AMMONIA EMISSION FROM LAND APPLIED FARM YARD MANURE – FIRST RESULTS

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ABSTRACT

Ammonia emission were measured from land applied FYM with three air velocity conditions (1, 2 and 3 m/s) and three application rates (20, 40 and 60 Mg/ha) by means of three Open Large Dynamic Chambers. Each device is made up of a ventilated chamber (24m^2), a fan connected to a galvanized sheet iron pipe 10 m long - equipped with an internal flow conditioner-, and an air sampling system positioned at the end of the pipe. Two anemometers measure air velocity within the pipe and under the chamber. Measurements were carried out in two different temperature conditions (5-21°C - autumn season and 0-7°C - winter season). Results of the carried out trials pointed out a significant effect of air velocity on ammonia emission, while no significant effect of the application rate. Environmental temperature significantly affected ammonia emission too. Autumn ammonia losses ranged between 10% and 28.6% of the total Nitrogen spread on the soil, while winter ones ranged from 5% to 18.7%.

INTRODUCTION

Animal waste spreading represents a critical moment of their management strategy since it influences the nutrients availability for the crops (Jarvis and Pain, 1990) and it is considered as the main source of ammonia emission to air (Meisinger and Jokela, 2000). Despite the good availability of data concerning ammonia emission from land spread liquid manure, few data are nowadays available on ammonia emission generated from land applied solid manure. This lack of information especially concerns south Europe countries. Measurement of ammonia release from solids such as straw-based manure leads to a number of difficulties such as the recognition of significant local source (Phillips et al., 2000) and requires to operate with large sampling areas. With the aim to cover this gap of information, three Open Large Dynamic Chambers (OLDC) for the measurement of the ammonia emission from land applied farmyard manure were designed, developed and tested and measurement of ammonia emission from FYM were performed in two different temperature conditions (autumn and winter).

MATERIALS AND METHODS

For the measurement of ammonia emission three (OLDC) were used. Each device (fig. 1) is made up of:

A *chamber* covering a surface of 24 m^2 (length 6.0 m, width 4.0 m, height 2.4 m);

A *fan* (max. flow rate 37650 m^3/h), connected to a galvanized sheet iron pipe (∅ 1 m, length 10 m) equipped with an internal flow conditioner. Pipe and flow conditioner function is to avoid air rotation within the pipe, making homogeneous air sampling possible close to pipe outlet.

An *air sampling system* made up of a pump, a flow meter, a volume meter and an acid trap. The system collects samples of outgoing air from 15 different sampling points spread on pipe outlet;

two *anemometers*: a first one for the measurement of the air velocity within the pipe and second one under the chamber.

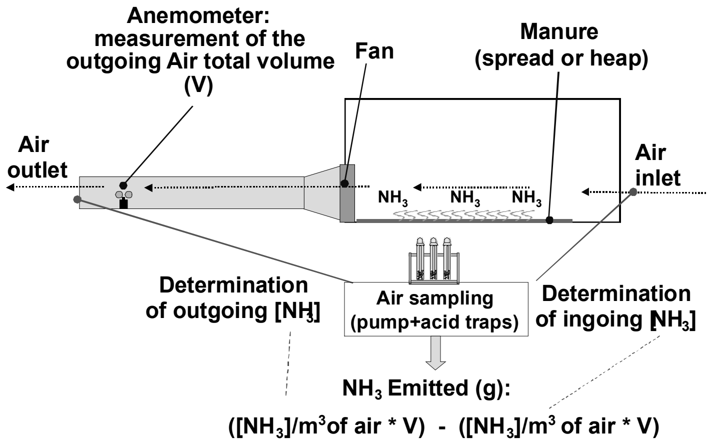

Figure 1. *The Open Large Dynamic Chamber and its working principle.*

The device allows to operate with good uniformity of air velocity on the soil surface covered by the chamber. Previous trials (Balsari et al., 2004) performed during the device setting showed that air flowing on the ground surface reaches the maximum homogeneity (CV 7% - 16%) when the area (5 m long and 2 m wide) in front of the fan is considered (fig. 2). Each OLDC allows measuring ammonia emission with three air velocities (1-3 m/s).

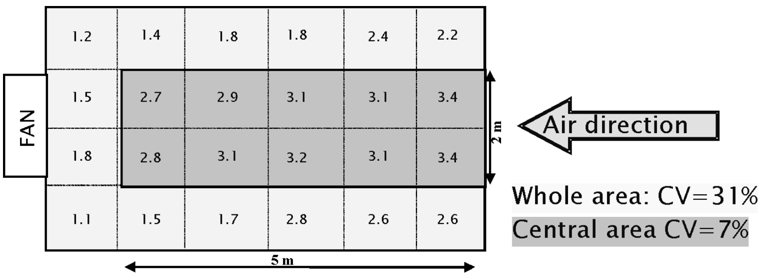

Figure 2. *Values of air velocity measured on the soil surface within the chamber.*

Table 1. *Trial conditions and FYM characteristics.*

Trial	Application rate (Mg/ha)	Air velocity (m/s)	TS (%)	pH	TKN (g/kg)
1	20	2	29	8.6	6.4
2	40	2	24	8.1	5.4
3	60	2	28	8.0	6.7
4	40	1	24	8.1	5.2
5	40	3	29	7.8	5.4
6	20	2	30	8.3	13.3
7	40	2	35	8.0	5.4
8	60	2	23	7.9	9.1
9	40	1	23	8.2	9.0
10	40	3	22	8.3	7.8

In order to assess the effect of application rate and air velocity on ammonia emission, five trials were performed in three replicates and repeated for two seasons (tab. 1). Each trial had a duration of approximately 96 hours, with four sampling of the acid traps during the first 24 hours after the spreading, and one daily sampling during the following 72 hrs. FYM used for the trials was collected from a manure heap of a dairy cattle breeding farm and immediately spread within the chamber (central area - 10 m^2) on the surface of a sandy soil (pH 8.2, TS 84.5-92.0%). Farmyard manure used for the trial was characterised by generally high total solids content and by a TKN content ranging from 5.2 g/kg up to 13.3 g/kg.

Wind speed within the chamber and environmental temperature were continuously measured during each trial. Results were analysed by factorial ANOVA.

RESULTS

Measurement of ammonia emission (tab. 2) performed both in autumn and winter conditions on land applied FYM showed that increasing air velocity within the OLDC determines a significant increase of ammonia release to air (fig. 3a). No significant effect of application rate was pointed out (fig. 3b), probably due to low temperature conditions recorded during winter trials when measuring ammonia emission with 40 Mg/ha and 60 Mg/ha (0.6 and 1.4°C respectively, versus almost 8°C recorded with application rate of 20 Mg/ha). Autumn ammonia losses ranged between 10% and 28.6% of spread TKN. Cooler temperatures of winter trials significantly limited ammonia emission from land applied FYM. In this latter case, ammonia losses ranged from 5% to 18.7% of the applied TKN. CV values, recorded during the trials, ranged between 9.1 and 26.3%, showing an acceptable repeatability of results.

***Table 2**. Main results of the trials.*

Trial	Temperature (°C)	Average air velocity (m/s)	Emission (% of applied TKN)	CV (%)
1	17.4	2.3	26.5	15.9
2	21.2	2.4	23.8	9.1
3	16.7	2.4	28.6	10.7
4	14.2	1.3	10.0	12.4
5	5.1	3.6	24.5	10.2
6	7.6	2.3	13.7	26.3
7	0.6	2.3	9.5	16.9
8	1.4	2.4	5.0	21.5
9	4.5	1.4	11.7	18.2
10	4.5	3.4	18.7	19.4

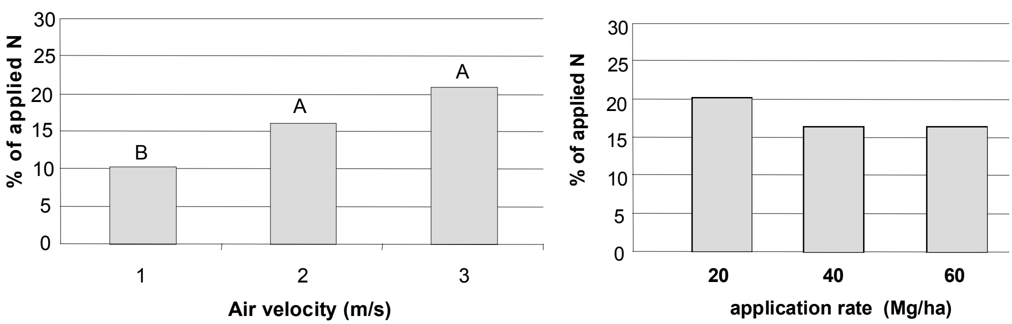

***Figure 3**. Effect of (a) wind speed and (b) application rate on ammonia emission (Tukey's test, α =0.05).*

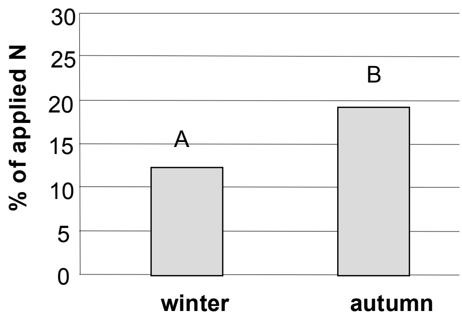

Figure 4. *Effect of environmental temperature on ammonia emission (Tukey's test, α =0.05).*

CONCLUSIONS

Nitrogen losses from land applied FYM ranged from 5% up to 28.6% of applied TKN. These results are close to those (ranging from 9% to 21%) of trials performed by other Authors (Karlsson et al., 2001) in Northern Europe in similar temperature conditions. Ammonia emission were strongly influenced by environmental temperature and air velocity. Increasing both the parameters determines an increase of ammonia losses. Air velocity effect suggests to plough as soon as possible manure after land application in windy conditions. At the moment it still isn't clear the effect of application rate on ammonia emissions, since environmental temperature recorded during the trials were too different to allow a comparison of final ammonia emission rates. Nevertheless, previous trials (Balsari et al., 1992) performed on cow slurry underlined a similar trend (ammonia emission decrease when increasing application rate). Further trials will be performed in order to understand more clearly the effect of different parameters on ammonia emission and to find the best solutions in order to reduce losses.

REFERENCES

Balsari P., Gioelli F., Airoldi G. 2004. Open large dynamic chambers for the measurement of ammonia emission from land applied farmyard manure. Proc. Greenhouse Gas Emissions from Agriculture, mitigation options and strategies. Leipzig (D), 2004, pp. 241-242

Balsari P., Bechis S., Girodengo F. 1992. First results of tests on ammonia losses along with and after the distribution of slurryin the field. Proceedings of Treatment and re-utilization of farm effluents and sludges. Lecce 10th-12th December 1992.

Karlsson S. and Tersmeden M. 2001. Ammonia emissions from storing and spreading of manure – reference measurement. LIFE – Ammonia, March, 31

Meisinger J.J., Jokela W.E. 2000. Ammonia volatilization from dairy and poultry manure. Proc. from managing nutrients and pathogens from Animal Agriculture,. Camp. Hill, PA. March 28-30, pp. 334-354

Jarvis S.C., Pain B.F. 1990. Ammonia emission from agricultural land. *Proceedings Fertility Soc*. No 298. Greenhill house, Peterborough, England, 35 pp

Phillips V.R., Scholtens R., Lee S.D., Garland J.A., Sneath R.W. 2000. A review of methods for measuring emission rates of ammonia from livestock buildings and slurry or manure stores, Part 1: assessment of basic approaches, J. Agric. Eng. Res., 77: 355-364