

Short Communication

Effect of hydroquinone and copper coated urea on ammonia volatilization loss and n mineralization from tropical soil: Laboratory study

Nasima Junejo^{1*}, Khanif M. Y.², Khalil Ahmed Dharejo² and Arifin Abdu³

¹Institute of Tropical Forestry and Forest Product, 43400, University Putra Malaysia, Serdang, Selangor, Malaysia.

²Department of Land Management, Faculty of Agriculture, University Putra Malaysia, Serdang, Selangor, Malaysia.

³Department of Forest Production, Faculty of Forestry, University Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia.

Accepted 13 May, 2013

The faster urea hydrolyses process leads to high amount of ammonia gas emission from urea fertilized fields. Coating of urea with various materials is the most successful strategy to control N losses from urea fertilized fields. A laboratory study was conducted to evaluate the effects of uncoated urea, as compare to urea coated with hydroquinone and Cu on NH₃ volatilization loss and rate of urea hydrolysis in soil. The coated urea treatments were prepared by using Cu and hydroquinone solutions with a fluidized bed coating machine. Two experiments were carried out to evaluate the coated urea treatments labelled as UCu (Cu coated urea) and UHY (Hydroquinon urea). Both experiments were carried out on a sandy soil named as Serdang series. The soil was characterized for its properties by standard methods. In the first experiment the coated urea was evaluated for ammonia volatilization loss by using closed chamber force draft technique. Simultaneously, an incubation experiment was conducted to evaluate the effect of hydroquinone and Cu coated urea treatments for their hydrolyses rate or mineralization process. It was estimated by the results that ammonia volatilization from Hydroquinon coated urea treated soil reduced 25% however, Cu coated urea showed 30% reduction in ammonia volatilization loss as compare to uncoated urea. In incubation experiment recovery of urea from soil was 50% more in coated urea as compare to uncoated urea. It is concluded that coating of urea with urease inhibitors can reduce successfully the ammonia volatilization loss and increased the recovery of urea either coated by Cu or hydroquinone.

Key words: Urease inhibitor, urea, hydroquinone, Cu (Copper).

INTRODUCTION

The rapid growth in population and food demand increase the use of fertilizer materials. Despite improvements in the practices of nutrient application, the fertilizer use efficiency especially for macronutrients is not satisfactory. Urea is one of the most popular sources of Nitrogen. Use of urea, often been singled out for its adverse effects on the environment as well as on human

being (Keeney, 1997; Ahmed et al., 2006). Ammonia emission from fertilized fields may results in deposition on neighbouring ecosystem, consequently causing damage to vegetation (Watson, 2009). Some of the ammonia may be oxidized and converted into nitric acid, which forms acidic rain. To avoid environmental damage and improve urea efficiency, the research to find out an environmental

*Corresponding author. E-mail: neelum85@hotmail.com.

Table 1. Selected physical and chemical properties of the soil samples used.

Soil	Sandy loam
pH in water	5.0
Clay %	17
Sand %	50
Silt %	33
Total C %	2.0
Total N %	0.1
Cu content	0.05
Exchangeable cations	
K (cmol _c kg ⁻¹)	0.2
Mg (cmol _c kg ⁻¹)	4.0
Ca (cmol _c kg ⁻¹)	0.9

friendly coating is going on the entire world. The phytotoxicity and high cost of proposed materials may reduce their practical applications (Sahrawat et al., 1987; Ahmed et al., 2008).

Cu and hydroquinone are introduced as competent urease inhibitor by Bremner and Douglas (1971). However, hydroquinone was reported a controversial inhibitors. It improves urea efficiency but increase methane emissions (Malla et al., 2005). It was assumed that the coating of urea with Cu can work as hydroquinone coated urea. Cu is already proved previously as urease inhibitor and on the other hand it is an essential nutrient for the plant growth. The concept of incorporating nutrient by one source of fertilizer may be useful in improving the delivery of more than one nutrient through coating one nutrient with another. To evaluate and compare the effectiveness of Cu and hydroquinone coated urea a laboratory experiment was conducted. This finding was promising because, if effective, gel coated fertilizers could be easily made, environmentally safe and relatively inexpensive as compare to other coated urea.

MATERIALS AND METHODS

Preparation of coated urea

Hundred grams of granule urea was coated by hydroquinone and Cu solutions of (1 gm hydroquinone and CuSO₄ mixed in 10 ml water separately) were coated by fluidized bed coating machine Glatt GC70 then kept for 48 h in a desiccator. Three treatments were used in the experiment labelled as; urea, hydroquinone coated urea (HyU) and Cu coated urea (UCu). The amount of Cu and hydroquinone was estimated on the bases of various trials had been done in laboratory as preliminary experiments and on the bases of the molecular weight of the chemicals.

Soil sampling and analysis

A sandy loam acidic soil (Typic Paleudult) was taken from experimental farm of University Putra Malaysia. The soil was

air-dried, ground, and sieved to pass through 2-mm sieve. The soil was kept in labelled self-adhesive plastic bags for the laboratory analysis. The following soil Physico-chemical characteristics were performed: (i) Soil pH was analysed using a soil/water (1: 2.5) using a glass electrode, (ii) Organic carbon was determined by the Walkley black method (Walkley and Black 1934), (iii) Exchangeable cations Potassium (K), Calcium (Ca) and Magnesium (Mg) using 1 N NH₄OAc (Thomas, 1982) (iv) Mineral N (NH₄-N and NO₃-N) by steam distillation method (Bremner, 1965) (v) Total N by the salicylic acid digestion- Kjeldahl procedure (Mulvaney and Bremner 1982), (vi) Mechanical analysis of the soil was done using pipette method and the texture class determined by the USDA soil textural triangle and urease activity in soil was determined by Bremner and Douglas Method (1971) (Table 1).

Ammonia volatilization losses

The experimental setup was based on force draft technique (Fenn and Kissel, 1973). The closed dynamic (aerobic) air flow system contained an air exchange chamber (ground glass Erlenmeyer 500 ml) and trapping flask (ground glass Erlenmeyer 250 ml), both stopper were fitted with an inlet outlet facility. The inlet of the chamber was connected to a heavy duty air pump, while the outlet was connected by polyethylene tubing to the trapping flask fitted with a glass distribution rod which was immersed in trapping solution of 2% boric acid. The chamber was filled with 300 gm of fresh soil. The soil was wetted to 25% moisture holding capacity and 400 ug/g of N was added in each treatment the trapping flask contain 2% boric acid solution to capture NH₃. The extract was titrated by 0.1 N hydrochloric acid solutions on daily basis till 6 weeks to record ammonia volatilization loss percent of three treatments followed by three replications (Table 2).

Incubation experiment

This study was an incubation experiment. It was carried out to study the effect of coated Urea on mineralization of Urea N in Serdang's sandy loam soil. 20 cm³ sized plastic vial filled with twenty grams of soil, to make four sets of soil samples. Each set of soil samples contain 21 samples, was treated with 180 mg of fertilizer. The samples received seven different treatments, with three replications. Moisture content was maintained at 25% for each treatment. These treatments were replicated three times. The treated samples were incubated for four weeks. Every week the

Table 2. Treatments with urease inhibitors.

Treatments	Labels
Urea	U
Hydroquinon + urea	UHY
Cu + Urea	UCu

Table 3. Cumulative mean results of ammonia volatilization loss in Serdang series for 4 weeks.

Treatments	Ammonia volatilization loss %
U	25.61a
UHY	18.35b
UCu	13.90c

Different alphabets indicate significant difference between means using Tukey's test at P=0.05.

one set of incubated samples analysed for mineral N by steam distillation method (Douglas and Bremner, 1971) and recovered Urea N by calorimetric method. The statistical design of experiment was CRD and statistical analysis had been done by SAS system version 9.1.

RESULTS AND DISCUSSIONS

The soil was low in total N and Cu as indicated in Table 1 and soil properties was similar as mentioned by Paramananthan (2000). Addition of Cu and Hydroquinone as Urease inhibitor were found effective in reducing the ammonia losses as shown in Table 3. Ammonia volatilization losses became 25 to 30% less after coating (Table 3). The ammonia loss % was lower for Cu coated urea (UCu) than UHY. Rate of mineralization was also become slow as shown in Table 4 due to the effects of inhibition of urease activity. The recovery of urea is significantly higher in the Cu coated urea treatments during four weeks. Cu is more effective than hydroquinone coating in reducing the ammonia volatilization loss by reducing elevation of pH and slowing down the urea mineralization process. Coating of Urea with CuSO_4 produce acidity at microsite and reduced ammonia loss, by controlling elevation in pH (Shaw et al., 1954; Mobley and Hausinger, 1989). Coating with natural polymer and palm stearin lower the diffusion of urea from soil solution to the microsite and immobile the urease for a time being (Purakayastha et al., 1997; Reddy and Sharma, 2000; Shamsuddin et al., 2009).

Conclusion

It was concluded that Cu coated urea reduced 30% volatilization losses as compare to hydroquinone treatments. The results of experiment showed that Cu

and hydroquinone are effective equally as Urease inhibitors but the Cu is more preferable to reduce urea loss from soil because it is an essential micronutrient which is very important in physiological process of plant.

ACKNOWLEDGEMENT

The author is thankful to University Putra Malaysia for providing research facilities in the Department of Land Management.

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