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A NOVEL PLATFORM PROVIDING SERVICES IN THE MEASUREMENT OF POTENTIALS FOR AMMONIA VOLATILISATION

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INTRODUCTION

Ammonia emissions from crops are a major international environmental and sanitary concern. Their prevention and mitigation require a better knowledge and quantification of sources. But ammonia emissions due to agricultural practices are highly variable and make their quantification rather difficult. At the same time, the demand in reliable characterisation of ammonia volatilisation is growing: manufacturers are formulating new N fertilisers less susceptible to volatilisation; the quantity and variety of organic products are increasing, in relation with the increasing use in agriculture of a large variety of wastes in alternative ways of waste-disposal landfill or incineration and the emergence of new products in connection with industrial processes (e.g., energy production from biomass, agrofood industries).

There was a lack of reliable method adapted to the acquisition of references on ammonia volatilisation. That is the reason why we designed a laboratory volatilization set-up aiming at precisely characterizing the ability of any soil, commercial fertilizer or organic manure to volatilize in well controlled conditions, and thus aiming at helping decision making concerning its use in field for plant fertilisation. We are now able to propose a commercial offer for potentials of ammonia volatilisation in the novel platform of INRA Transfer, at EcoSys.

MATERIAL AND METHODS

The laboratory set-up is based on the classical dynamic enclosures (Génermont et al., 2014). Volatilization is calculated following the mass balance principle: flux is the product of the sweeping air flow rate and the difference in ammonia concentration between the input and the output of the enclosure, divided by the experimental area. The originality and the advantage of this set-up compared to the existing ones are that it incorporates controls on most important parameters and has been automated for routine use.

First, the enclosure was specifically designed in order to (i) host either intact soil cores or reconstituted soils or even organic product alone and (ii) ensure the homogeneous contribution of the whole experimental surface. The substrate is contained in a 15 cm diameter ring leading to an experimental surface area of 177 cm². Height can be adjusted from a few mm to several 10 cm. Experiments and numerical simulations were performed to design the head-space, optimising mass transfers, flow fields and exchange processes in laminar flow.

Then, emission conditions are controlled. The measurement enclosures are maintained at constant temperature in a thermostated incubator. The air which sweeps the enclosures is (i) purified (3 filters), (ii) brought to chosen a moisture (steam generator) and (iii) controlled to a desired flow rate 0-10 L min⁻¹. For routine measurements, air temperature (15°C), humidity (95%) and flow rate (3.5 L min⁻¹) were chosen as a better compromise between their known influence on ammonia volatilisation variation and technical constraints: particularly, humidity was chosen close to saturation to avoid substrate surface drying and artificial volatilisation reduction.

The concentration at the output is measured by trapping ammonia in acid solution in a continuous or sequential way to reduce the interventions. The analysis of the solutions is carried out later on at the laboratory.

The tests performed on the laboratory set-up show: (i) no ammonia contamination by the materials chosen, (ii) an acid trap bubbler efficiency of 100% and (iii) a recovery of ammonia of 97% ± 5%.

Fifteen enclosures are used simultaneously to characterize 4 substrates with 3 replicates per substrate, and carry out 1 reference treatment for quality control. The duration of a measurement is of a few days to a few weeks, depending on the duration of the volatilization event, with typically 5 sampling periods.

RESULTS AND DISCUSSION

Measurements have been continuously carried out on various organic products and fertilizers from mid-2013. Ammonia volatilisation magnitude measured in the laboratory set-up is in the same order as the one measured in the field. The volatilisation dynamics is also well rendered. The set-up is well adapted to characterise various kinds of products and sort the potential of volatilisation, from very low ones (less than 1 kg ha⁻¹) to very high ones (several 100 kg ha⁻¹).

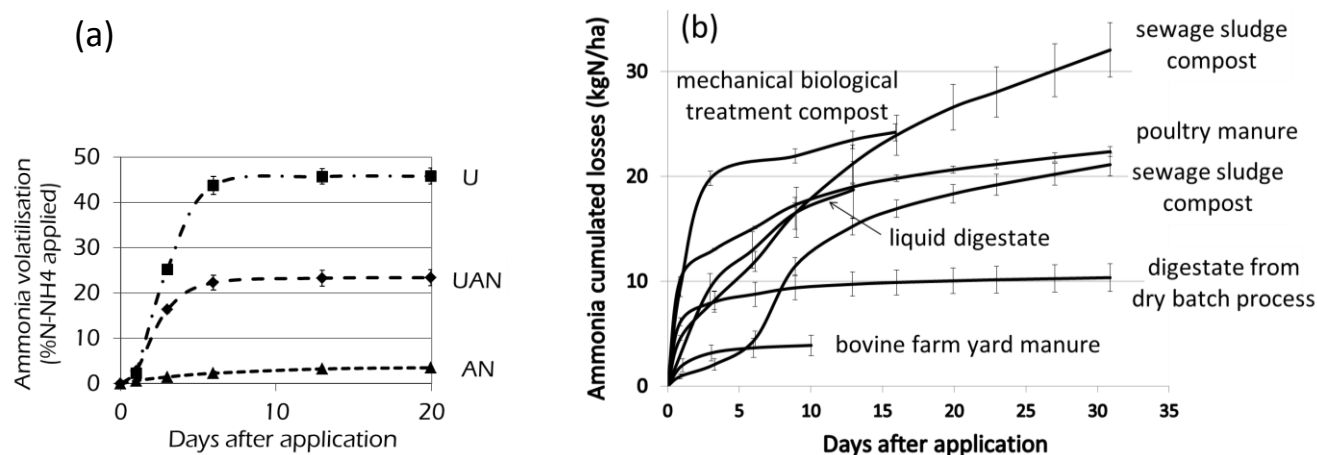


Figure 1. examples of results obtained using the laboratory set-up in case of (a) commercial mineral fertilisers on an alkaline reconstituted soil at 18°C or (b) various organic products on intact soil cores at 15°C

CONCLUSION

This set-up is thus well adapted to the objectives purchased i.e. the acquisition of references for new organic materials and mineral fertilisers. Measurements are being continuously carried out in order to produce references and typologies as regards volatilisation. The following step is to add to this set-up an integrated tool which will allow calculating the ammonia volatilisation encountered in real field conditions, useful for diagnosis, decision making and emission factor updating.

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