Evaluation of ammonia fluxes at the soil-air interface using semi-open chamber and passive sampler: an approach based on the ammonia gas diffusion

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Intensive farming is recognized as aggressive to the environment. The use of large amounts of nitrogen fertilizers contribute to losses of nitrogen compounds not only by leaching but also by the formation of volatile compounds. Global emissions of these compounds into the atmosphere are still underestimated. We describe, in this work, a method to quantify ammonia fluxes at the soil-air interface of easy and low-cost application that can help amplify measures of ammonia in different regions of the planet. Ammonia (NH_3) is the major alkaline gas in the atmosphere and plays an important role in neutralizing acids, forming ammonium salts, which are precursors of fine-particulate matter formation ($PM_{2.5}$). This aerosol has a deleterious impact on the air quality, increasing the human health risk and mortality. In this way, quantifying ammonia emissions is critical not only to recognize potential effects on the environment but also to validate the action of emission control mechanisms. In this work, a new semi-open collector chamber with passive samplers is presented. The chamber is fixed on the ground during the sampling and inside it is formed an atmosphere, containing the gases emitted by soil, in steady state. Passive samplers fixed inside the collection chamber are used to measure the composition of this atmosphere. The passive sampler for ammonia was built from commercial polystyrene monitors and cellulose filters impregnated with oxalic acid solution. The amount of ammonia was obtained by measuring the absorbance of the dye formed in solution (Berthelot Reaction). A linear behaviour was obtained between absorbance and NH_3 concentrations (linear range 1-30 μmol L^{-1}, n=3, r^2=0.9991, LOD=0.6 μmol L^{-1}, LOQ=1.0 μmol L^{-1}). The passive samplers were evaluated regarding repeatability and storage presenting satisfactory results (relative standard deviations less than 15% and signal stability until 60 days of storage). The semi-open chambers were built with passive samplers fixed on the top of transparent plastic boxes (27 x 36 x 28 cm). On each side wall of the box were opened eight holes with 2 cm diameter. Finally, the chambers were used in a sugarcane plantation area located in Gavião Peixoto (21º48'35.1"S 48˚26'38.7" W), São Paulo State (Brazil). They were installed in two random points of the plantation (n=6) and in an additional point where no fertilizer was applied to serve as control (n=3). As a source of nitrogen fertilizer, coated urea was applied at 80 kg N ha^{-1} over the soil. The sampling period was 24h during the first 10 days and 3 or 2 times a week after that. As results, intense loss of NH_3 was observed in the first 9 days after fertilizer application and no significant emissions after this period (84 days of monitoring), with a cumulative N-NH_3 loss of 0.355 g ha^{-1}. Similar value to that was predicted by measurements of ammonia gas present in the atmosphere of the region. Therefore, the proposed semi-open collector based on the ammonia gas diffusion is simple, cheap, portable and demonstrate to be able for determination of N-NH_3 volatilization losses in agriculture.