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Nitrogen Losses from a Clay-rich Soil used for Cereal Production in south-western Sweden

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Abstract

Addition of fertiliser nitrogen (N) in crop production increases yields and protein contents, but all is not taken up by the crop. Instead, some of the N is lost to air and waters, contributing e.g. to climate change, stratospheric ozone depletion, eutrophication and acidification. There is a need for a holistic perspective on different types of N losses, and also to include yield quantity and quality in the assessment of different mitigation options and treatments. This thesis combined the study of nitrous oxide emissions and N leaching with measurements and analysis of yields in five fertiliser treatments in cereal production. The fertiliser treatments were control (no fertiliser N added), mineral N as ammonium nitrates at two different rates (recommended and 50 % higher than recommended) and two organic N sources (biogas digestate and pig slurry). The plant available N input in organic fertilisers was between the two mineral N input rates. In the three years studied, the gap between N input and N in yield was always larger in the higher mineral N treatment, biogas digestate and pig slurry treatments than in the recommended mineral N treatment. Still, it was only the higher mineral N treatment that had significantly greater N leaching than the control, in two of the three years studied. The relatively low leaching in the organic fertiliser treatments, despite high N surpluses, appears to be an effect of ammonium fixation and adsorption to negatively charged clay particles. Emissions of nitrous oxide from the recommended mineral N treatment were close to the control, while all the three treatments with larger N surpluses had significantly higher emissions than the control. In the higher mineral N treatment, the great nitrous oxide emissions were associated with high nitrate concentrations in the drainage water. This was not the case in the biogas digestate and pig slurry treatments, and it could not be concluded whether the high emissions were driven by the addition of N, of degradable organic matter or a combination of both. However, a laboratory study on freeze-thaw related nitrous oxide emissions in the treatments with recommended mineral N rates and pig slurry indicated that the organic matter had a stimulating effect on nitrous oxide fluxes. For both N leaching and nitrous oxide emissions, post-season N losses dominated the annual budget. In relation to yield, N leaching was approximately equal from all fertilised treatments, while nitrous oxide emissions were lowest from the recommended mineral N treatment and greater for the higher mineral N, biogas digestate and pig slurry treatments. This study illustrates that, even if some circumstances, like high N access and wet conditions, in general increase the risks of both N leaching and nitrous oxide emissions, these two pathways of losses do not always go hand in hand. In this study, the discrepancy in responses was mostly an effect of ammonium fixation/adsorption and input of organic matter influencing the two pathways differently.

Keywords: nitrogen, fertilisers, soil, nitrous oxide, nitrogen leaching, ^{15}N, nitrogen use efficiency, nitrogen budget, agriculture, Sweden