EFFECT OF ORGANIC NITROGEN FERTILIZER SOURCE, APPLICATION METHOD, AND APPLICATION RATE ON AMMONIA VOLATILIZATION FROM DRIP IRRIGATED LETTUCE

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Introduction

Nitrogen (N) application as fertilizer is essential to support plant growth, but adding N fertilizers without proper management leads to release of gaseous compounds such as ammonia (NH_3). Nitrogen loss from organic and inorganic fertilizers by NH_3 volatilization is a critical concern for many reasons including ecosystem effects, human health issues, and an economic concern from losing N through emissions leaving less N for plants to use. As a result, the amount of NH_3 loss from fertilizers reduces fertilizers effectiveness and thus, as NH_3 emissions increase, the nitrogen use efficiency of crops decreases (Bouwman *et al*., 2002). It is important to optimize fertilizer selection, rate, and application method, in order to protect the environment.

Objectives

1- Compare NH_3 volatilization of four organic N fertilizers (blood meal, feather meal, fish emulsion and cyano-fertilizer).
2- Evaluate the effect of fertilizer application methods (pre-plant solid vs split liquid) on NH_3 volatilization.
3- Evaluate the effect of fertilizer application rates (28 and 56 kg N ha^{-1}) on NH_3 emissions.

Materials & Methods

The study was conducted at CSU's Horticulture Field Research Center in the summer of 2014. Two application rates of four fertilizers were applied to organic lettuce (28 and 56 kg N ha^{-1}), which were two solid fertilizers (blood meal and feather meal) and two liquid fertilizers (fish emulsion and cyano-fertilizer). Semi-open static chambers developed by Nômmik (1973) and modified by Araújo *et al. (*2009) were used in the experiment to measure NH_3 emissions. The solid fertilizers were applied in a sub-surface band 6 cm deep and 6 cm from the row a few days before transplanting, while liquid fertilizers were applied through drip irrigation every week over the growing season starting two weeks after transplanting. After taking the samples from the field, they were extracted using 250 ml of 2 M KCl. Extracts were taken to the Natural Resources Ecology Lab for NH_3 analysis.

Results

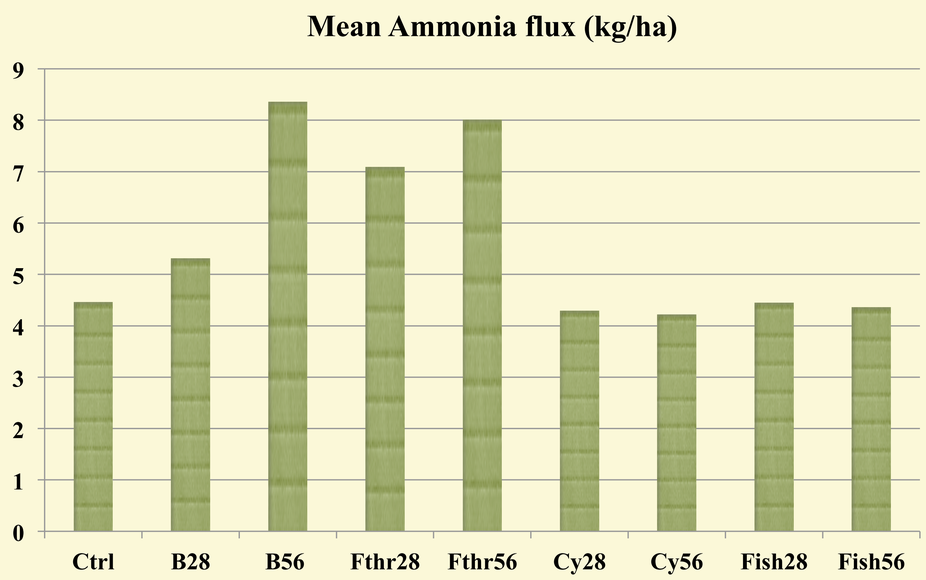

Figure 1. Mean seasonal NH_3 flux. Ctrl = Control, B =Blood meal, Fthr = Feather meal, Cy = Cyano-Fertilizer, Fish = Fish emulsion, 28 = 28 kg N ha^{-1}, 56 = 56 kg N ha^{-1}.

The Proc mixed procedure in SAS indicted that there was a significant difference among the fertilizers (P-value= 0.0004).
Tukey-Kramer test indicated that there was a significant difference between feather meal at both rates vs cyano-fertilizer and fish emulsion. Furthermore, there was a significant difference between blood meal at 56 kg N ha^{-1} vs cyano-fertilizer and fish emulsion at both rates.
Dunnet's test indicated that there was a difference between control vs blood meal applied at 56 kg N ha^{-1} (P = 0.0034) and significant difference between control and feather meal applied at 28 and 56 kg N ha^{-1} (P = 0.0202 and 0.0059) respectively. There was no difference between control vs blood meal applied at 28 kg N ha^{-1}.
The liquid fertilizers applied through fertigation (fish emulsion and cyano-fertilizer) did not significantly increase NH_3 emission as compared to control, even when applied at the higher rate.

Discussion

This experiment was conducted to quantify NH_3 volatilization from four different organic fertilizers applied at different N rates and using different application methods. The results indicated that blood meal applied at 56 kg N ha^{-1} and feather meal at both N rates had the highest NH_3 fluxes based on mean estimates, Tukey-Kramer test, and Dunnet's test. On the other hand, NH_3 fluxes from cyano-fertilizer (28 and 56 kg N ha^{-1}), fish emulsion (28 and 56 kg N ha^{-1}), and blood meal at 28 kg N ha^{-1} were not different than NH_3 fluxes from the control. Fertigation of liquid fertilizers (cyano-fertilizer and fish emulsion) resulted in less NH_3 emission than pre-plant, sub-surface banded solid fertilizers. In addition, there was no effect of fertilizers application rate according to SAS test. Furthermore, there was probably an effect of temperature on NH_3 volatilization over the growing season. There is no known scientific literature comparing NH_3 volatilization from organic N fertilizers. As a result, further study is required to confirm these findings.

References

Araújo, E.S., T. Marsola, M. Miyazawa, L.H.B. Soares, S. Urquiaga, R.M. Boddey, andB.J.R.Alves. 2009. Calibration of a semi-opened static chamber for the quantification of volatilized ammonia from soil. (In Portuguese, with English abstract.) Pesqi. Agropecu. Bras. 44:769–776.

Bouwman, A.F., L.J.M. Boumans, and N.H. Batjes. 2002. Estimation of global NH3 volatilization loss from synthetic fertilizers and animal manure applied to arable lands and grasslands. Global Biogeochem. Cycl. 16: 8 –13.

Nômmik, H. 1973. The effect of pellet size on the ammonia loss from urea applied to forest soils. Plant Soil 39:309–318.

NRCS. 1980. Soil survey of Larimer County Area, Colorado. http://soils.usda.gov/survey/online_surveys/colorado/larimer/Text-Part%201.pdf. Accessed 29 September 2013.

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