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Feedlot Surface Conditions and Ammonia Emissions

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Summary

*Moisture and urine were applied to a feedlot surface in a 2x2 factorial design. Forced-air wind tunnels were used to determine differences in the net flux of ammonia (NH_3) being volatilized. Surface DM, pH and surface temperature were all analyzed within each treatment to determine effect on NH_3 net flux. No effects of urine were detected. There were differences detected due to moisture and moisture*time with the dry plots releasing significantly more NH3.*

Introduction

Feedlot surface conditions continually change due to variations in temperature, moisture, manure, urine and microbial population. NH_3 emissions continually change due to the time of year, time of day, environmental conditions and feedlot surface conditions. Past reports indicated an increase in NH_3 flux during the summer due to an increase in soil temperature and N level (*2006 Nebraska Beef Report,* pp. 92-93).

NH_3 flux usually follows a diurnal pattern with the NH_3 concentration increasing from early morning, peaking at midday and then decreasing into early evening. Our first hypothesis is the application of urine will increase NH_3 emissions from the feedlot pen surface. Additionally, as plots with moisture added begin to dry an increase in NH_3 flux will be observed. According to diurnal patterns and temperatures, our second hypothesis is NH_3 loss will be highest during the afternoon.

Procedure

The experiment was conducted the first 3 weeks of August 2005. Each week, cattle were removed from the pens the afternoon of day 0 and returned to the pens to re-equilibrate the surface the morning of day 3. Treatments were applied to 5.76 ft^2 plots on a feedlot surface as a 2x2 factorial. Factors included water addition at 0 or 4 gallons, to simulate a 1-inch rainfall and/or urine addition of 0 or 0.26 gallons (0.762 % N). Therefore, the four treatments were DRY (nothing added), DRY+URINE (urine added), WET (only water added), and WET+URINE (water and urine added). Water was applied to assigned plots at 6 a.m. on day 1. Urine was applied immediately prior to collection one on day 1 of designated plots. Plot location and treatment remained the same throughout 3 weeks. NH_3 samples were collected using two forced-air wind tunnels every 3 hours on day 1 from 6 a.m. to 9 p.m. On day 2, samples were collected every 6 hours from 8 a.m. to 8 p.m. Wind tunnels directed air over the surface at 0.3 m/s for 30 minutes per plot. A fraction of the airflow (0.024 m^3/s) was diverted for analysis and NH_3 was collected using a 0.2 *M* sulfuric acid trap. The trapped NH_3 was measured in the lab using a spectrophotometer. One-inch cores of the feedlot surface were collected, two at the beginning of day 1, and two at

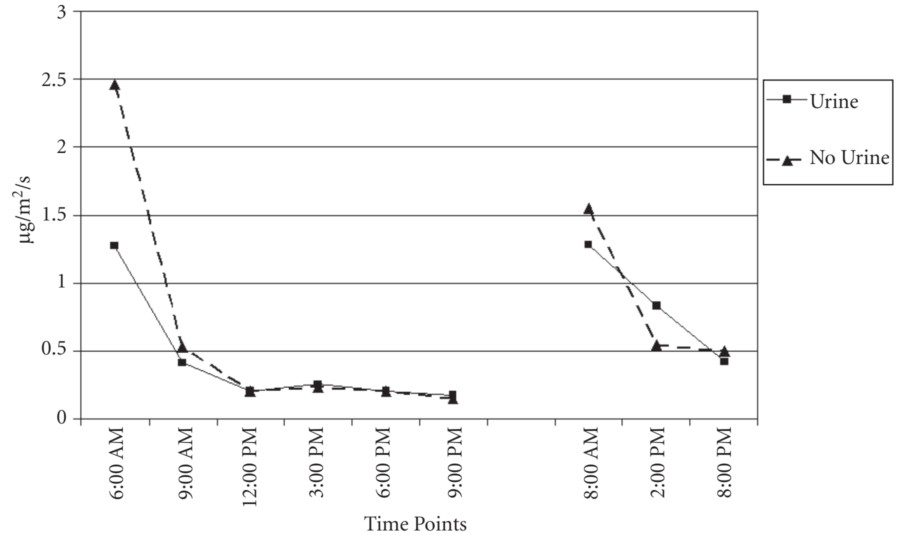

Figure 1. NH_3 emissions due to urine and time (interaction: $P = 0.78$; urine effect: $P = 0.46$).

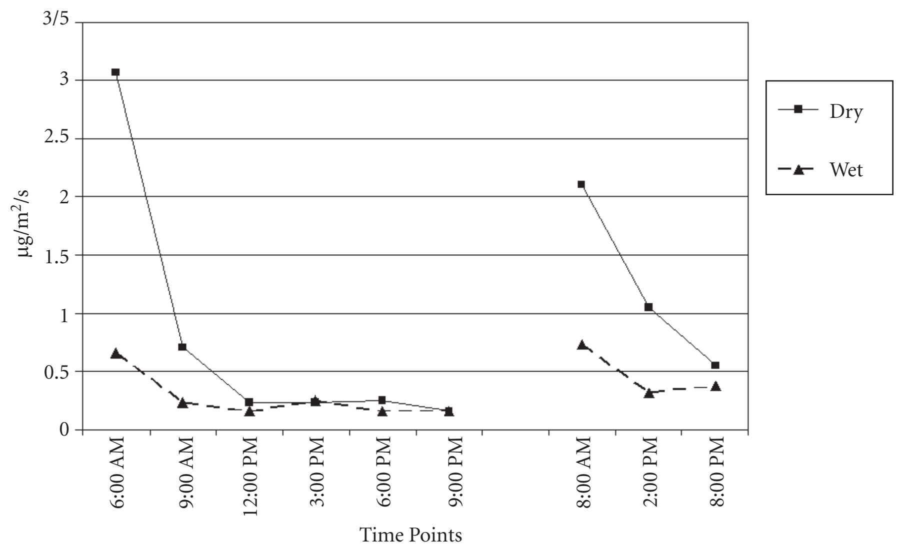

Figure 2. NH_3 emissions due to moisture and time of day (interaction: $P = 0.03$; moisture effect: $P < 0.01$).

Table 1. Core characteristics influenced by moisture and urine.

	DRY	DRY+ URINE	WET	WET+ URINE	P-value Moisture *urine	Moisture	Urine
Core N	1.18^{ab}	1.12^{ab}	1.11^{b}	1.22^{a}	0.02	0.74	0.49
Core pH	8.01	7.96	8.21	8.32	0.19	<0.01	0.72
Core Moisture	11.3	12.0	27.6	28.7	0.89	<0.01	0.53

[a,b]Means with different superscripts differ significantly ($P<0.05$).

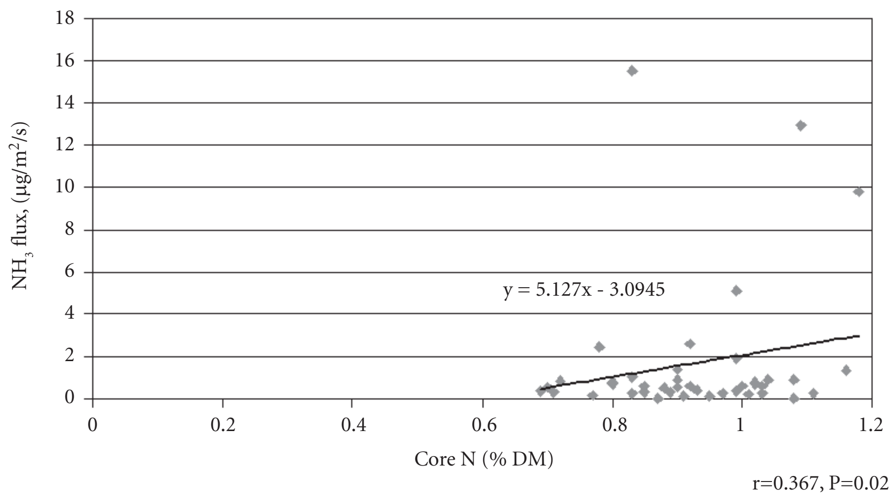

Figure 3. Correlation between N loss and core N.

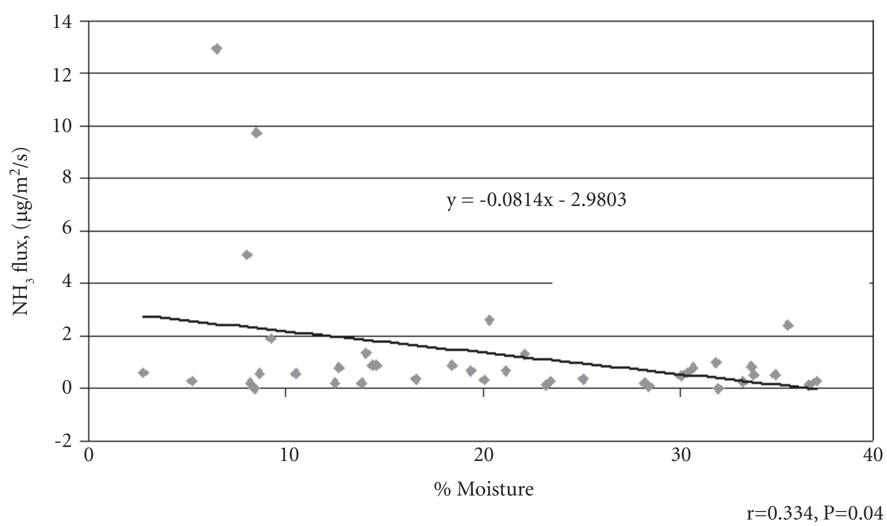

Figure 4. Correlation between N loss and core moisture.

the end of day 2. They were analyzed for DM, pH and N. Soil and surface temperatures were recorded at the beginning of each 30-minute period.

Results

There was no moisture*urine*time interaction (P= 0.57), no urine*time interaction (P= 0.78) and no main effect of urine (P= 0.46; Figure 1) . A moisture*time interaction (P= 0.03) was observed across all 3 weeks, the highest NH_3 loss was observed prior to 9 a.m. on both day 1 and day 2, with NH_3 losses decreasing to very low levels after 12 p.m. The net flux was affected by moisture (P<0.01) with the DRY and DRY+URINE plots emitting higher levels of NH_3 on both day 1 and day 2 (3.07 and 2.09 µg/m^2/s) versus the WET and WET+URINE plots emitting only 0.65 and 0.72 µg/m^2/s of NH_3 (Figure 2).

There was a significant moisture*urine effect (P= 0.02) on core N with the WET+URINE having a higher N level when compared to the other three treatments. Soil pH was effected by moisture (P<0.01) with WET and WET+URINE treatments having higher pH values. The WET and WET+URINE core moisture was twice the amount of that observed in the DRY cores (27.6 and 28.7 WET, 11.3 and 12.0 DRY; Table 1).

NH_3 flux weakly correlated to core N (r = 0.367, P = 0.02). As core N increased, the NH_3 emitted also increased (Figure 3). A low correlation (r = 0.334, P = 0.04) was observed between moisture and NH_3 flux. Emissions were high on DRY and DRY+URINE plots and as the WET and WET+URINE plots dried the emissions increased (Figure 4). At the high moisture of the WET and WET+URINE plots, the surface is moist and holds the NH_3 in solution. As the surface dries it allows the NH_3 to volatilize and be released.

In this trial, NH_3 loss appears to be related to soil moisture, with the greater loss from dry surfaces. The NH_3 flux followed a diurnal pattern with the greatest loss prior to 9 a.m. and decreasing into the evening. The diurnal trend of the lowest emissions during the midday, rather than the midday emissions being the highest, could be due to the repeated measurement of the plots throughout the day. This could have modified the microenvironment. The change in the microenvironment could have reduced the amount of NH_3 produced, and thus emitted, resulting in the low NH_3 flux midday. Low air exchange rates within the chamber can also modify the microenvironment reducing NH_3 loss.

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