Quantifying Ammonia Volatilization from Surface-Applied Fertilizers in Kentucky Bluegrass Grown for Seed, 2011

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Abstract

Kentucky bluegrass seed fields in central Oregon use surface-applied nitrogen fertilizers. Nitrogen loss as volatile ammonia is an economic and environmental concern. The objective of this study was to quantify ammonia volatilization from different nitrogen sources including urea, Agrotain-coated urea at a concentration of 1.5 and 3 lbs/ton and ammonium nitrate applied to the soil surface in the fall in commercial field in central Oregon. Ammonia volatilization losses were measured with a modified passive flux method, which consists of a rotating 10 ft-tall mast placed at the center of each 100 ft-diameter circular plot. At both locations, nitrogen loss due to ammonium volatilization was highest with urea followed by Agrotain-coated urea at 1.5 lbs/ton and Agrotain-coated urea at 3 lbs/ton. Ammonium nitrate provided the least amount of volatilization. Maximum temperatures and the amount of dew/frost appear to be important factors in ammonia volatilization in central Oregon. Any correlation with relative humidity and wind speed is hard to discern.

Introduction

Kentucky bluegrass seeds fields under irrigation in central Oregon and Hermiston, and under dryland conditions in eastern Washington, are fertilize with surface applied nitrogen (N). All three production areas receive their primary N application as top-dress in mid to late fall. These areas have diverse environmental characteristics from high elevation of central Oregon, low elevation of the lower Columbia Basin, and rolling terrain of eastern Washington. Differences in winter temperatures and production practices create different conditions for N loss. Soil characteristics and residue management vary between regions, as well as within regions.

Nitrogen loss due to volatilization was not a major concern when the cost of N fertilizer was low and ammonium nitrate was readily available. The replacement of ammonium nitrate by other fertilizers such as urea, raised concern among industry field representatives regarding increase N losses due to volatilization. Nitrogen losses as ammonia due to volatilization not only increases the operation cost for Kentucky bluegrass farmers but it is also an environmental concern because ammonia affects air quality. These are the reason why quantitative measurement of volatile ammonia loss is necessary – to define conditions where loss is minimal. Quantifying volatile ammonia will allow us to determine what level of efficiency is achieved through fertilization and also determine the economic value of the N losses.

The objective of this two-year study was to quantify N loss due to volatilization from urea, Agrotain-coated urea and ammonium nitrate, fall-applied to the soil surface to commercial

Kentucky bluegrass seed field. This report discusses results for the sites located in central Oregon.

Materials and Methods

Research in central Oregon was conducted on two Kentucky bluegrass (*Poa pratensis* L.) fields, one 50/acre field near Culver and the other a 75/acre field on the Agency Plains north of Madras. The last irrigation of the season had been completed just prior to application of fertilizer treatments at both locations. The Culver location was treated October 12, 2011 with four surface applied N sources: urea, Agrotain-coated urea at a concentration of 1.5 and 3 lb/acre and ammonium nitrate. The same four treatments were applied to the Agency plains location on October 18, 2011. Fertilizers were applied to 100 ft-diameter circle plots at a rate of 150 lb N/acre using a 3 ft Gandy turf spreader. Plots were arranged in a randomized complete block design with four replications. They were separated by a minimum of 300 ft to avoid possible ammonia cross-contamination between treatments.

Nitrogen volatilization losses through ammonia were measured with a modified passive flux method (Wood et al. 2000), which consists of a rotating 10 ft-tall mast placed at the center of each circular plot. Ammonia was sampled at five heights (1.5, 2.5, 4.8, 7.4, and 9.8 ft; Leuning et al. 1985). Each passive flux ammonia sampler consisted of a glass tube (0.28 inches diameter by 7.87 inches long). The end of the tube facing the wind was capped with a small opening to control airflow through the tube. The inside of the tube was coated with oxalic acid to trap ammonia from the air. The mast includes a wind vane that keeps the tubes facing into the wind. Two background masts were placed upwind of the predominant wind direction measure background ammonia naturally occurring in the environment, against which the treated plots can be measured. Sampling tubes were placed on the mast immediately following fertilizer application, and changed daily during the first week, then every-other day thereafter. The project duration was 23 days at Culver and 21 days on the Agency Plains.

Remotely operated weather stations were placed at each site but due to malfunctioning the Agrimet weather station at the Central Oregon Agricultural Research Center was for weather data collection including, air temperature, relative humidity, and wind speed. In addition, when tubes were changed during early morning observations were made concerning the presence of dew or frost.

Sampling tubes were collected, capped at both ends to prevent any further contamination of ammonia, and stored at 5ºC until processing at Hermiston. Processing began by shaking the tubes for 10 min with deionized water, then extracting and analyzing colorimetrically for ammonium (NH_4 +) (Sims et al. 1995). Total ammonia volatilized from applied fertilizers was quantified by subtracting the background ammonia measurements. Vertical flux of ammonia was determined by summing horizontal flux at each measurement height (Wood et al. 2000).

Results and Discussion

Comparison of Nitrogen Sources

Following application of 150 lb N/acre, nitrogen loss due to ammonia volatilization at both locations was highest with urea, followed by Agrotain-coated urea at 1.5 lb/ton, Agrotain-coated urea at 3 lb/ton, and ammonium nitrate providing the least volatilization (Figures 1, 2). Ammonia volatilization at Culver was 38 lb N/acre (25%) for urea compared to 18 lbs N/acre (12%) for Agrotain-coated urea at 1.5 lb/ton, 15 lb N/acre (10%) for Agrotain-coated urea at 3 lb/ton and 3 lb N/acre (2%) for ammonium nitrate. Ammonia volatilization at Agency Plains was 35 lb N/acre (23%) for urea compared to 27 lbs N/acre (18%) for Agrotain-coated urea at 1.5 lb/ton, 18 lb N/acre (12%) for Agrotain-coated urea at 3 lb/ton and 6 lb N/acre (4%) for ammonium nitrate.

Weather Conditions

During the initiation of the project at Culver high temperatures were in the 60's, with lows near 40^{o}F. High temperatures 14 days after treatment (DAT) had declined to near 50^{o}F, followed by an increase to near 70^{o}F 18 DAT (Figure 3). There was a corresponding drop in ammonia volatilization during this period (most notably on urea) that matches the decline in the daily high temperatures. The Agency Plains location was initiated 6 days after Culver. There was a stabilization of the ammonia volatilization losses from urea on the 8 and 13 DAT (Figure 4). Note that the 8 DAT on the Agency Plains is the same day as the 14 DAT at Culver. The high temperature 13 DAT again dropped from near 70^{o}F to 50^{o}F, followed by an increase to the low 60's before declining into the 40's.

Maximum temperatures appear to be an important factor in ammonia volatilization in central Oregon. Informal observations over the two year period of the study would suggest the amount of dew may also play an important role (Table 1). Any correlation with relative humidity and wind speed at the moment is hard to discern (Figures 5, 6).

References

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Sims, G.K., T.R. Ellsworth, and R.L. Mulvaney. 1995. Microscale determinations of inorganic nitrogen in water and soil extracts. Communications in Soil Science and Plant Analysis 26:303-316.

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Table 1. Observations made while changing tubes at Culver and Agency Plains, Oregon locations.

Culver			Agency Plains		
DAT[1]	Date[2]	Notes	DAT[1]	Date[2]	Notes
0	12-Oct	Heavy Dew	0	18-Oct	Light Dew
2	14-Oct	Heavy Dew	2	20-Oct	Heavy Dew
3	15-Oct	light dew	3	21-Oct	Heavy Dew
4	16-Oct	Heavy Dew	4	22-Oct	Light Dew
5	17-Oct	Frost	5	23-Oct	Heavy Dew
6	18-Oct	Frost	6	24-Oct	Light Dew
7	19-Oct	Light Dew	7	25-Oct	Light Dew
9	21-Oct	Heavy Dew	8	26-Oct	Light Dew
12	24-Oct	Light Dew	10	28-Oct	Dry
14	25-Oct	Light Dew	13	31-Oct	Light Dew
16	28-Oct	Light Dew	15	2-Nov	Light Dew
19	31-Oct	Frost	17	4-Nov	Frost
21	2-Nov	Frost	20	7-Nov	Frost

[1] DAT=Day after treatment
[2] Date of tube placement

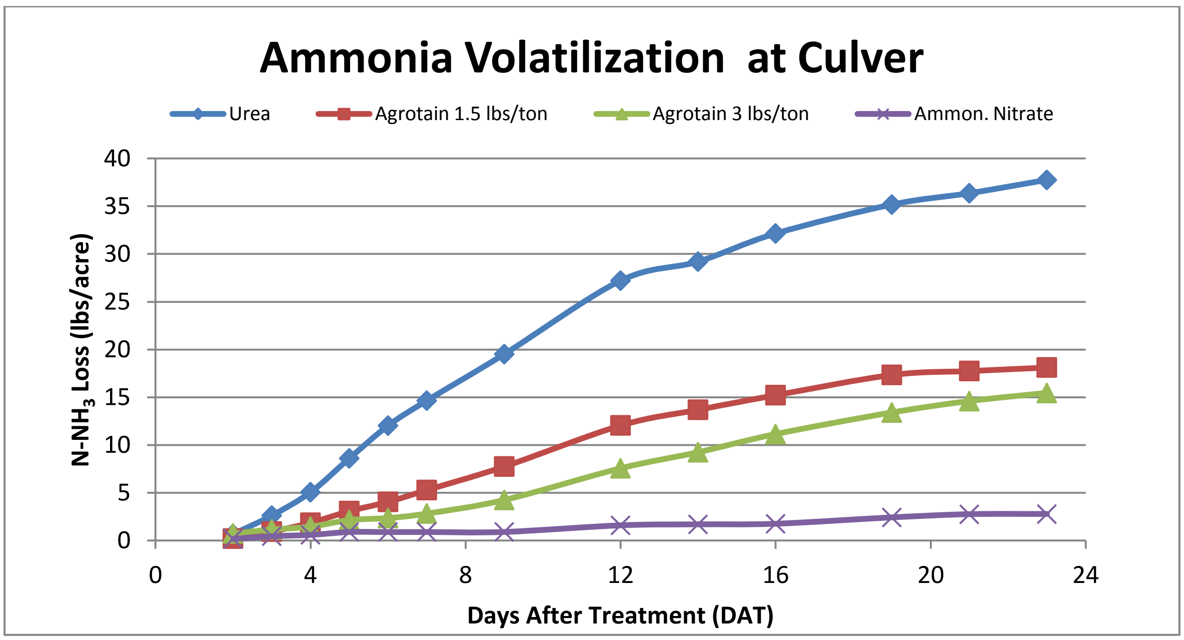

Figure 1. Ammonia volatilization from four nitrogen sources applied October 12, 2011 at Culver, Oregon.

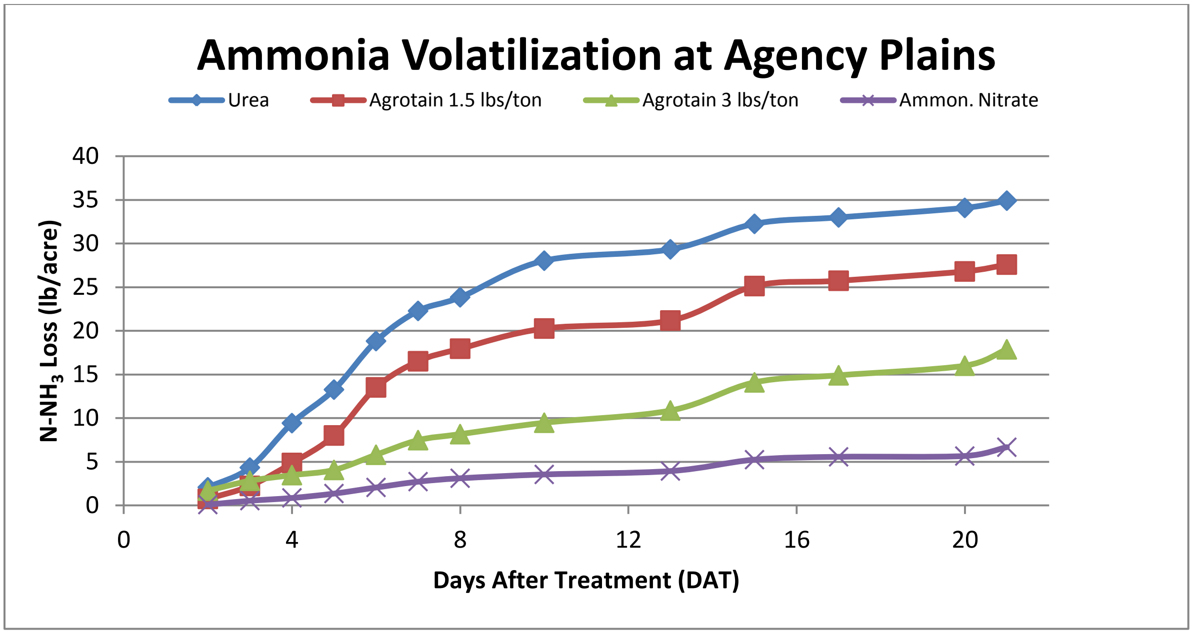

Figure 2. Ammonia volatilization from four nitrogen sources applied October 18, 2011 at Agency Plains, Oregon.

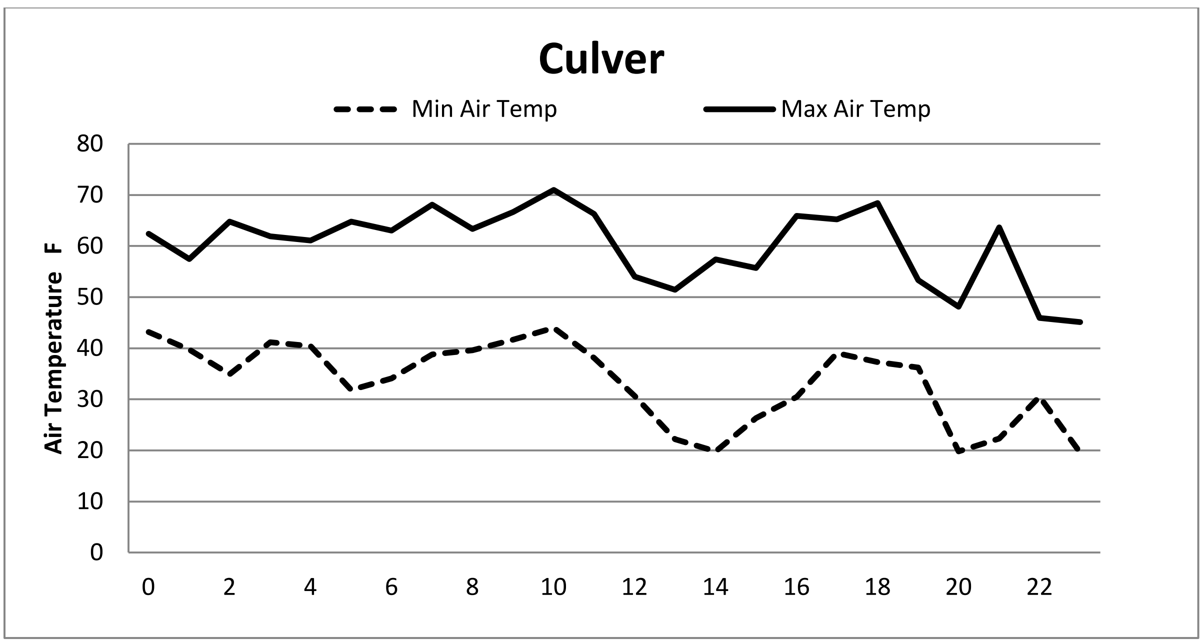

Figure 3. Air temperature maximums and minimums for 23 days of observations at Culver, Oregon.

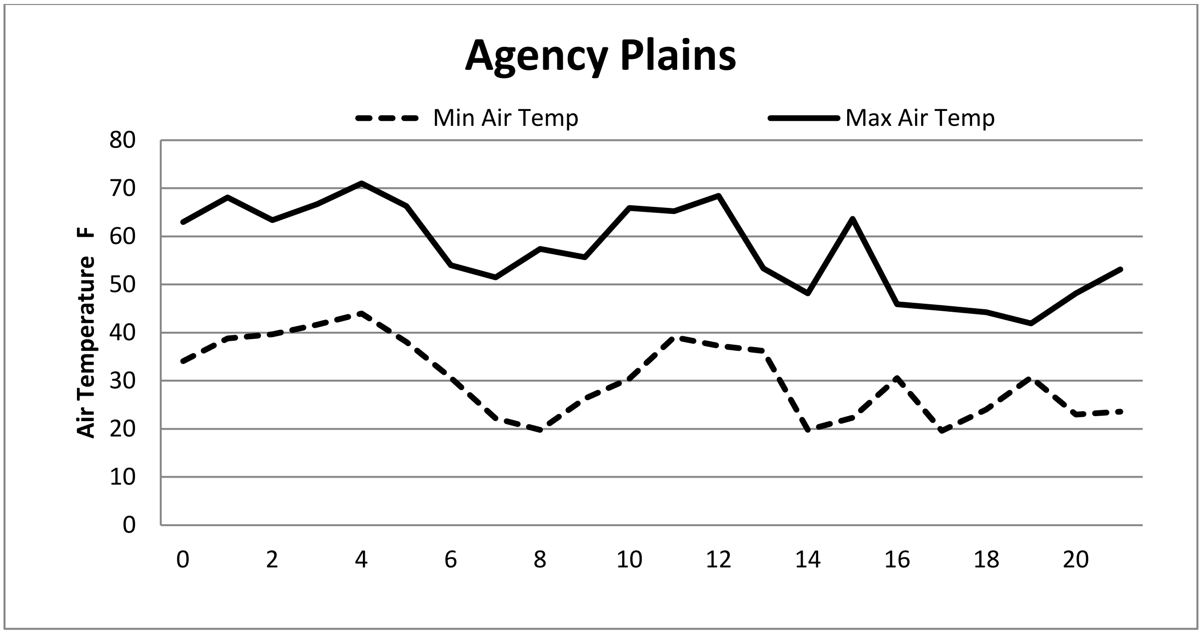

Figure 4. Air temperature maximums and minimums for 21 days of observations at Agency Plains, Oregon.

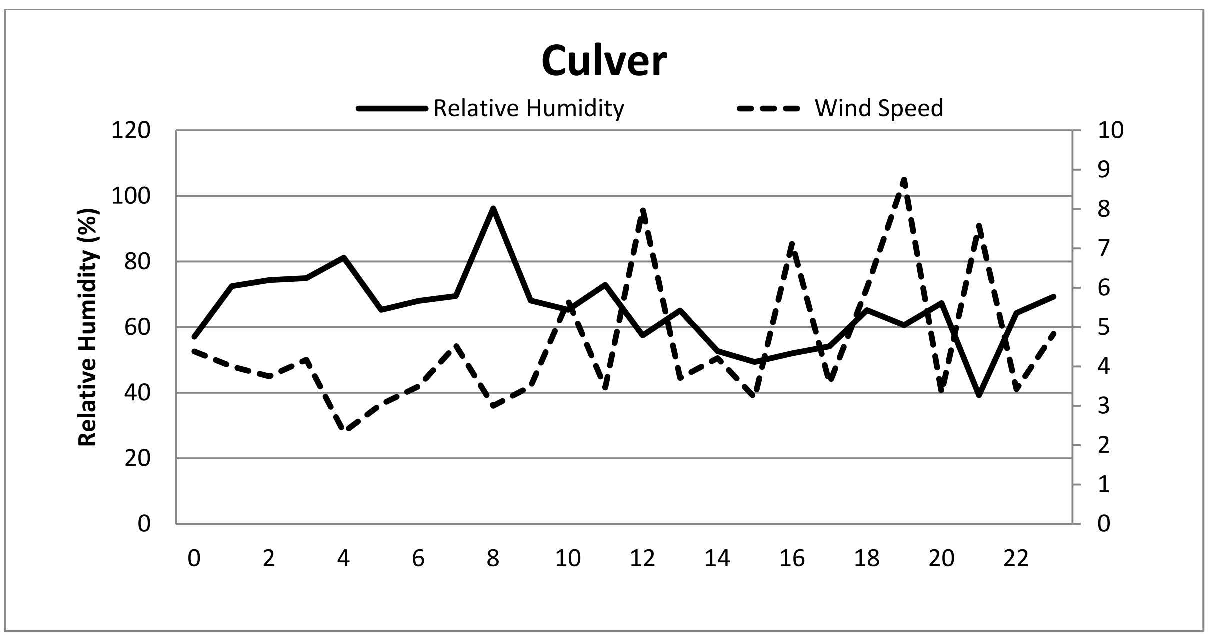

Figure 5. Percent relative humidity and average wind speed for 23 days of observations at Culver, Oregon.

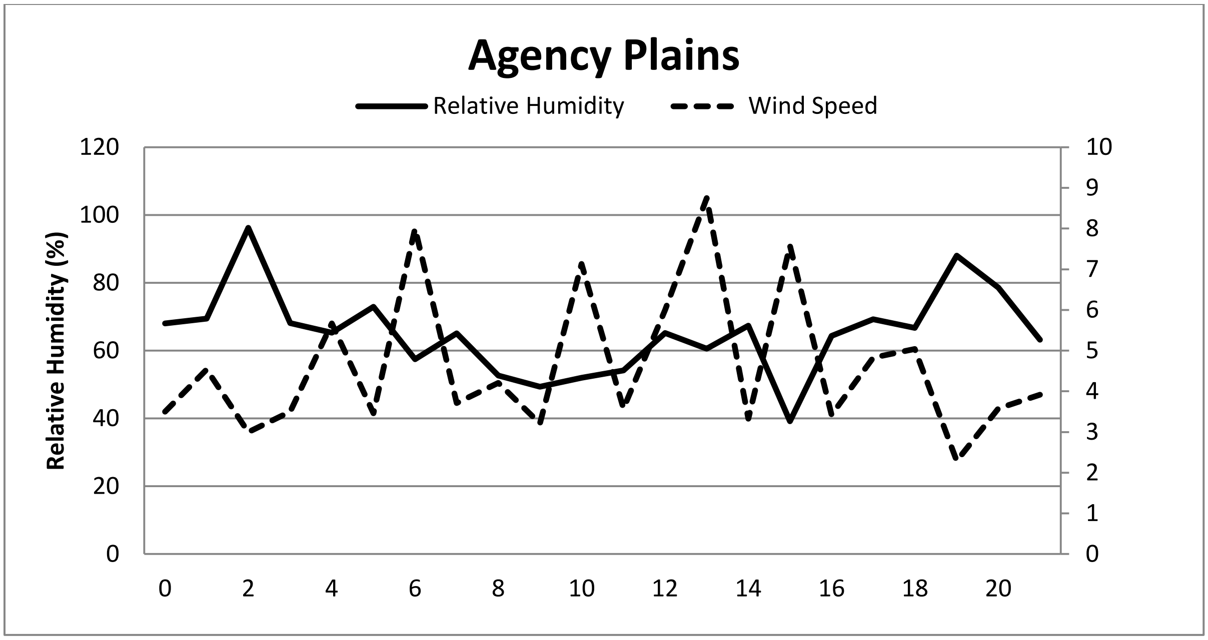

Figure 6. Percent relative humidity and average wind speed for 21 days of observations at Agency Plains, Oregon.