Combined effect of sugarcane trash mulch, slurry properties and tropical climatic conditions on ammonia volatilization after pig slurry application

Sansoulet J. [1, 2], Génermont S. [1], Morvan T. [3], Saint Macary H. [2], Paillat J.M. [2,3]

1) *INRA, AgroParisTech, UMR 1091, EGC, Environnement et Grandes Cultures, F-78850 Thiverval-Grignon, France*

2) *CIRAD, UPR Recyclage et risque, F-34398 Montpellier Cedex 5, France*

3) *INRA, Agrocampus Rennes, UMR1069, SAS, Sols Agronomie Spatialisation, F-35000 Rennes, France*

sophie.genermont@grignon.inra.fr

Overview

The purpose of this study was to characterize ammonia volatilization under tropical soil and climate conditions for two management practices commonly used for slurry application during the sugarcane inter-season: surface application on bare soil or on sugarcane trash mulch. Two experiments were carried out on the same field in Réunion Island, in August-September 2000 (dry and fresh season) and late October 2001 (just before humid and hot season), respectively. They involved a macro-plot set-up for field measurement of ammonia volatilization using the micrometeorological mass balance method. Whereas emissions were comparable between the two seasons with the bare soil treatments, sharply contrasting results were obtained with the mulch treatments, with emissions drastically lower in August and higher in October. This paradoxical result was due to differences in the intrinsic properties of the slurries (particularly dry matter content) interacting with the physical characteristics of the sugarcane mulch (liquid retention, exchange surface area) and the chemical properties of the soil and sugarcane mulch (ammonium adsorption), together with the weather conditions. This study highlights the need for advises for specific ammonia abatement strategies.

Introduction

In Réunion Island, in the tropics, sugarcane is grown on large areas (26 000 ha, 57% of the island's total farmland) and pig slurry output is applied on the sugarcane fields (Chabalier et al., 2006). The effect of the interaction between sugarcane trash mulch and pig slurry characteristics on ammonia volatilization has not been characterized. One of the determinants of NH_4^+-N availability at the soil surface where volatilization occurs is the slurry's ability to infiltrate the soil. This is related to soil texture and structure as well as slurry viscosity, which mainly depends on its dry matter content (Génermont and Cellier, 1997). Moreover, it is known that plant mulches (i) tend to increase organic matter content, which usually provides for a high infiltration rate (Findeling et al., 2003), and (ii) can store significant amounts of water, so reducing the amount of rain reaching the soil, which might influence slurry infiltration and thus ammonia volatilization. The purpose of this study was to characterize ammonia volatilization under tropical farming practices, and especially to explore what effects the presence on the soil surface of a sugarcane trash mulch has on slurry infiltration and ammonia availability for volatilization.

Methods/Approach

Two experiments were carried out on the same field in Réunion Island, in August-September 2000 (dry and fresh season) and late October 2001 (just before humid and hot season), respectively. Experiments were designed to compare two treatments: pig slurry application (i) on bare soil and

(ii) on sugarcane trash mulch. They involved a macro-plot set-up for field measurement of ammonia volatilization using the micrometeorological mass balance method (Misselbrook et al., 2005).

Results

With the bare soil treatments, emissions were rather similar: 34% and 47% of applied ammoniacal nitrogen in August-September 2000 and October 2001, respectively. With the mulch treatments, sharply contrasting results were obtained with emissions drastically lower in August (experiment 1) and higher in October (experiment 2), reaching 10% and 108% of applied ammoniacal nitrogen respectively.

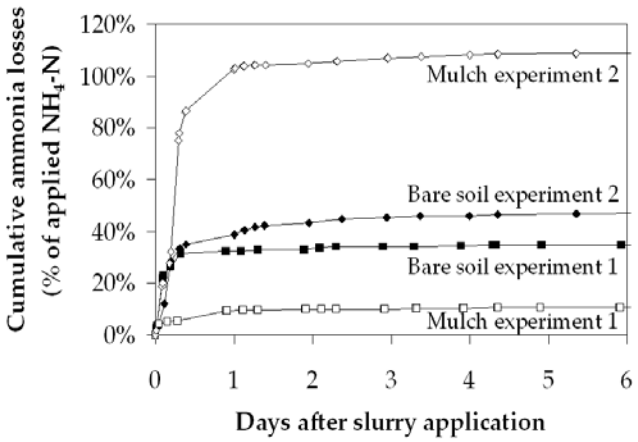

Fig. 1. Cumulative losses of ammonia plotted as percentage of applied NH_4^+-N on bare soil and sugarcane trash mulch after application of pig slurry

First, ammonia volatilization was much faster under hot and windy tropical conditions (experiment 2) than under temperate weather conditions (experiment 1). Secondly, the results showed that the presence of sugarcane trash mulch may either drastically reduce ammonia volatilization, provided the slurry leaches under the mulch or is washed through it by rain (experiment 1, slurry dry matter = 3.5%), or, on the contrary, drastically enhance ammonia volatilization if the slurry is not liquid enough to leach and is retained on the sugarcane mulch (experiment 2, slurry dry matter = 6.3%). In this latter case, weather effect on ammonia volatilization is enhanced, because the high specific surface of the mulch specific of about 40 cm^2 cm^{-3} results in a much increased exchange surface between slurry and atmosphere.

As a conclusion, on bare soil, slurry would be best applied under conditions as cool and windless as possible, and preferably before a rainfall event. In case of slurry application on sugarcane trash mulch, slurries with low dry matter content would be preferable. An efficient method would be to inject the slurry under the mulch.

References

Chabalier P.F., van de Kerchove V., Saint Macary H., (eds.) (2006). Guide to organic fertilization in Reunion. Guide de la fertilisation organique à La Réunion. Saint Denis, La Réunion, France, 302 pp.

Findeling A., Ruy S., Scopel E., (2003). Modeling the effects of a partial residue mulch on runoff using a physically based approach. Journal of Hydrology (Amsterdam) **275**, 49-66.

Génermont S., Cellier P., (1997). A mechanistic model for estimating ammonia volatilization from slurry applied to bare soil. Agricultural and Forest Meteorology **88**, 145-167.

Misselbrook T.H., Nicholson F.A., Chambers B.J., Johnson R.A., (2005). Measuring ammonia emissions from land applied manure: an intercomparison of commonly used samplers and techniques. Environmental Pollution **135**, 389-397.