THE NH3-ABATING EFFECT OF SLURRY INJECTION AS INFLUENCED BY SOIL MOISTURE IN A SEMIARID ARABLE SOIL

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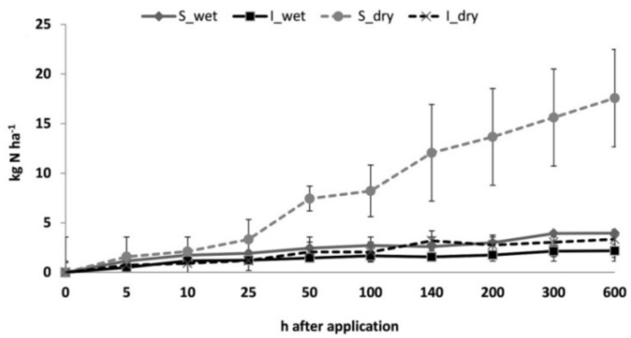
Accumulation of large volumes of dilute slurries is considered one of the major problems related to intensive farming (Sommer et al., 2004). In the EU-27, more than half of the total N excretion is applied to croplands due to technical advantages for farmers (e.g. reuse of nutrients). However, the N use efficiency of slurries produced by livestock is low, i.e. only 20-52% of the excreted N is recovered by crops. Much of the remainder can be lost into the atmosphere as ammonia (NH3), nitrous oxide (N2O), dinitrogen (N2) and nitrogen oxides (NOx). In the case of NH3, 80-90% of these emissions in the agricultural sector arise from the excreta produced by livestock (FAO, 2006). In Spain, slurries are, commonly, almost entirely surface applied to land via high-rate irrigation systems, which reduce the N fertiliser efficiency of animal slurries due to NH3 volatilization (Misselbrook et al., 2005). Research in several European countries has demonstrated that the injection of slurry, compared with surface broadcast application, may reduce NH3 emissions by as much as 90% (Misselbrook et al., 2005). Land spreading of slurries is therefore a serious concern, which also offers great potential for cost effective abatement through slurry application techniques. Some authors have reported on the influence of certain physicochemical factors such as temperature and soil moisture on the effectiveness of low emission slurry application techniques. Smith et al. (2000) suggest that soil conditions and, in particular, moisture status have important impact on NH3 emissions from applied slurries. Two field experiments were carried out on a fertilized barley (Hordeum vulgare) crop in central Spain with the main objectives of: (1) quantifying the NH3 emissions from an agricultural soil amended with pig slurry by means of a micrometeorological technique (IHF method) in a Mediterranean area; (2) comparing two application techniques (surface broadcast and shallow injection) to gain insight about the effectiveness of shallow injection as a mean of reducing NH3 volatilisation; and (3) the evaluation of the influence of soil moisture content on NH3 volatilisation and on the effectiveness of slurry injection as a mitigation method.

Materials and methods

The study was conducted in a Typic Xerofluvent in Madrid (40º 18´ 14´´ N; 3º 25´ 57´´ W) on a barley (Hordeum vulgare) crop. Some relevant characteristics of the top soil layer (0-20 cm) were: total organic matter, 1.4%; pHH2O, 8.1; bulk density, 1.47 Mg m-3; CaCO3, 3.4%; field capacity, 20.2% (w/w); porosity, 46%; sand, 37%; silt, 45%; and clay, 13%. The average annual temperature and rainfall (over the last 10 years) in this area were 13.5 ºC and 460 mm, respectively. The characteristics of the pig slurry were: total N, 3.1 g kg-1; total C, 18.02 g kg-1; DOC, 0.5 g kg-1; NH4+-N, 2.3 g kg-1; pH, 7.51 and moisture content, 98.4%. Four rectangular plots (16 m2) (i.e. two replicates per treatment) were delimited before the application of the slurry. Total volume of applied slurry was 8 m3 per plot adjusted to provide 85 kg N ha-1 as basal fertilization. Pig slurry was applied by both broadcast application and shallow injection on the 2nd November and 12nd December, for experiments 1 and 2, respectively. The micrometeorological mass balance method (Leuning, 1985; Misselbrook, 2005) was used for measuring NH3 emissions from treated plots.

Results and discussion

Ammonia volatilisation significantly peaked after slurry application in the two experiments. However, under conditions of high soil moisture (WFPS≥70%), resulting from intense rainfall (i.e. 44 mm, in the first week of November), total NH3 emitted was not higher than 4 kg N ha-1 (4.6% of the applied N). Under these conditions, shallow injection reduced NH3 volatilisation by 46% compared with surface broadcast. In contrast, results from the second experiment showed that surface application of slurry over a drier soil (13.5 mm rainfall, WFPS≤55%) enhanced N losses through NH3 volatilisation up to 17.6 kg N ha-1 (20.7% of applied N). Since soil temperature was not significantly different between the two experiments (i.e. 16.7 vs 15.8ºC, respectively), it could be concluded that the NH3-abating effect of injection was significantly affected by conditions of soil moisture, with an 81% decrease compared to surface application of the slurry. Under conditions of high soil moisture, NH4+ from the slurry would have been rapidly oxidized to NO3-, easily leached by the intense rainfall, thus decreasing NH3 losses. Additionally, as the soil was almost saturated, the effectiveness of shallow injection over the placement of the slurry in deeper zones of the soil was decreased. Under drier conditions, the injection of the slurry reduced the contact surface between the fertilizer and the atmosphere thus decreasing volatilization.



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