MICRONUTRIENT COULD WORK AS UREASE INHIBITOR

By Nasima Junejo, PhD

Nitrogen is an essential nutrient to meet our ever growing need for food, feed and fibre. Nitrogen can be used only its reactive forms which include inorganic forms such as NH^3, NH^4, NO^2, HNO^3,N^2O, NO^3 etc., and organic forms such as urea which are important element of N cycle. The natural formation of reactive forms of N is too low. So, fertilizer application is crucial to meet the needs of agriculture, as it plays a major role in improving growth and yields. It has been observed that 30% surface applied N was lost, especially when it applied as Urea or ammonium form of fertilizer. Urea is most commonly source of N fertilizer when urea is applied to soil it is rapidly hydrolyzed to $NH^{4-}N$ and subsequently transform to NO^{3-} N. The $NH^{4-}N$ is subjected to gaseous loss through NH^3 volatilization, while NO^3 is subjected to denitrification and leaching losses. The N loss from applied urea can be as high as 50%. This constitutes an important economic loss. The NO^3 that undergoes denitrification is reduced to N^2 and N^2O and escape to the atmosphere. Nitrous oxide is a potent greenhouse gas that has the global warming potential of 310. In a recent study (Singh et al., 2008) it was also reported that N^2O can deplete the O^3 layer allowing more ultra violet light to enter the earth resulting in increased global temperature. The NO^3 leaching can reduce plant N uptake and can cause NO^3 pollution of the ground water. Due to both economic and environmental concerns the interest on improvement of urea efficiency has received worldwide attention.

Hydrolysis of Urea in Soil

$$CO(NH_2)_2 + 2H_2O \rightarrow (NH_4)_2CO_3$$

$$(NH_4)_2CO_3 \rightarrow 2NH_4^+ + CO_3^{2-}$$

$$CO_3^{2-} + H_2O \rightarrow HCO_3^- + OH^- \rightarrow CO2 + H2O + OH$$

$$NH_4^+ + OH \rightarrow H_2O + NH_3\uparrow$$

Use of Urease inhibitors is one of the most successful strategies to reduce N losses from surface applied urea. UIs (Urease Inhibitors) slow the conversion of urea to NH_4^+ by inhibiting the urease enzyme, which reduces the NH_4^+ concentration in the soil solution and, hence, lowers the potential for NH^3 volatilization and seedling damage; slow urea hydrolysis allows more time for it to release nitrogen from the fertilizer micro site. Many research studies have confirmed that inhibitors are effective in delaying the conversion of either urea to NH_4^+ (UIs) or NH_4^+ to NO_3^- (NIs). Most research has shown that the application of UIs to soil with urea reduces NH^3 volatilization and N^2O emissions. A number of compounds have been tested for their inhibitory effects to improve the efficiency of urea,however,most of them has limited use due to their high cost and lack of availability (Ahmed et al.,2008). In addition, some of the urease inhibitors are phyto-toxic and are banned in most parts of the world (Watson, 2009).

There are several strategies that have been adopted to reduce ammonia volatilization loss, such as;

1. Modification in placement, rate and method of fertilizer application.
2. Amendment and coating of urea with soluble salts of Calcium, Potassium, and magnesium.
3. Controlled/Slow release fertilizers (CRF/SRF).
4. Use of Inhibitors.
5. Use of plant-growth promoting microorganisms in reducing nitrogen losses

The use of micronutrients, such as Cu and Zn were foundas nontoxic, easily available and nutritious type of urease inhibitor which is effective to reduce ammonia loss of surface applied urea from agricultural fields (Junejo et al., 2009).Before describing the inhibitory effects of micronutrient such as Cu and Zn; it is important to understand their role in plant production and status in soil. Copper is an essential element for all crops, and it influences both carbohydrate and nitrogen metabolism in plants (Mengle and Kirby, 1987). Cu is present in soils as oxides, carbonates, silicates and sulphides. Copper availability decreases in soil solutions due to adsorption of Cu in soil exchange complexes as well as due to chemical fixation of Cu as sulphides (Lea et al., 1993). Zinc is also an essential nutrient that plays an important role in plant growth, and Zn is an important part of protein that works as a synthesizer of sugars and starch (Sharma, 2006). Zinc is the most common crop micronutrient deficiency, particularly in high-pH soils. Notably, 50% of cultivated soils in the world are classed as Zn-deficient (Alloway, 2004).

As urease inhibitor, Cu and Zinc inhibit the activity of urease enzyme which is responsible for urea hydrolysis by replacing the molecules from urease enzyme bodies made of Ni and the complex formation at the active site caused inhibition in enzymes activity.The application of Cu coated urea *(Figure 1 & 2)* reduced hydrolysis process and microsite pH 20 to 30 percent *(Figure 2)* from soils; resulting in reduction of ammonia loss *(Table 1)* and nitrogen mineralization (Junejo et al., 2012).

Treatments	NH_4 volatilization loss (%)			Means
	Serdang	Munchong	Holyrood	
Urea	38 a	44 a	58 a	**47A**
Cu coated urea	28 b	38 b	39 c	**35B**
Cu & Zn coated urea	28 b	31 c	46 b	**35B**
Means	**26.5C**	**36.3B**	**44A**	

The values with same capital letter within means of treatments columns and rows (soils) and the values with same small letter within columns are not significantly different at P>0.05 (Junejo et al., 2011).

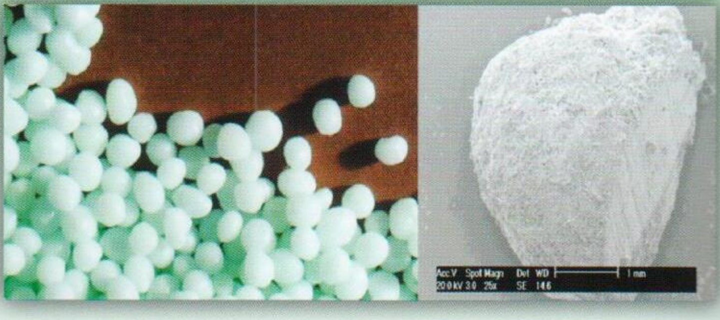

Figure 1 : Micronutrient coated urea ((Junejo et al., 2009)

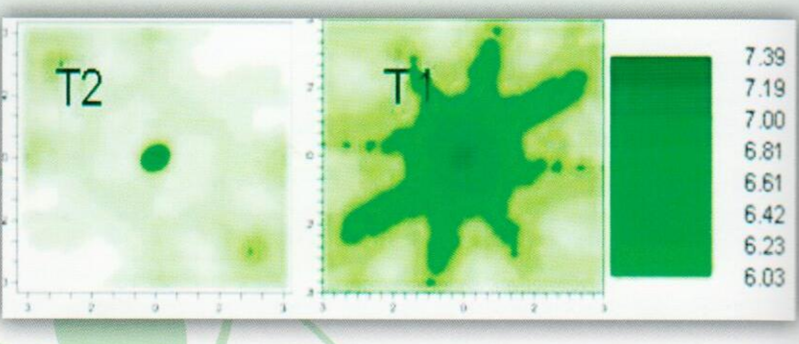

Figure 2 : Effects of uncoated urea (T1) and urea coated with Cu (T2) on urea hydrolysis and microsite pH from Serdang soil series (Junejo et al., 2011).

The field evaluation of micronutrient coated urea indicated a 30% increase in various crops yieldsand N uptake improved by 28.3 and 23.9% because reduced nitrogen losses and micronutrient supply (Junejo et al., 2011). The concept of releasing more than one nutrient through one source is useful for improving the efficiency of chemical, when such alternatives are applied. Modification of urea with micronutrients is economically and environmentally useful in large agricultural fields.

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