EVALUATION OF NITROGEN GAS LOSS FROM POLYMER COATED AND POLYMER SULFUR COATED UREA

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STUDY OBJECTIVES

- INCREASE N EFFICIENCY
- IMPROVE AGROECONOMICS
- DECREASE ANTHROPOGENIC POLLUTANTS
- DECREASE GREENHOUSE GAS EMISSIONS

INTRODUCTION

Broadcast topdressing fertilizer N application for turfgrass is a common practice. These applications result in loss of N to the atmosphere via nitrous oxide (N_2O) emissions and ammonia (NH_3) volatilization. Control release fertilizers potentially increase N efficiency and decrease atmospheric N loss.

Objectives:
- Quantify nitrous oxide (N_2O) and ammonia (NH_3) emissions for conventional and control release fertilizers
- Evaluate the effectiveness of Polymer Coated (PCU) and Polymer Sulfur Coated (PSCU) Urea in reducing N_2O and NH_3 emissions compared to conventional uncoated urea

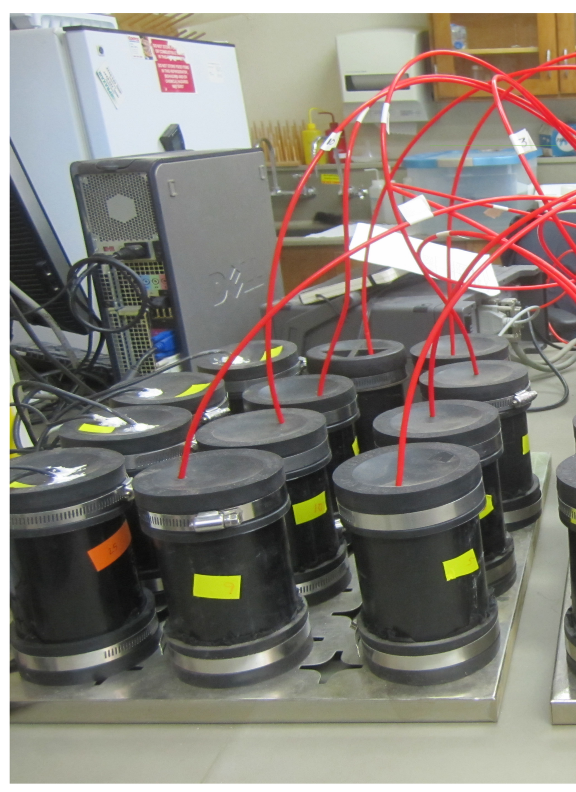

Figure 1: Semi enclosed system allowing capture of N gas emissions for sampling

Figure 2: 4cm diameter PVC cylinder nested within the 7.75cm cylinder with sand filling the medium to allow for air flow during sampling.

METHODS

- Treatments: 1) untreated control, each treatment recieved an application of twenty fertilizer prills 2) 146 g N m^{-2} uncoated urea, 3) 104 g N m^{-2} PCU (Duration 45™) and 4) 111 g N m^{-2} PSCU (PCU and PSCU from Agrium Advanced Technologies, Loveland, CO, USA); replicated four time in Random Design
- Treatments surfaced applied to 65% water filled pore space Timpanogos Loam
- Soil and fertilizer incubated in a semi enclosed system under constant temperature environment. Soil was placed inside a 4 cm diameter x 12.7 cm long PVC cylinder nested inside a 7.75 cm diameter x 15.3 cm PVC cylinder. The area in-between cylinders was filled with dry, medium sized quartz sand. The top of outer cylinder was sealed with a rubber cap. The bottom of the cylinders were left open to the atmosphere so that when the gas sampler evacuated the headspace air for analysis, air could be replaced via flow upward through the sand (refer to figure 2)
- The entire headspace air was collected every 20 minutes using Innova 1309 multiplexer and analyzed for N_2O and NH_3 using an Innova 1412 Photoacoustic, Field Gas analyzer (Lumasense Technologies, Santa Clara, CA, USA)
- Significance between treatment daily means done with ANOVA, with a Tukey-Kramer means separation.

RESULTS AND DISCUSSION

PCU
- NH_3 volatilization equal to control and 4.9 times less than uncoated urea (figure 4)
  - -Urea > PCU 43 out of 48 days (figure 3)
- N_2O emissions 1.9 times greater than control but 1.2 times less than urea (figure 4)
  - -Urea > PCU 15 days
  - -PCU > Control 32 days (figure 5)

PSCU
- NH_3 volatilization 1.6 times greater than control but 3 times less than urea (figure 4)
  - -PSCU > control 15 days (figure 3)
- N_2O 2.3 times greater than both control and PCU, 1.1 times less than urea (figure 4)
  - -Urea > PSCU 3 days (figure 5)

Soil NH_4 and NO_3
- PSCU and PCU both contain 5.9 times less soil NH_4 than uncoated urea (figure 6)
  - -Possible explanation for significant decrease in PCU and PSCU volatilization
- PSCU NO_3 < Urea NO_3 (figure 6)

Tentatively accounted between 75-93% of applied N

NH_3 Daily Average Emissions

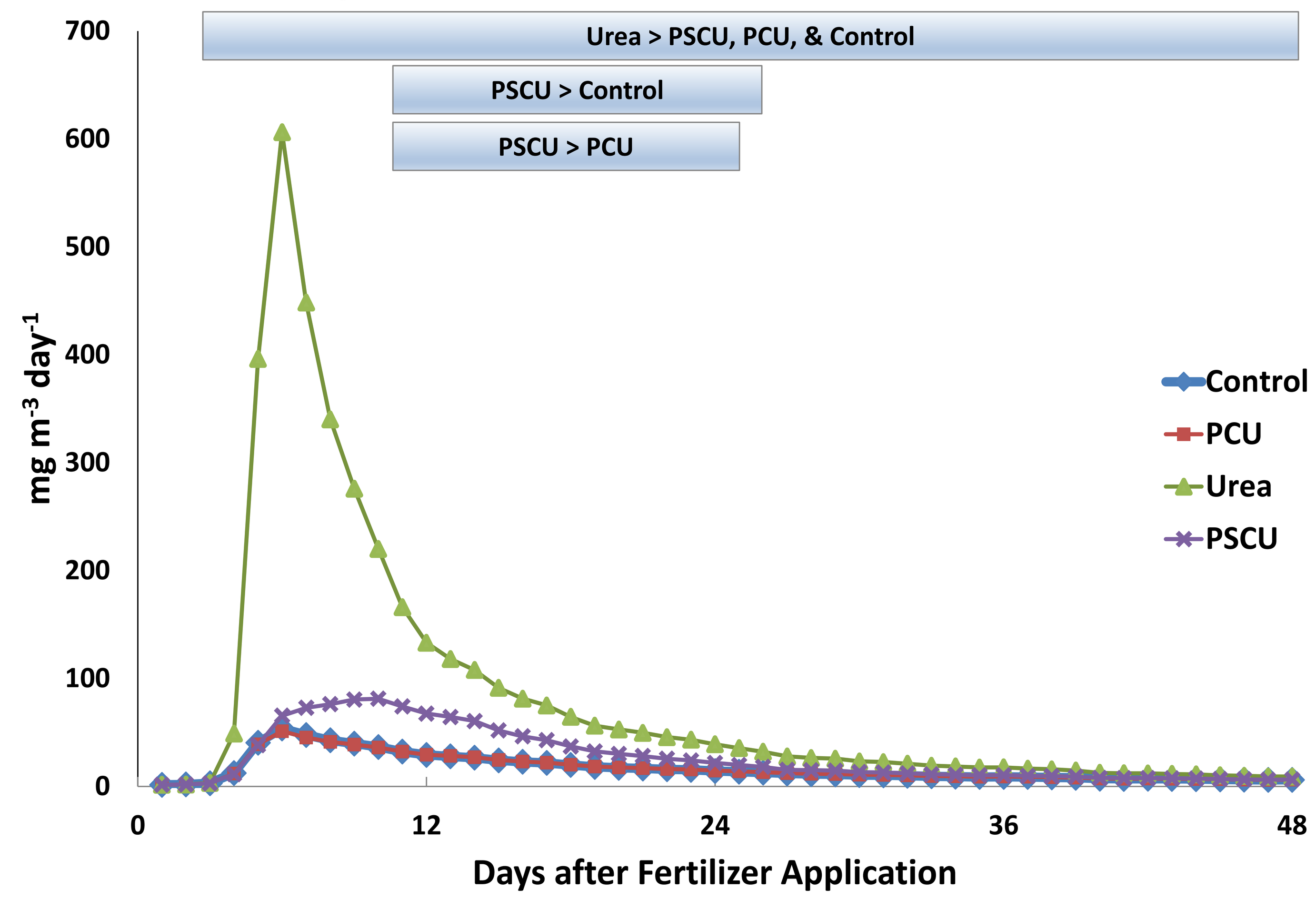

Figure 3: Daily concentrations of NH_3 gas emissions from soils that have been treated with uncoated urea, PCU, and PSCU fertilizers compared to an unfertilized control. Bars at top of graph represent days where the treatments were significantly different from each other.

Cumulative N_2O and NH_3 Emissions

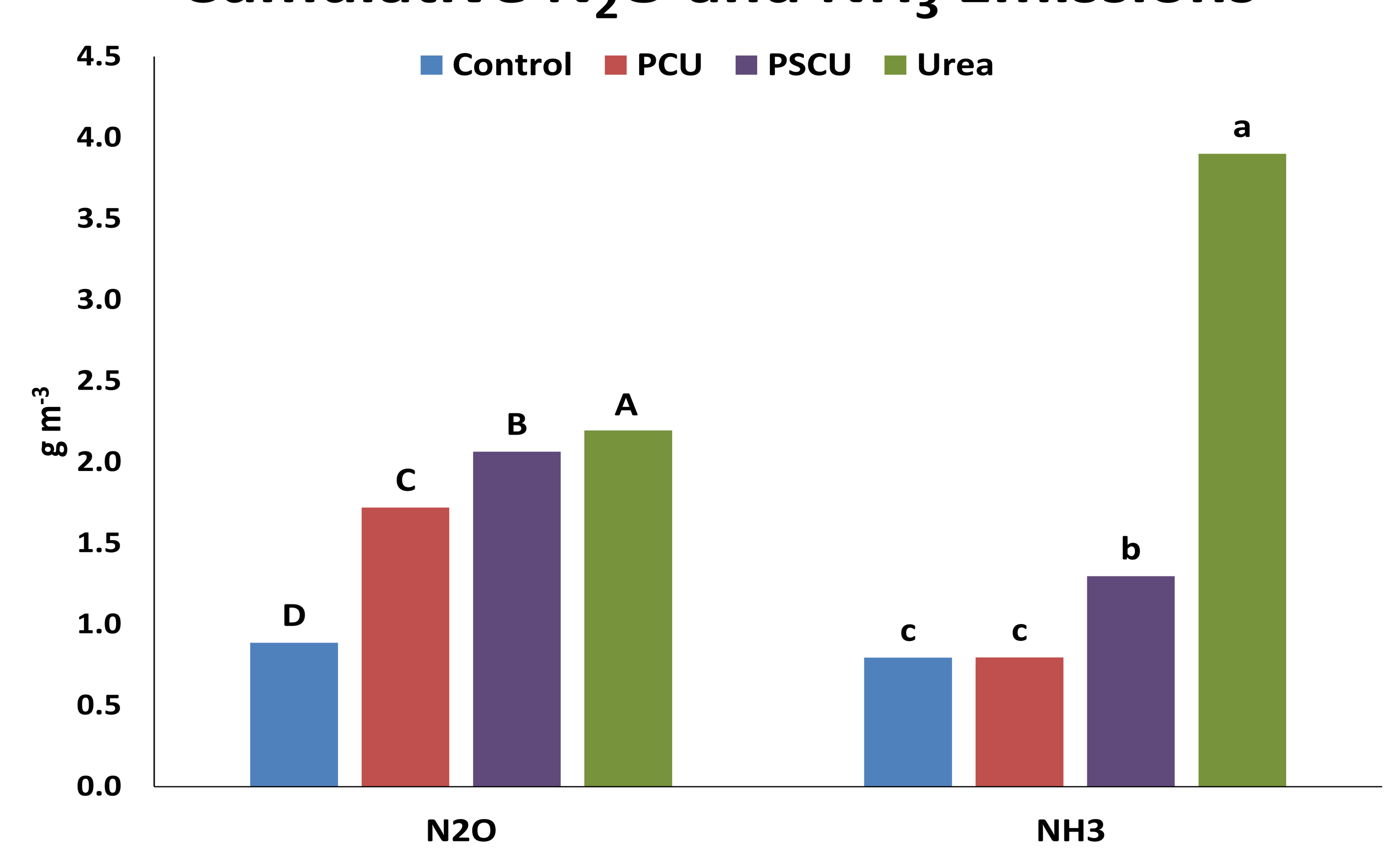

Figure 4: Cumulative concentrations of N_2O and NH_3 gas emissions from soils that have been treated with uncoated urea, PCU, and PSCU fertilizers compared to an unfertilized control. Letters on top of bars represent statistical difference.

N_2O Daily Average Emissions

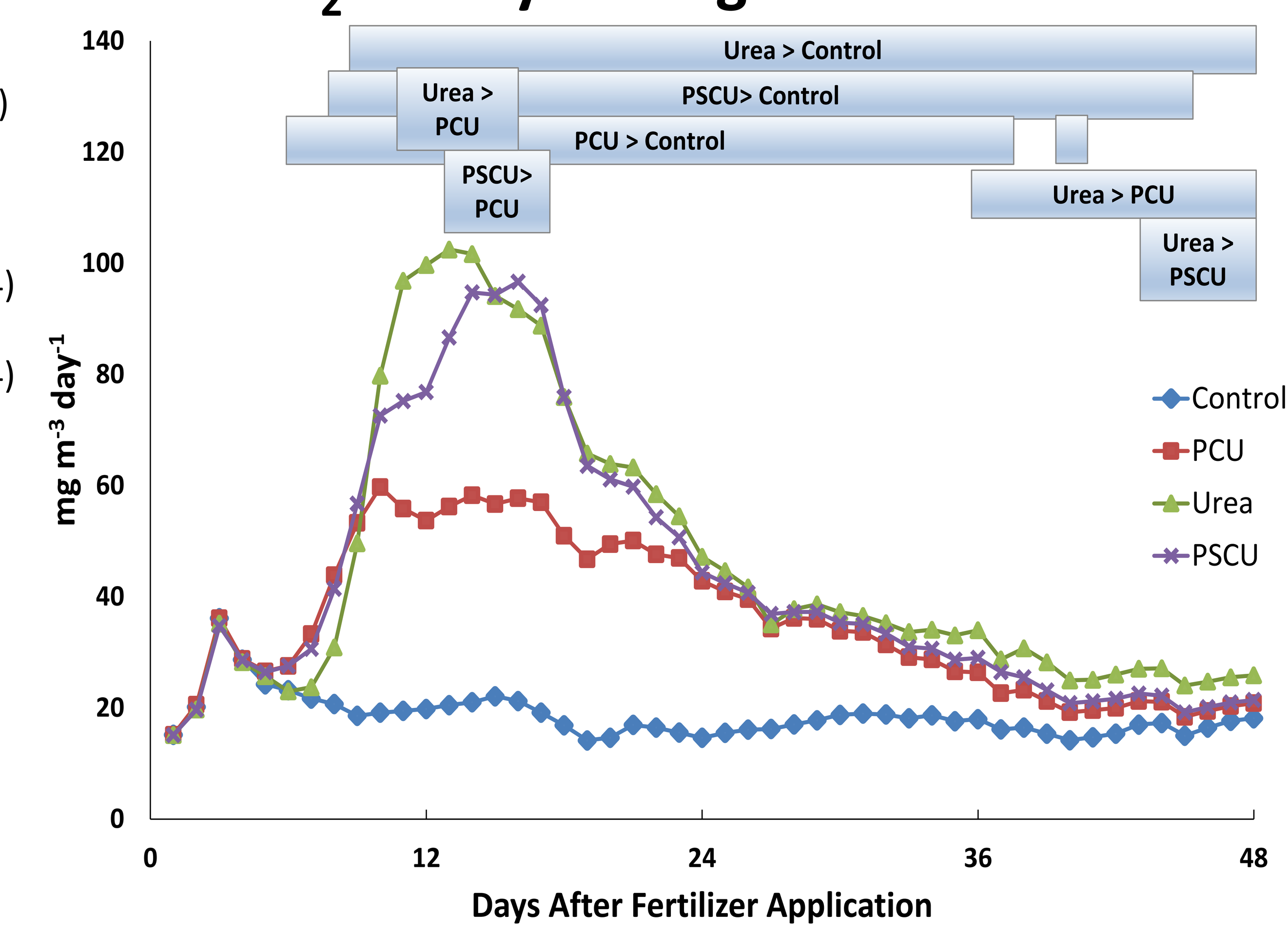

Figure 5: Daily concentrations of N_2O gas emissions from soils that have been treated with uncoated urea, PCU, PSCU fertilizers compared to an unfertilized control. Bars at top of graph represent days where the treatments were significantly different from each other.

Soil NH_4 and NO_3^-

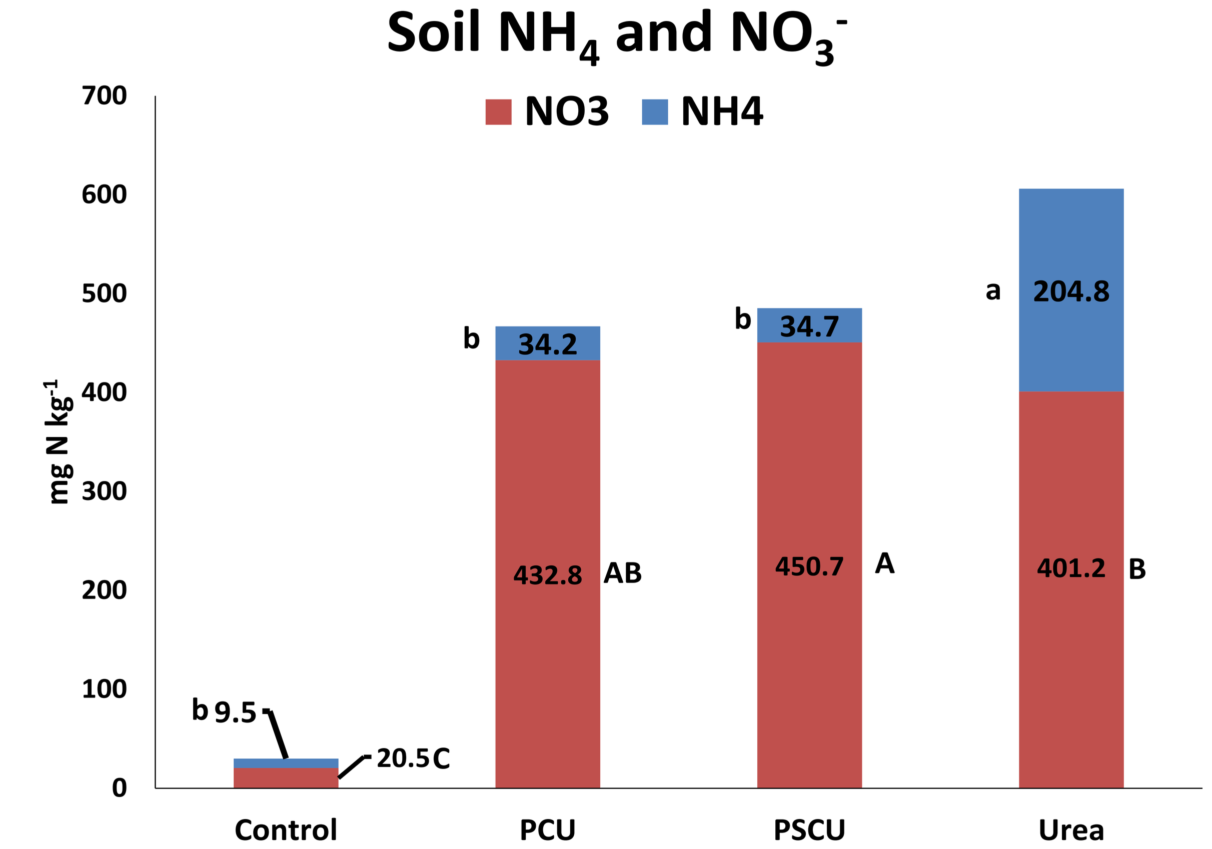

Figure 6: Individual treatment soil NO_3 and NH_4 levels 48 days after fertilizer application of PCU, PSCU, uncoated urea, and control. Letters next to bars represent statistical difference.

CONCLUSIONS

Polymer coated and polymer sulfur coated urea were found to emit significantly less N_2O and NH_3 than uncoated urea. PCU reduced volatilization equal to the control, eliminating loss of fertilizer applied N through this mechanism. PSCU reduced NH_3 volatilization, though not as great as PCU. Quantification of N_2O and NH_3 emissions supports previous research that polymer and sulfur coatings reduce N gas loss. In this study PCU was more effective at reducing N gas loss; this may be due to a shorter shelf life of PSCU, or quicker degradation of the polymer coating due to sulfuric acid build up.

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