360

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ODOUR AND AMMONIA EMISSIONS FROM LIVESTOCK FARMING

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360

AMMONIA EMISSIONS DURING AND AFTER LAND SPREADING OF SLURRY

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Summary

Ammonia emissions during and after land spreading of slurry can rise up to 80% of the applied NH_4–N and occur mainly in the first hours after spreading. Mode of application, slurry dry matter content, atmospheric temperature and soil moisture are the essential hazard factors. Application of highly viscous slurry on stubbles and straw, on compacted soils or grassland impairs infiltration into the soil and results in high ammonia volatilization. Immediate incorporation into the soil,-application at low temperature and possibly diluting of viscous slurry are proper measures to decrease ammonia losses and air pollution.

1. INTRODUCTION

Ammonia emissions into the atmosphere are supposed to be about 80% and more due to animal production. During and after land spreading of animal slurry they can appear in considerable or even very high quantities. On the one hand they give rise to environmental – toxicological problems concerning forest decline and acidification of soils, on the other hand economically they are real losses of nitrogen to the farmer (1,2,3,6).

Basically the pattern of ammonia release shows a logarithmic curve increasing rapidly with pH and temperature. Under practical conditions the main parameters are: temperature and flow of air, soil properties, vegetation, type (dry matter content) and mode of application of slurry.

2. MATERIAL AND METHODS

The common methods to determine ammonia losses are:

a) closed dynamic system under controlled conditions (growth chamber) (5)
b) wind tunnel under field conditions (4)
c) micrometerological measure system
d) indirect and unspecific method by different N–uptake in plant experiments

In our institute we have worked with the method a) and b) (air flow rate equivalent to a 35–fold air exchange/min), sometimes completed with d). Slurry was applied on the basis of equal amounts of ammonium–N (commonly used in the practice):

- 100 kg NH_4–/ha on arable land
- 60 kg NH_4–/ha grassland

3. RESULTS AND DISCUSSION

Ammonia losses of slurry as influenced by mode of application, dry matter content of slurry and temperature.

Mode of slurry application is the most important factor; while losses were very high (50%) after surface application, incorporation with a cultivator reduced them to about one fifth (fig 1). Due to mixing of slurry and soil, more slurry ammonium is getting into contact with sorptive sites of the soil and thus escaped potential evaporation (4).

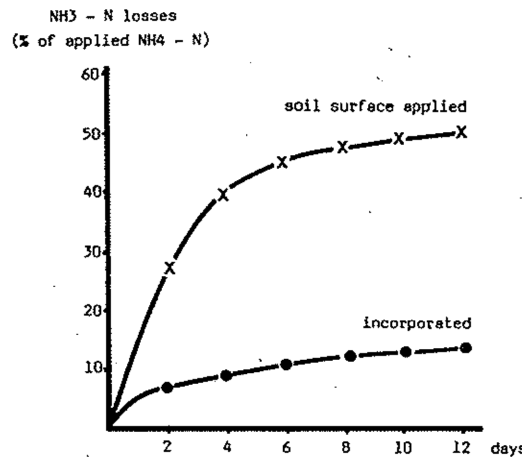

Fig. 1: Ammonia losses from cattle slurry dependent on application mode (silty loam, pH 6.5)

In another experiment (5) under controlled conditions (fig.2) the greatest losses (about 40%) appeared already in the first hours after surface application and decreased later (accumulated curve). Ammonia volatilization rised with temperature (5°C to 20°C) and dry matter content (1 – 6.4–8%) of slurry.

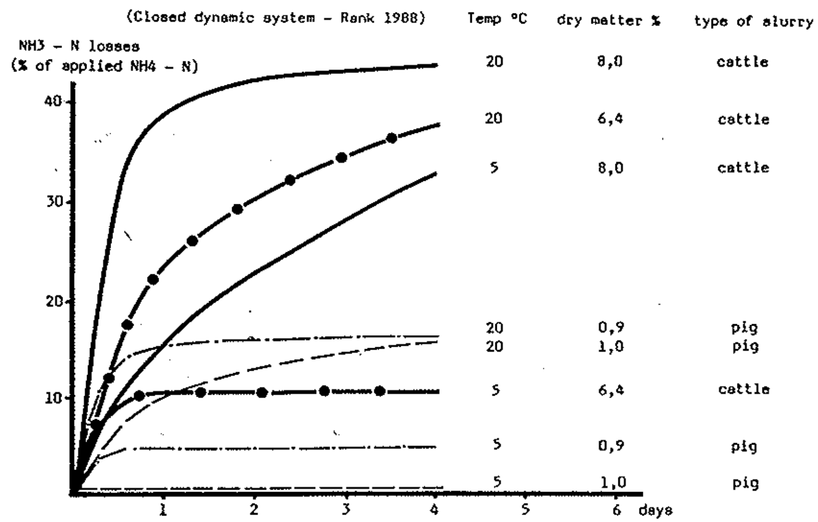

Fig. 2: Ammonia losses from slurry depending on dry matter content and temperature

Application of slurry with 10% dry matter on stubbles and wheat straw (4) in August (28°C) reached losses of 70% compared with 40% in case of 5% dry matter (fig. 3). After November application (14°C) on a compacted soil after corn harvest the losses decreased from 40% to 10% (with 7.8 resp. 1.5 % dry matter). In both cases the effect is due to differing infiltration: slurry with low viscosity infiltrated into the soil more rapidly and thus enabled a stronger sorption of NH_4-N. Highly viscous slurry remained on the soil surface for a longer period with direct contact to the atmosphere.
Compared with these factors the pH of the slurries (generally between 6.8 and 8.0) is not so relevant, and therefore not described here in details.

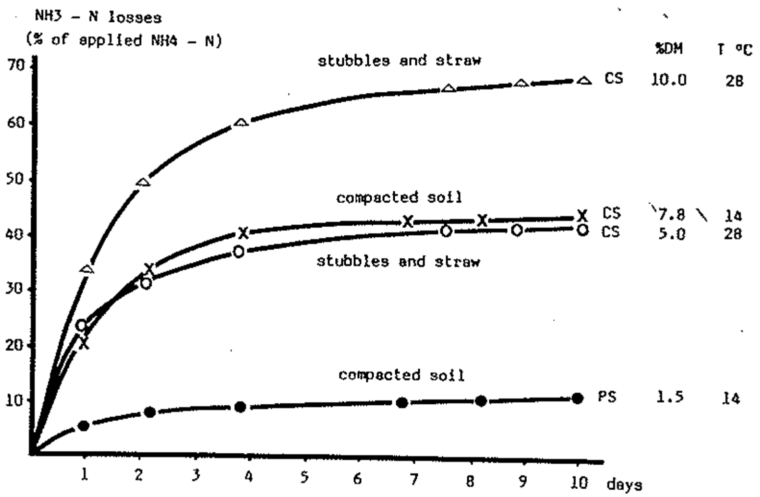

Fig. 3: Ammonia losses after surface application of cattle (CS) and pig slurry (PS) on stubbles and straw (Aug.) or compacted soil (Nov.) on silty loam (pH 6.5).

Ammonia losses as influenced by soil type and moisture

Concerning the type of soil (5) highest losses were found on the light sandy soil, lowest on silty loam again with great differences between surface applications and incorporation (fig. 4). With respect to soil moisture (fig. 5), in a dry soil (10% of total water capacity) the losses are considerably higher (5) than in a soil with 30% of total water capacity).

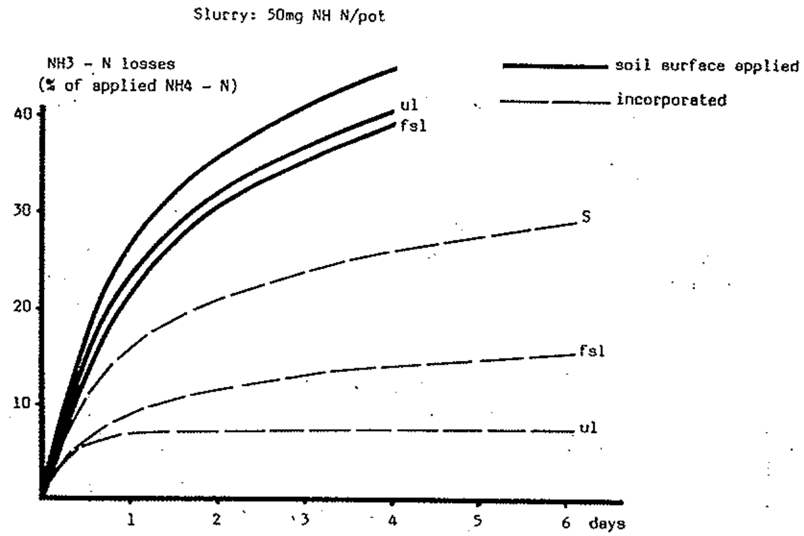

Fig. 4: Ammonia losses from slurry on silty loam (pH 6.5) fine sand loam (pH 7.3) and sand (pH 6.0) Temp. 20°C

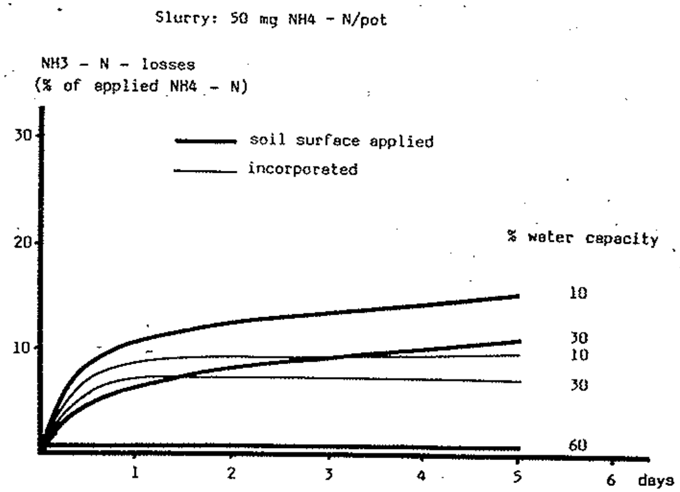

Fig. 5: Ammonia losses from slurry depending on soil moisture – silty loam, pH 6.5, 20°C

Slurry application to growing crops

One of the possibilities to use slurry in spring is the application to growing crops (4) in lower quantities (20 – 30 m^3/ha). A crop canopy with winter cereals (fig. 6) decreased ammonia volatilization by 50 % and more against surface application on a bare soil on behalf of lowering wind velocity close to the soil surface and partly also direct uptake of NH_3 by plants.

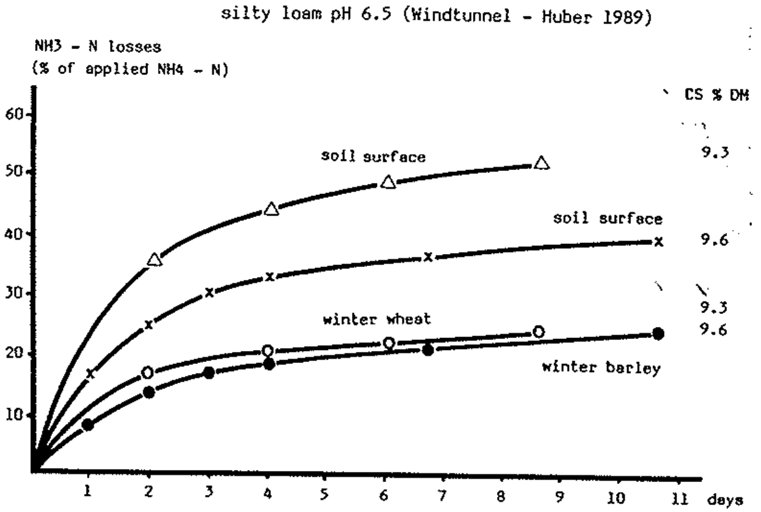

Fig. 6: NH_3 losses after spring application of cattle slurry (CS) into growing crops (winter wheat, winter barley: EC 29–32) or on soil surface resp.

Slurry application to grassland

On grassland extremely high losses (nearly 80 %) were observed after slurry application in late summer with dry and warm weather and a high dry matter content of the slurry (fig. 7). With low temperatures in winter (minimum –2°C, maximum 15°C) losses resulted to 20 % and were not very much higher than after surface application on bare land. Obviously the sod impaired the infiltration of slurry, so that less NG_{4+} could be sorbed by the soil. In this case slurry diluted with water can reduce the losses greatly.

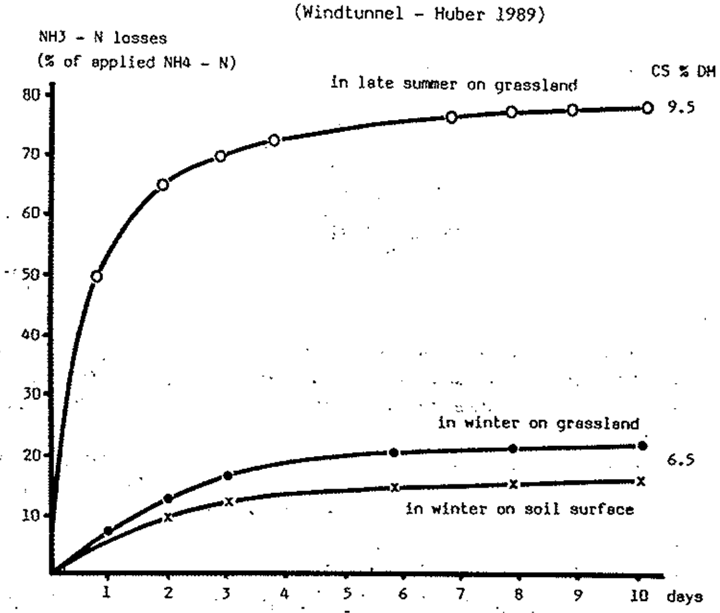

Fig. 7: NH_3 losses from cattle slurry (CS) on grassland – silty loam pH 6.5

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