MITIGAZIONE DELLE EMISSIONI DI NH_3 DA FERTILIZZAZIONE CON LIQUAME BOVINO

MITIGATION OF NH_3 EMISSIONS DUE TO CATTLE SLURRY FERTILISATION

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Abstract
Agriculture is known as the major source of atmospheric ammonia (NH_3). The strategies to reduce the emissions of this gas have become an important focus in many countries to prevent environmental issues and to reduce the loss of nutrients and energy from cropping systems. Appropriate slurry application techniques are fundamental strategies to reduce nitrogen losses. This study presents an evaluation of the best agronomical practices for reducing NH_3 emissions from cattle slurry spreading on arable lands. Two different application techniques with two incorporation procedures were assessed in four different field trials in the Po Valley. The NH_3 concentration measurements were performed using passive samplers, while a dispersion model has been used for estimating NH_3 fluxes at field scale. The best abatement strategy from slurry application has proved to be the direct injection into the soil, with a reduction of about 95% with respect to the surface spreading, while a contextual incorporation was able to reduce the emission of more than 85%.

Parole chiave
Emissione di ammoniaca, liquame, incorporazione, iniezione, distribuzione superficiale
Keywords
Ammonia emission, slurry, incorporation, injection, surface spreading.

Introduction

The environmental issues associated to NH_3 emissions in atmosphere include acidification of soils, eutrophication of water and formation of secondary particulate matter. The main global sources of atmospheric ammonia (NH_3) are related to agriculture (FAO/IFA, 2001). The storage and application of livestock manures largely contribute to the overall NH_3 volatilization (Buijsman, 1987). It is well known that the total amount of NH_3 lost from applied-liquid manure is influenced by the characteristics of manure (pH, nitrogen content, dry matter), the meteorological conditions at the time of application, the presence of canopy and soil characteristics. Therefore, the application method is one of the most important factor affecting the time of liquid manure exposure to the air, and hence NH_3 emissions.
The aim of this study was to evaluate the best application method of slurry in arable lands, for reducing NH_3 losses to atmosphere.

Material and methods

Four different field trials were set up in the Po Valley and two application methods were compared: (i) direct injection and (ii) surface spreading of cattle slurry. In particular, for what concern the surface spreading, three incorporation practices into the soil were taken into account: at the same time of spreading, 24 hours later and no incorporation.
A short description of the field trials is given in Tab. 1; the nitrogen content of the slurries is reported as percentage of the total ammoniacal nitrogen applied (TAN). The measurements were performed through the use of long term exposure passive samplers (Tang *et al.*, 2001), associated to the determination of the atmospheric turbulence by using a sonic anemometer.

Tab.1 – Principali caratteristiche delle prove sperimentali. TAN è il contenuto in azoto ammoniacale del liquame bovino
Tab.1 - Main characteristics of the trials; TAN is the total ammoniacal nitrogen content in the cattle slurry.

Acronym	*Fertilising method*	*Incorporation procedure*	*TAN [kg N-NH_4^+ ha^{-1}]*
SS	Surface spreading	no	68
SI	Surface spreading	after 24 hours (harrowing)	95
SIC	Surface spreading	immediate (harrowing)	66
INJ	Injection at 25 cm depth	after 24 hours (ploughing)	139

Data were processed by the backward Lagrangian stochastic model WindTrax (Flesch *et al.*, 2004; Carozzi *et al.*, 2013)

Results and discussions

The cumulated fluxes are reported in Fig. 1. A fast increase of NH_3 emission after the application was detected in all the field trials. The direct injection of slurry (INJ), counted a total cumulated NH_3 emission equal to 2.5% with respect to the TAN applied. The surface spreading without incorporation (SS) stated a loss of 44.4% of the TAN. The

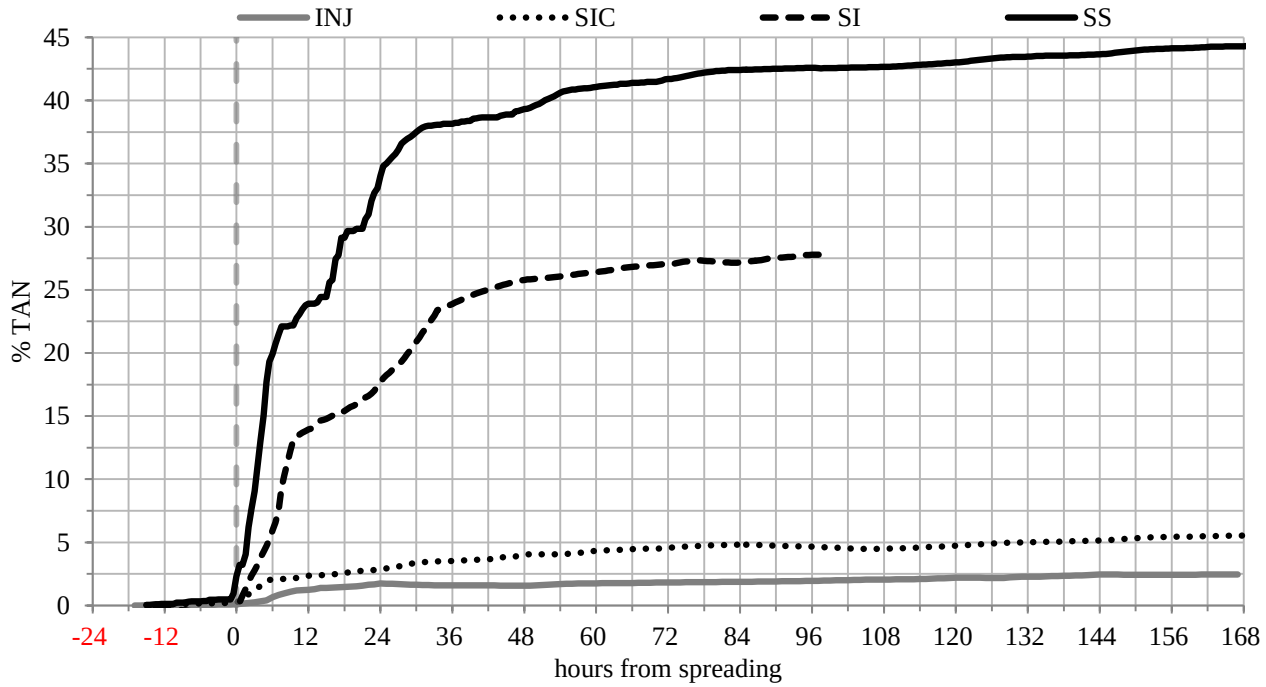

Fig.1 – Flussi cumulate di ammoniac (NH_3) come percentuale di azoto ammoniacale applicato (%TAN), ottenuti usando il modello WindTrax (si veda testo per riferimenti sul modello) per differenti tecniche di spandimento: iniezione (INJ), spandimento superficiale senza incorporazione (SS), incorporazione superficiale a 24 ore (SI), e contemporaneamente allo spandimento (SIC) .

Fig.1 - Cumulated ammonia (NH_3) fluxes as percentage of total ammoniacal nitrogen appliaed (%TAN), obtained using WindTrax model (see text for references to the model) for different slurry spreading techniques: injection (INJ), surface spreading without incorporation (SS), surface incorporation at 24 hours (SI), and at the time of spreading SIC-11).

incorporation after 24 hours of surface slurry (SI), described lower emissions, equivalent to 28.5%, while the incorporation at the same time of spreading (SIC), shown a great abatement of emissions, equal to 5.6% of TAN.

Conclusions

The method of slurry application and the incorporation procedures has shown to be efficient practices to determine the reduction of NH_3 emissions from arable land. When the incorporation follows the slurry spreading operation, the reduction of NH_3 losses are higher. In fact, when the incorporation is executed at the same time of spreading, the reduction is about 87% with respect to surface spreading. When the incorporation occurs 24 hours later, the abetment results in the order of 36%. The best abetment strategy for NH_3 emissions is obtained with the direct injection, determining a reduction of 94%. In this context, the decrease of NH_3 losses from cattle slurry contributes both to reduce the environmental issues associated to this compound, and to increase the availability of nitrogen for crop productions.

References

Buijsman, E., 1987. Ammonia emission calculation - fiction and reality. In: Asman, W.A.H., Diederen, H.S.M.A. (Eds.), Ammonia and Acidification: Proceedings of EURASAP Symp. RIVM, Bilthoven, Netherlands, pp. 13-27.

Carozzi M., Loubet B., Acutis M., Rana G., Ferrara R.M., 2013. Inverse dispersion modelling highlights the efficiency of slurry injection to reduce ammonia losses by agriculture in the Po Valley (Italy). Agricultural and Forest Meteorology 171–172, 306–318.

FAO/IFA, 2001. Global Estimates of Gaseous Emissions of NH_3, NO and N_2O from Agricultural Land, Rome: Food and Agriculture Organization of the United Nations (FAO)/International Fertilizer Industry Association (IFA), 106 pp.

Flesch T.K., Wilson J.D., Harper L.A., Crenna B.P., Sharpe, R.R., 2004. Deducing ground-to-air emissions from observed trace gas concentrations: A field trial. Journal of Applied Meteorology, 43(3): 487-502.

Tang Y.S., Cape J.N., Sutton M.A., 2001.Development and Types of Passive Samplers for Monitoring Atmospheric NO2 and NH3 Concentrations. In Proceedings of the International Symposium on Passive Sampling of Gaseous Pollutants in Ecological Research. The Scientific World, 1: 513-520