QUANTIFYING AMMONIA VOLATILIZATION FROM SURFACE-APPLIED FERTILIZERS IN CENTRAL OREGON KENTUCKY BLUEGRASS SEED PRODUCTION

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Situation

Kentucky bluegrass seed fields in central Oregon, Hermiston, and in the dryland conditions of eastern Washington all use surface-applied nitrogen (N). The areas have diverse 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 risks for N loss. Soil characteristics and residue management vary between regions, as well as within regions. All three production areas receive their primary N application as topdress in mid- to late fall. When ammonium nitrate was available and N fertilizer cost low, volatile N loss was not a major concern. Recent observations by field representatives raise questions about the amount of N loss from volatilization of ammoniacal fertilizers such as urea.

Volatile N loss costs Kentucky bluegrass growers, wastes resources, and is an environmental concern. Ammonia in the air reacts with nitrous oxides and sulfur dioxide to form an aerosol product that produces smog and is a PM-2.5 particulate (U.S. Environmental Protection Agency designation). Quantitative measurement of volatile ammonia loss is necessary to define conditions where loss is minimal, and to put a cost to the loss and account for the N in fertilizer efficiency.

The objective of this second-year study was to quantify as pounds per acre ammonia volatilization from urea, Agrotain-coated urea and ammonium nitrate, applied to the soil surface in the fall under commercial field conditions to identify potential improvements in fertilizer management in grass seed production systems.

Procedures

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 fertilizer application at both locations. The Culver location was treated October 12, 2011 with four surface-applied N fertilizers, urea, Agrotain-coated urea at 1.5 lb/ton, Agrotain-coated urea at 3 lb/ton, and ammonium nitrate. The same four treatments were applied to the Agency plains location on October 18, 2011.

Fertilizers were applied to a 100-ft- diameter circle 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.

Ammonia volatilization losses 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. Sampling tubes were placed on the mast immediately following fertilizer application, and changed daily during the first week, then every-other day thereafter. The duration of the project was 23 days at the Culver location and 21 days on the Agency Plains.

Sampling tubes were collected, capped at both ends to prevent any further collection 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).

Remotely operated weather stations (Campbell Scientific, Logan, UT) were placed on the edge of each field to collect data related to air temperature, soil temperature, humidity, rainfall, and wind speed and direction during the duration of the project at each location. Unfortunately, these onsite stations did not provide reliable data so the Agrimet weather station at the Central Oregon Agricultural Research Center on the Agency Plains was used for temperature, relative humidity, and wind speed.

Results

Comparison of nitrogen sources:

Following application of 150 lb N/acre, nitrogen loss due to ammonia volatilization across 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 with the least volatilization. Ammonia volatilization across both locations averaged 36 lb N/acre for urea. Informally, it appears the amount of Agrotain applied to the urea is correlated to the amount of ammonia volatilization, with 22 lb N/acre for Agrotain-coated urea at 1.5 lb/ton, 16 lb N/acre for Agrotain-coated urea at 3 lb/ton, and data from the fall of 2010 indicated a loss of 9 lb N/acre for Agrotain-coated urea at 5 lb/ton. Losses with ammonium nitrate were 4 lb N/acre during the fall of 2011 and averaged 6 lb N/acre across the two years of the project.

Over a 23-day period at Culver, ammonia volatilization was 38 lb N/acre (25 percent) for urea compared to 18 lbs N/acre (12 percent) for Agrotain-coated urea at 1.5 lb/ton, 15 lb N/acre (10 percent) for Agrotain-coated urea at 3 lb/ton and 3 lb N/acre (2 percent) for ammonium nitrate. Over a 21-day period at Agency Plains, ammonia volatilization was 35 lb N/acre (23 percent) for urea compared to 27 lbs N/acre (18 percent) for Agrotain-coated urea at 1.5 lb/ton, 18 lb N/acre (12 percent) for Agrotain-coated urea at 3 lb/ton and 6 lb N/acre (4 percent) for ammonium nitrate.

Weather conditions:

During the initiation of the project at the Culver site, day time high temperatures were in the 60s, with night-time lows near 40^{o}F. At 14 days after treatment (DAT) high temperatures had dropped from 70^{o}F to 50^{o}F, followed by a rise to near 70^{o}F at 18 DAT. There is a corresponding drop in ammonia volatilization on 14 DAT (most notably on urea) that matches the drop in the daytime high temperature. The Agency Plains location was initiated six days after Culver. There is the corresponding flattening of the curve in ammonia volatilization for urea on 8 DAT and again on day 13. Temperature again dropped from near 70^{o}F to 50^{o}F at 13 DAT, followed by a rebound to the low 60s before dropping back down into the 40s. Informally, there appears to be a correlation between day time temperatures and level of volatilization at both locations. Any correlation with relative humidity and wind speed is more difficult to discern.

Summary of two-year project:

Heavy dew and higher temperatures appear to increase the amount of ammonia volatilization under central Oregon conditions. Unlike companion projects in the Columbia Basin where the volatilization curve is reported to flatten to near horizontal in two weeks, our curves often continue on an upward trajectory throughout the third week of monitoring this season. Perhaps overnight dew or frost, followed by warm days that create a daily freezing and thawing cycle promotes continued ammonia volatilization. The effect of relative humidity and wind speed on volatilization is less clear.

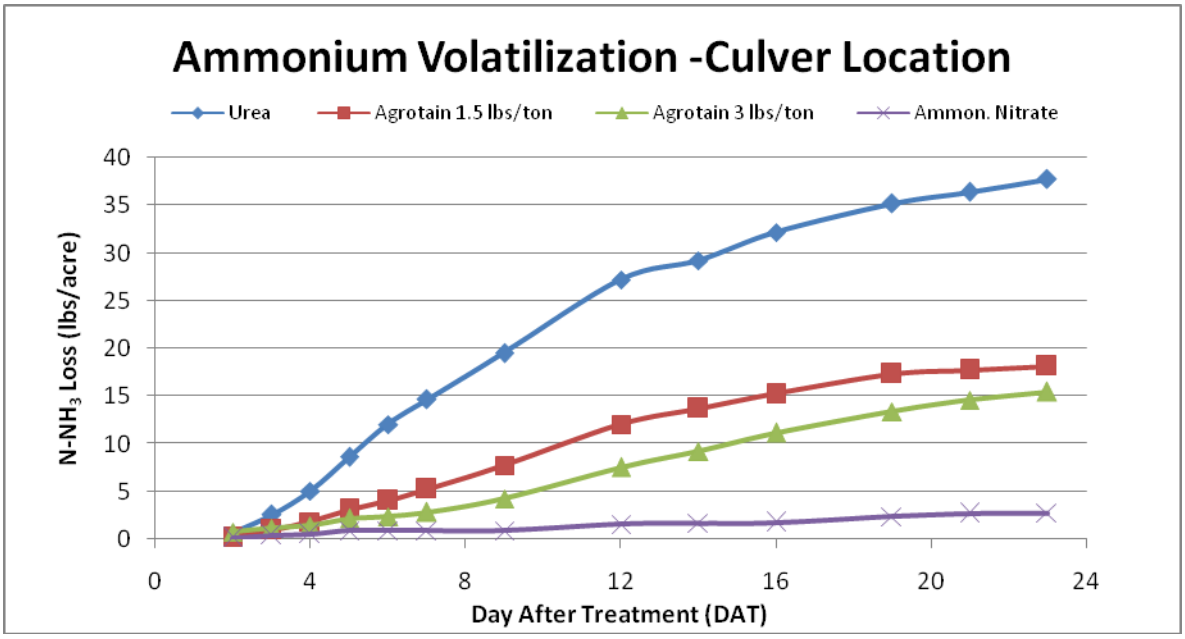

Figure 1. Ammonia volatilization loss from four nitrogen sources at Culver initiated October 12, 2011.

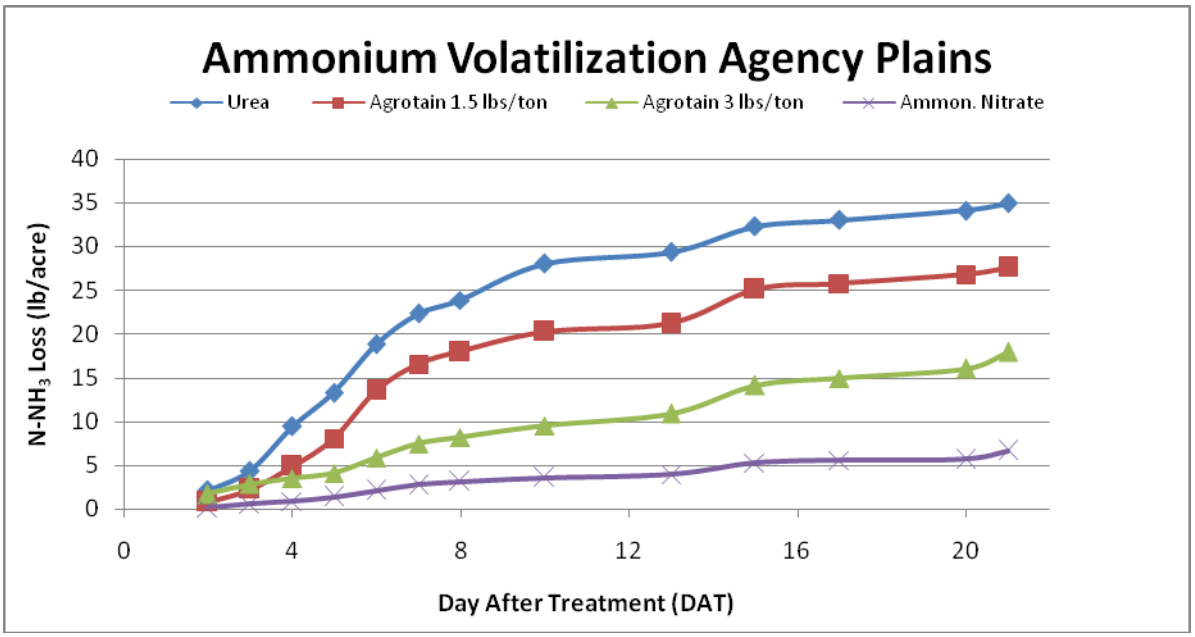

Figure 2. Ammonia volatilization loss from four nitrogen sources on Agency Plains initiated October 18, 2011.

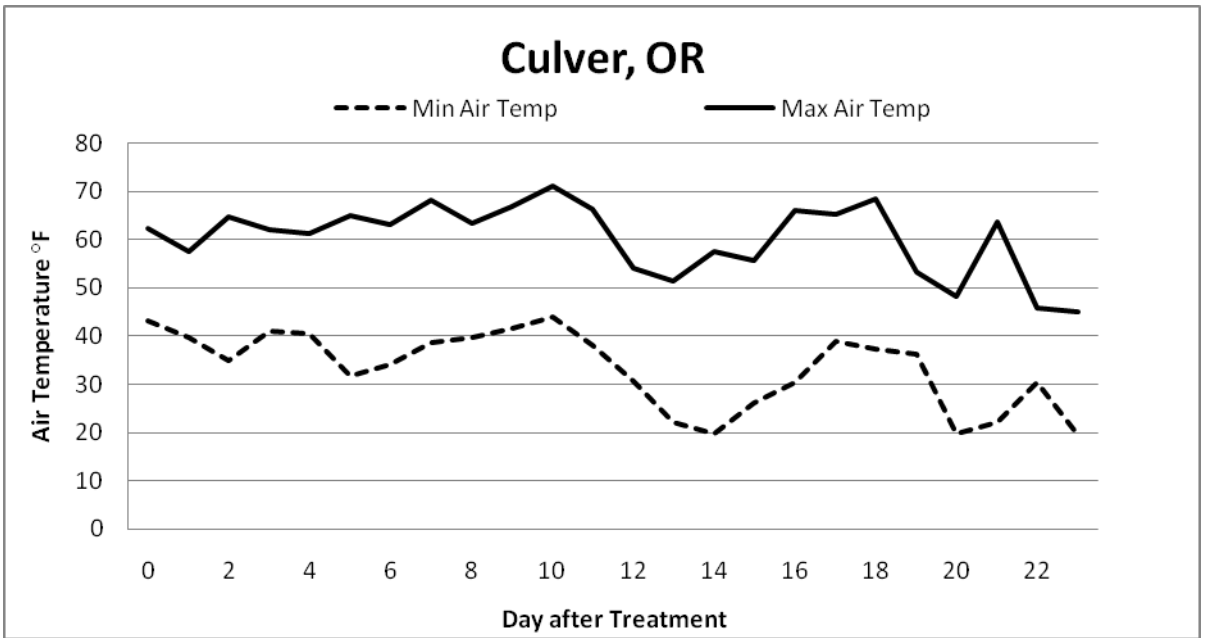

Figure 3. Air temperature maximums and minimums for 23 days of observations at Culver, OR.

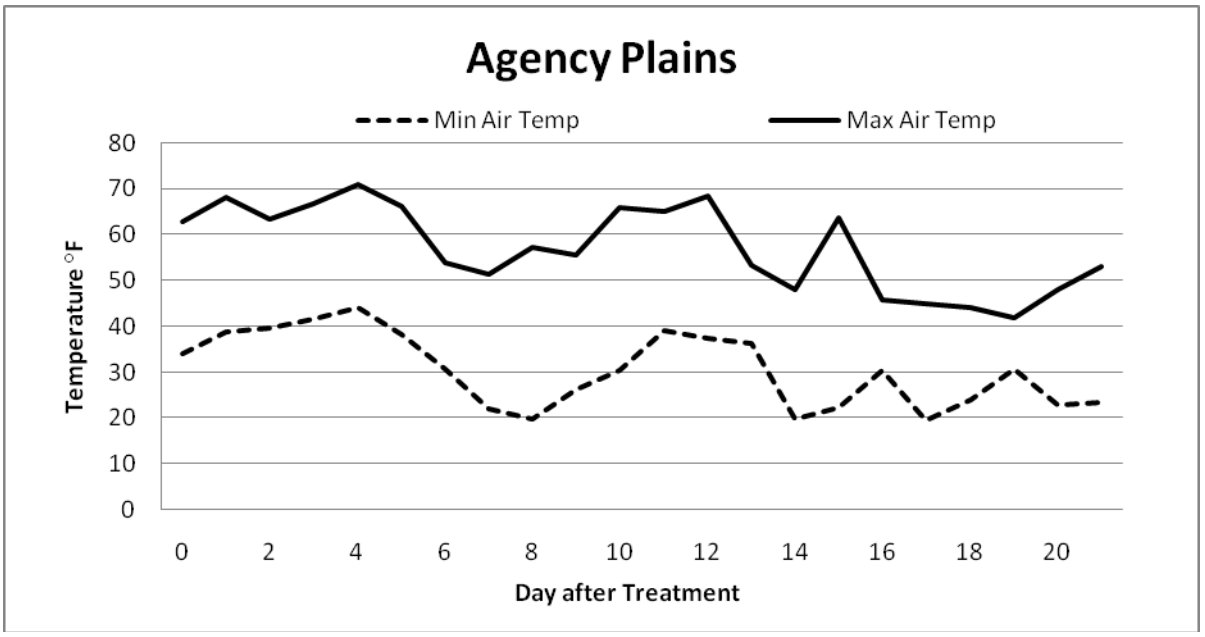

Figure 4. Air temperature maximums and minimums for 21 days of observations at Agency Plains.

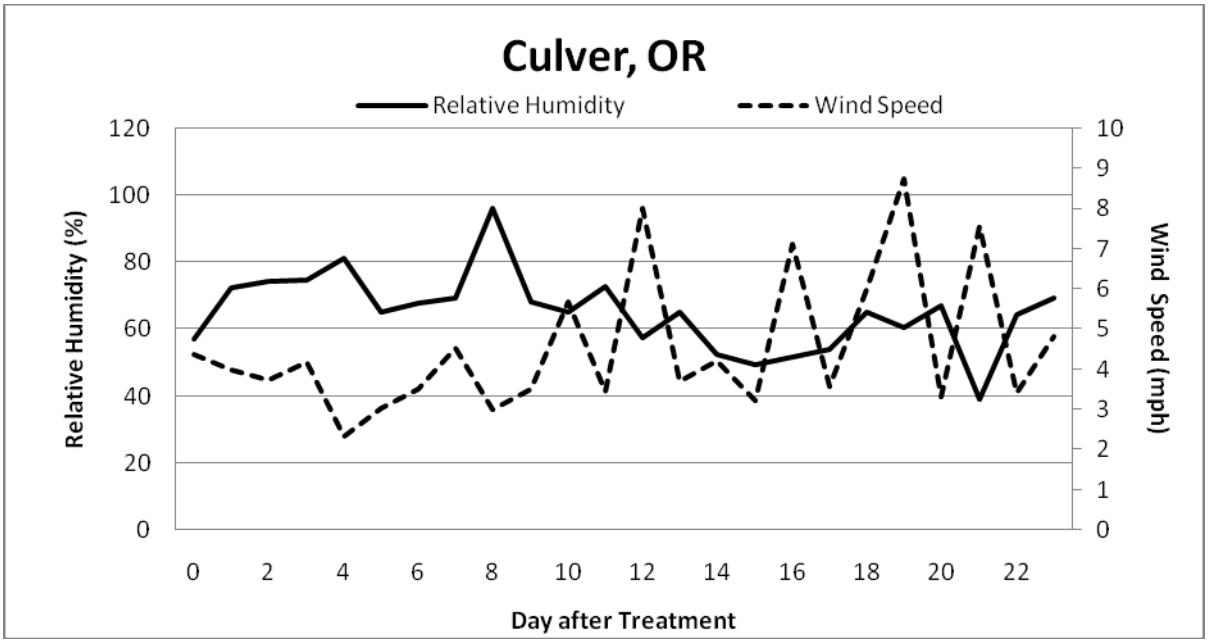

Figure 5. Percent relative humidity and wind speed for 23 days of observations at Culver, OR.

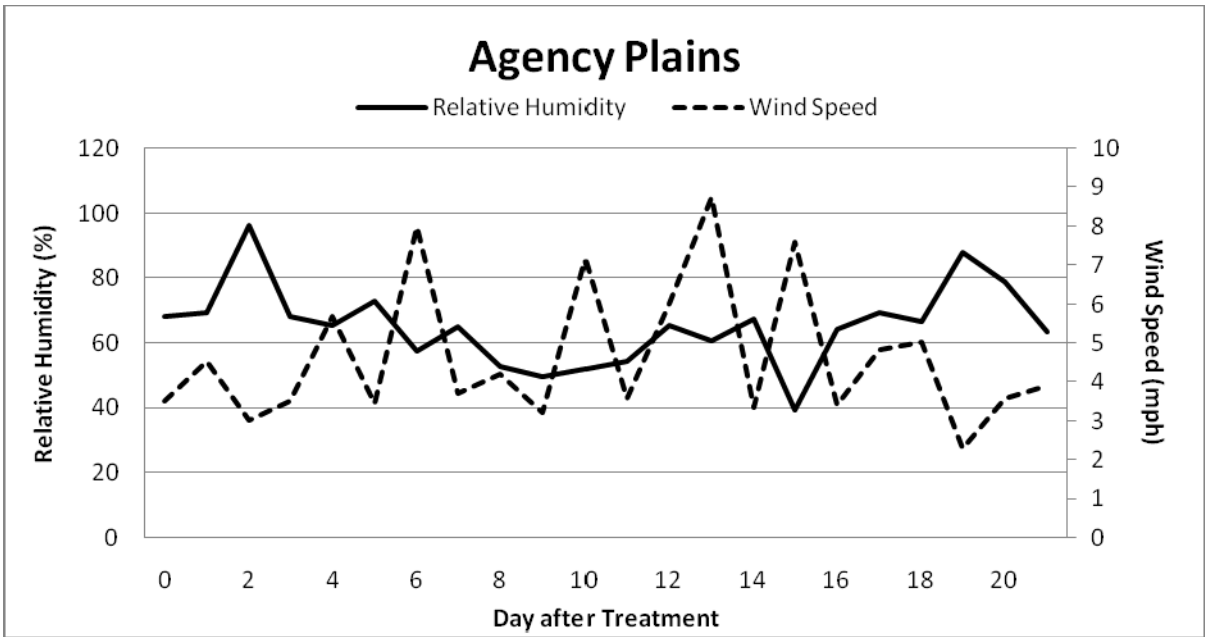

Figure 6. Percent relative humidity and wind speed for 21 days of observations at Agency Plains.

Table 1. Observations made while changing tubes at Culver location and Agency Plains, 2011.

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

References

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