malaysia. He received his primary education from Sekolah Rendah Kebangsaan Peserai, Batu Pahat, Johor before continuing his secondary education at Sekolah Menengah Kebangsaan Dato' Onn in the same state. In 2003, Mohd Taufik joined the Ministry of Higher Education Level Matriculation program at Melaka Matriculation College, Malaysia before pursuing his degree program. In 2007, he was awarded a Bachelor of Bioindustry from Universiti Putra Malaysia. In December 2007, he pursued a Master of Science in Agrotechnology at Universiti Putra Malaysia Bintulu Sarawak Campus, Malaysia. Mohd Taufik has four publications and a gold medal at International Trade Fair "Ideas-Inventions-New Products" (iENA 2009) 2009, November, Nuremberg, Germany.

LIST OF PUBLICATIONS

1. Mohd Taufik Mohd Yusuff, Osumanu Haruna Ahmed, Wan Asrina Wan Yahya, and Nik Muhamad Ab Majid. 2007. Effect of Organic and Inorganic Fertilizers on Nitrogen and Potassium Uptake and Yield of Sweet Corn Grown on Acid Soil. American Journal of Agricultural and Biological Sciences 2(2): 118-122.

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LIST OF AWARD

1. Ahmed Osumanu Haruna, Rosliza Samsudin, Auldry Chaddy Petrus, **Mohd Taufik Mohd Yusuff**, Susilawati Kasim, Nik Muhamad Ab. Majid, Aminuddin Husin, Ahmad Husni Mohd. Hanif, 2009. Efficient Technology for Controlling Ammonia Pollution. Gold Medal, iENA 2009, Germany.