Improved Method for Measurement of Ammonia Volatilization in the Field


ABSTRACT

We developed a method for determination of ammonia (NH₃) volatilization from land applied nitrogen (N) that is a modification of proven passive flux methods, and is an improvement over reduced cost, labor, and analytical requirements. The method uses a rotating meter centered in a circular plot. Sample tubes are glass tubes (7 by 200-mm) coated on the inside with oxalic acid to trap NH₃. The method was tested against one of the proven methods. A circular plot (15-m radius) was established, urea applied (200 kg N ha⁻¹), and NH₃ volatilization measured for six days thereafter. Linear relationships existed between our method and the reference method, as indicated by r² values of 0.92 and 0.86 for horizontal and vertical fluxes, respectively. The glass tubes were used consistently measured more NH₃ volatilization than samplers from the reference method. However, given that most micrometeorological methods underestimate NH₃ volatilization, we feel that our method improves accuracy. Thus, our method for field scale determination of NH₃ volatilization reduces initial costs as well as labor and analytical requirements, without sacrificing accuracy.

INTRODUCTION

Ammonia (NH₃) volatilization can be a significant pathway for nitrogen (N) loss from many agricultural systems. To improve estimates of N budgets, accurate measurements of NH₃ volatility from field-scale studies in typical systems are needed. Currently, however, there is no method for field-scale measurement of NH₃ volatility that is user-friendly with respect to initial costs, and time and labor requirements. We have developed and tested a new passive flux NH₃ collection method for determining NH₃-N loss from land-applied animal waste that combines the best aspects of the Leuning et al. (1989) and Schjørring et al. (1992) proven methods, i.e. low analytical and labor requirements (Leuning et al., 1989) and low initial cost (Schjørring et al., 1992).

MATERIALS AND METHODS

- Location: Turfgrass Research Unit campus of Auburn University, AL
- Urea applied at rate of 200 kg N ha⁻¹
- Rotating meter in center of 15m radius plot with glass tubes and NH₃ sampler (Leuning et al., 1989) mounted side by side.
- Glass Tube - 7-mm diameter by 200-mm length inside coated with oxalic acid (3% w/v in acetone) steel-stainless steel disk with 1 mm hole
- Height = 0.63, 1.42, 2.11, 3.00 m
- NH₃ collected for 6 days after application
- NH₃ extracted with deionized water and analyzed for NH₃-N colorimetrically with a microtplate technique (Simone et al., 1996)
- Vertical flux of NH₃ from plate area was determined by calculating the horizontal flux at each of the four heights and summing the horizontal fluxes from each height

The equations used were modified as follows from Schjørring et al. (1992):

\[ \text{Horizontal Flux} = \frac{M}{t} \]

where: \( M \) - mass of NH₃ captured
\( t \) - time of measurement

\[ \text{Vertical Flux} = \frac{V}{t} \]

where: \( V \) - vertical flux
\( h \) - height of measurement interval

GASS TUBE INFORMATION

Glass tube dimensions: 200-mm length, 7-mm id, 10-mm od
- Company that supplies the stainless steel disks and snap caps for the glass tubes: Mikrolet A/S, Aal Kieris Vej 34, DK-8270 Hjørring, DENMARK
- Price: 21.14-24.96 DANISH KRONER (DKK)

Stainless steel disk: 0.065-mm THK, 10-mm diam, 1-mm hole in center
- Price: 19.08 DKK

CONCLUSIONS

- Strong linear relationships between our method and the Leuning et al. (1989) method for both vertical and horizontal fluxes.
- Because of simple cylindrical shape, the tubes can be more completely extracted.
- Our method results in a 10X reduction in NH₃ analyses/plot measurement time compared to the Schjørring et al. (1992) method.
- Each glass tube costs US $1.36 which is 18X less than the US $200.00 NH₃ sampler (Leuning et al., 1989).
- The experiment showed that our method absorbed 10% less of the N applied as urea than did the Leuning et al. (1989) method. Our research has shown that micrometeorological methods can underestimate true ammonia volatilization. Given this, our method, which recorded higher ammonia losses, more accurately measured ammonia volatilization compared to the Leuning et al. (1989) method.

- We devised and tested a new method of measuring field-scale NH₃, volatilization from land-applied N that is less expensive, less complex, and more accurate than methods previously available.

REFERENCES


