THE EFFECT OF UREASE INHIBITOR NBPT ON AMMONIA VOLATILIZATION LOSS FROM UREA FERTILIZER: A META-ANALYSIS

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INTRODUCTION AND OBJECTIVE

The urease inhibitor AGROTAIN® nitrogen stabilizer (market by Koch Agronomic Services, Wichita, KS, USA) slows urea hydrolysis and reduces loss potential of ammonia (NH_3) volatilization. AGROTAIN has N-(n-butyl) thiophosphoric triamide (NBPT) as active ingredient that needs to be converted to its analog N-(n-butyl) phosphoric triamide (BNPO) to inhibit the urease enzyme. Loss potential depends on soil and environmental conditions such as soil pH, soil moisture, temperature, and amount and time of rainfall after fertilizer application. Thus, the inhibitor effect on ammonia volatilization loss is variable.

Urea hydrolysis reaction:

$$CO(NH_2)_2 + 2\,H_2O \xrightarrow{urease} (NH_4)_2\,CO_3$$

$$(NH_4)_2\,CO_3 + H_2O \longrightarrow 2\,NH_4^+ + OH^- + HCO_3^-$$

$$NH_4^+ + OH^- \rightleftharpoons NH_3 + H_3O$$

This study integrated available results of 34 laboratory and field studies to compare ammonia volatilization loss from urea and urea treated with NBPT.

MATERIALS AND METHODS

Studies: 34 laboratory and field

Survey of Literature: Cab Abstract, Science Direct, Scopus, Web of Science and Google Scholar

Observations: 112 published 1990-2013

Climate Zones: Temperate, Cold, Tropical and Arid

Treatments: Urea and Urea + NBPT

Soil and Managment Factors

Soil pH (<5.5; 5.5-6.5; >6.5-7.5 and >7,5)

Soil Textures (Coarse: <18; Medium: 18-35 and Fine: >35 % clay)

Soil Carbon (>1; 1-2 and >2 %)

NBPT Rates (< 530; 530-1060 and >1060 mg kg^{-1} urea)

N Fertilizer Rates (<80; 80-160 and >160 kg ha^{-1} N)

Data Analysis

Cumulative NH_3 losses (Sigmoid function using SigmaPlot)

$Y = Y_{max}/(1 + exp\,(-(t - t_{1/2})/b))$,

Y: cumulative NH_3 loss as a percentage of applied N; Y_{max}: maximum NH_3 loss;

t: days after fertilizer application, $t_{1/2}$: time at which 50 % of the losses occur;

b: parameter of the equation.

% Decrease in NH_3 volatilization (R-Project)

RESULTS

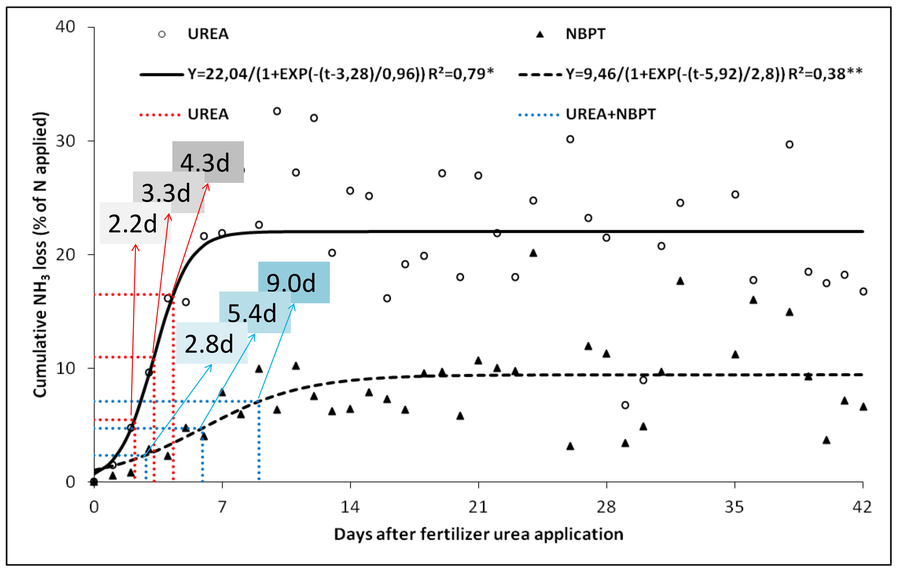
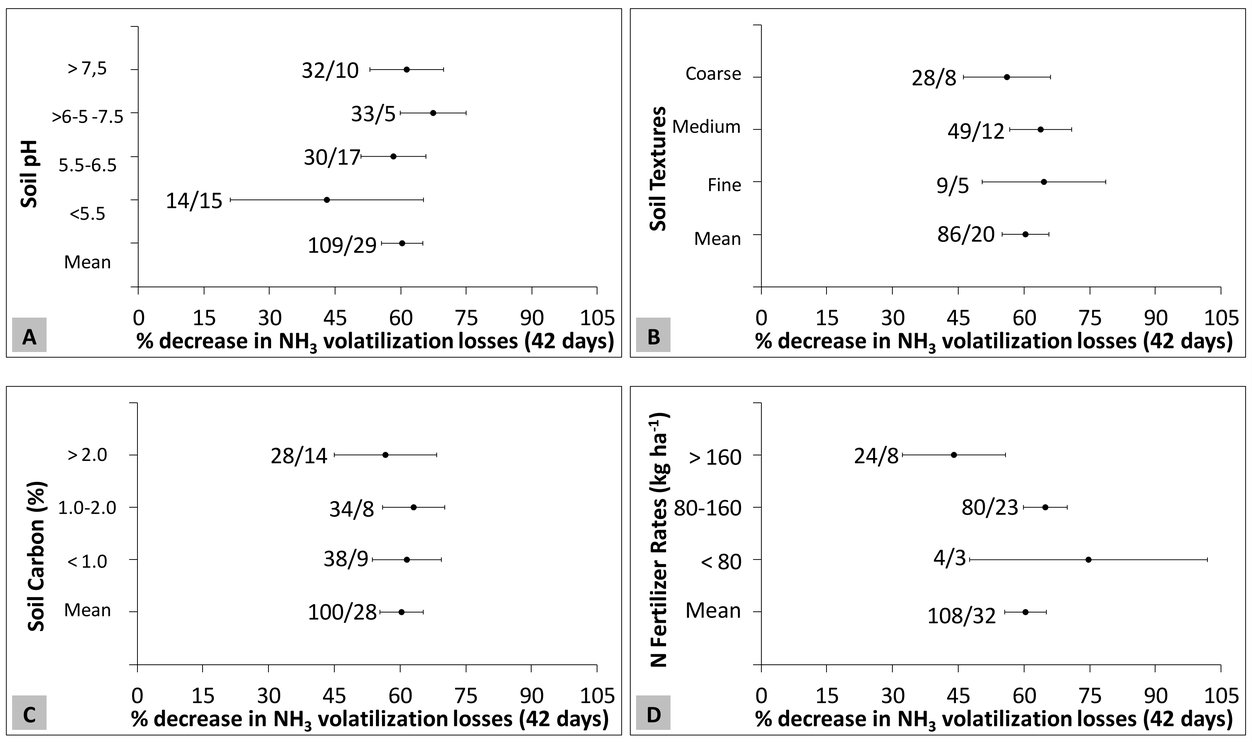


Fig 1 - Cumulative losses of NH_3 for 42 days after aplication of urea (UREA) and urea treated with urease inhibitor NBPT (UREA+NBPT). The points of the curves adjustment correspond to the arithmetic average of daily cumulative volatilization compiled from 34 scientific papers. The dashed red lines (UREA) and blue lines (UREA+NBPT) represent the days for losses of 25, 50 and 75% of applied N.



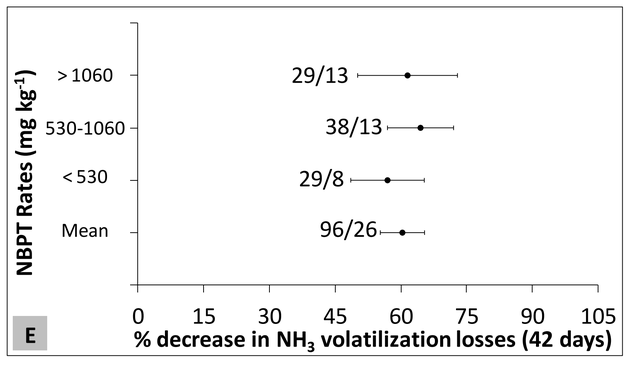


Fig 2 – Groups of soil pH effect (A), soil textures (B), soil carbon (C), N fertilizer rates (D) and NBPT rates (E) on reduction of NH_3 losses using urease inhibitor NBPT 42 days after fertilizaer application. The sample size (number of pairs urea and urea+NBPT) is shown on the left of the confidence intervals (95%) followed by the number of studies reviewed.

CONCLUSIONS

In all studies analyzed, urea+NBPT reduced losses compared to urea.

The results indicated that, when conditions favor losses, treating urea with NBPT is effective in reducing ammonia volatilization loss.

ACKNOWLEDGMENTS

KOCH AGRONOMIC SERVICES, LLC

ORGANIZATION

American Society of Agronomy | Crop Science Society of America | Soil Science Society of America

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