Measuring Gaseous Nitrogen Losses from Volatilization of Applied Anhydrous Ammonia
PROPOSAL TO THE AGRICULTURAL RESEARCH FOUNDATION
Oregon Wheat Commission

TITLE: Measuring gaseous nitrogen losses from volatilization of applied anhydrous ammonia.

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FUNDING HISTORY: None previous 3 years; 2010-2011 request

ABSTRACT: Fertilizer input costs amount to about 35% of the variable cost of wheat production and typically nitrogen is the single most expensive purchased input. Anhydrous ammonia (NH3) is the most common and least expensive form of nitrogen fertilizer. Volatilization of ammonia from fields where anhydrous ammonia has been applied is an issue from two aspects: 1) volatilization reduces the amount of plant available N (growers pay for N that is lost) and 2) volatilization losses of ammonia contribute to adverse environmental effects that will most likely lead subject to regulation in the near future. This project will conduct an investigation into the measurement of volatilization losses of NH3 following application of anhydrous ammonia into a summer fallow wheat field. Experimental variable will be three levels of soil water content. The end product will be more precise understanding of NH3 losses related to soil water content and various other soil characteristics and quantitative measure of NH3 released to the atmosphere.

OBJECTIVES

1. Measure the gaseous loss of ammonia nitrogen following the application of anhydrous ammonia with a shank applicator at three different soil water contents.
2. Provide general guidelines and recommendations to minimize volatilization and provide efficient use of fertilizer input costs.

PROCEDURES

Objective 1

A summer fallow field will be indentified for study. A randomized complete block experimental design will be utilized. An area of approximately 40 acres will be required for this experiment to insure minimal interaction between treatments. Treatment areas will be 100 ft diameter circles separated by 300 ft intervals. The intervening area is not utilized for the experiment, but is required for isolation. With 4 treatments and 3 replications an area of 900 x 1300 ft is required (Figure 1). Three treatments with varying soil water content and a control (no applied ammonia) will be created. Each plot of each treatment will require a circle to be created. Treatment 1 will receive additional tillage to create a drier soil water content in the zone of injection and ammonia injection, treatment 2 will be the grower standard field operation with subsequent ammonia injection, treatment 3 will receive additional water applied by sprinklers mimicking a soil condition near field capacity using a portable tank-fed irrigation source and subsequent ammonia injection. A background ammonia collecting mast will be placed upwind of the prevailing wind direction to measure ammonia coming onto the site.   Ammonia levels from the background mast will be subtracted from the treatments for calculating ammonia loss. A fourth treatment will be a control that has no ammonia applied. This control will have the applicator run through the plot but not have any ammonia applied. This control will only be conducted at the grower standard tillage practice. The ammonia rate will be the standard rate used by the grower cooperator.   In June, a shank type anhydrous application will be used to apply the nominal rate of nitrogen into the appropriate treatments. Volatilization will be compared between the treatments.

The difficulty in measuring ammonia loss from anhydrous ammonia applications is to get the anhydrous applied in a 100 foot circle. A 20 applicator will be used with five passes to get as close to a circle as possible. A final pass inside the circle edge will help insure a uniform application.

Immediately after ammonia application, volatilization losses will be measured using a modified passive flux method (Wood et al, 2000). This method consists of a rotating 10-ft tall mast placed at the center of the circular plot. Ammonia is sampled at five heights (1.5 2.5, 5, 7.5, and 10 ft Leuning et al., 1985) (Figure 2). Each passive flux ammonia sampler consists of a glass tube (1/4 in i.d. x 4 in long) (Figure 2). The inside surface is coated with 3% w/v oxalic acid to trap ammonia from the air. A wind vane on the mast keeps the tubes facing into the wind. Upwind background samples will be collected for each plot on masts placed upwind of the plot in the direction of the prevailing wind. The sampling tubes will be changed on regular intervals as dictated by conditions to allow sufficient concentrations of NH_3 to be detected. Masts will be placed with ammonia collection tubes immediately after application. Sample tubes will be collected at short interval initially. Initially, this may be hourly, then as time from application increases intervals will increase. Measurements will continue for 1 week or until equilibrium conditions are reached. An *Adcon* Telemetry weather station will be placed at the study area to measure air temperature, soil surface temperature, humidity, rainfall, and wind speed and direction.

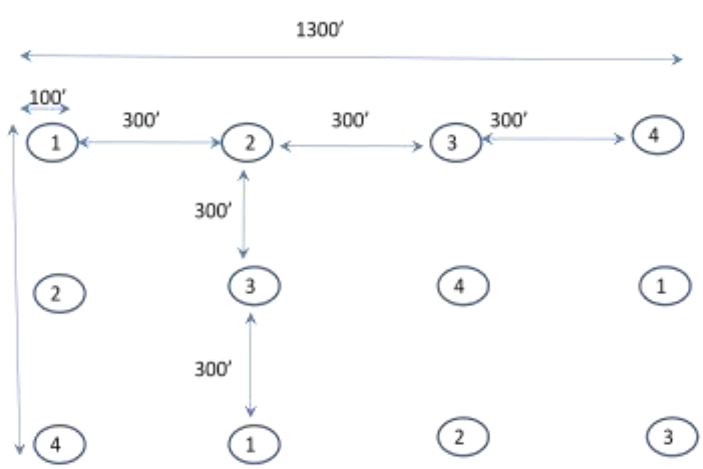

Figure 1. Schematic of experiment dimensions

Figure 2. Mast and collection tube.

Ammonia collection samplers will be sent to the laboratory and amount of volatilized ammonia determined. Sampling tubes will be shaken for 10 minutes with deionized water, then extracted and analyzed colorimetrically for ammonium (NH_4^+) (Sims et al., 1995). Total ammonia volatilized from applied fertilizer will be quantified by subtracting the background ammonia measurements. Vertical flux of ammonia will be determined by summing horizontal flux at each measurement height (Wood et al., 2000; Schjoerring et al., 1992). Losses of ammonia through volatilization will be subjected to analysis of variance (Statistix 8, 2003) using LSD for mean separation. Recommendations to minimize volatilization losses and maximize N retention will be written and presented.

Objective 2

Results will be analyzed and summarized. Results will be presented at a variety of meetings, including local grower meetings and wheat league.

TIMLINES

Identify field and cooperators March April
Lay out field experiment May-June
Install soil water treatments May-June
Apply anhydrous ammonia June or alternatively August
Collect and measure NH3 June or alternatively August
Analyze data June-August or September-November
Summarize Data and write recommendations December March

JUSTICATION: After an anhydrous application, an undetermined percentage of nitrogen is lost to the atmosphere through ammonia volatilization. This results in release of ammonia, a powerful smog forming gas, into the atmosphere as well as loss of N available to crops. Ammonia combines in the air with other greenhouse gasses such as nitrous oxide and sulfate to form PM2.5 and PM10 particulates. These particulates form smog particles that are difficult to purge from the lungs. For example, the Columbia River Gorge Scenic Area is thought to be ammonia limiting for smog. By studying ammonia volatilization in different field conditions after application of anhydrous ammonia, we will develop a better understanding of fertilizer efficiency and the potential contributions to the atmosphere. From data provided by this experiment, improved recommendations can be made that reduce volatilized ammonia and improve the amount of N available to crops. This is a win-win situation for producers because input costs are reduced and environmental benefits are achieved. Also by funding this project the Oregon wheat industry will demonstrate a proactive approach to an issue that is likely to escalate to national significance. Having sound information in hand can divert heavy handed regulatory approaches.

BUDGET:

Salary:		
Research Assistant 0.18 FTE	$6,494	
Graduate Student 0.6 FTE	$8,584	
OPE for all categories		
Research Assistant (.54)		$3,506
Graduate Student (.10)		$1,416
Travel: Domestic (in state)		$1,000
Travel to plot area,		
Travel OWC Research Review to present results.		
Travel to OWGL Annual conference to present results.		
Supplies and Materials:		
Lab Fees		$7,944
Stakes, flags, sample bags, etc		$1,825
Total		$30,769

RELATION TO OTHER RESEARCH: We are not aware of other investigators in the PNW that are conducting this work on wheat. Jess Holcomb and Don Horneck have conducted similar work using dry urea on grass seed fields.

LITERATURE CITED

Leuning, R., F.R. Freney, O.T. Denmead, and J.R. Simpson. 1985. A sampler for measuring atmospheric ammonia flux. Atmos. Environ. 19:1117-1124.

Schjoerring, J.; Sommer, S.; Ferm, M. A simple passive sampler for measuring ammonia emission in the field. Water Air Soil Pollut. 1992, 62, 13-24.

Sims, G.K.; Ellsworth, T.R.; Mulvaney, R.L. Microscale determinations of inorganic nitrogen in water and soil extracts. Commun. Soil Sci. Plant Anal. 1995, 26, 303-316.

Statistix 8 Analytical Software. 2003. Statistix 8 User’s Manual, Analytical Software, Tallahassee, FL.

Wood, C.W.; Marshal, S.B.; Cabrera, M.L. Improved method for field-scale measurement of ammonia volatilization. Commun. Soil Sci. Plant Anal. 2000, 31 (5), 581-590.