Managing slurry applications to minimise nitrogen and phosphorus losses in drainage waters from clay soils

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Introduction

- An estimated 47 million tonnes of slurry supplying *c.*210 000 tonnes of nitrogen (N) and *c.*50 000 tonnes of phosphorus (P) are applied to agricultural land in the UK each year.
- On drained land, the rapid transfer of water from the soil surface to drains, via soil macropores, can lead to elevated nutrient concentrations and losses in drainage waters following slurry application.

Site details

- Brimstone Farm, Oxfordshire, UK; clay soil of the Denchworth Association (54% clay). 9 arable and 9 (arable reversion) grassland hydrologically isolated plots (40m x 48m).
- Each plot has pipe drains at 48m spacing and 90cm depth, with permeable fill to within 30cm of the surface, and secondary mole drainage at 50cm depth and 2m spacing.
- Drainflow volumes were measured continuously using v-notch weirs. Water samples were collected on a flow proportional basis and analysed for NO_3-N, NH_4-N, and total dissolved P (TDP).
- Cattle slurry (*c.*45 m³/ha, 120 kg/ha total N and 20 kg/ha total P) was applied to the arable and grassland plots in autumn (August-October), winter (November-January) and spring (February-April) in cropping seasons 2003/04, 2004/05 and 2005/06.

Results

- NO_3-N concentrations were greatest following autumn slurry applications to arable land (peak concentrations 20-30 mg/l greater than from control plots). There was no effect of slurry application timing on NO_3-N concentrations from the arable reversion grassland plots (mean concentrations below the EC 11.3 mg/l NO_3-N limit).
- The autumn slurry application timings, which were made before the soil reached field capacity, generally had no measureable effects on drainage water NH_4-N or TDP concentrations (Figures 1 & 2).
- On both the arable and grassland plots, following slurry applications in water and spring, there were large peaks in NH_4-N (greater than the Freshwater Fish Directive limit of 0.78 mg/l NH_4-N) and TDP concentrations, where slurry was applied to 'wet' soils and enough rainfall followed soon afterwards to generate drainflow.

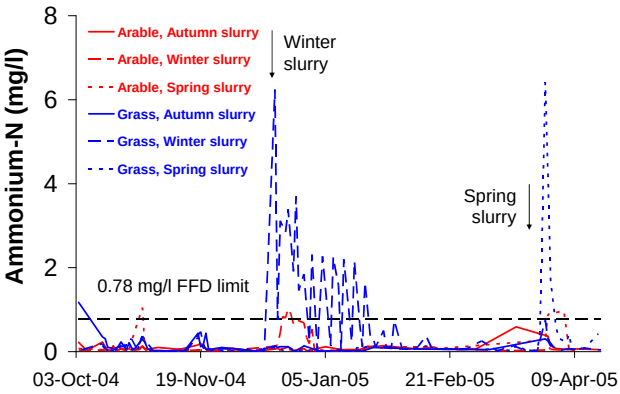

Fig 1. NH_4-N concentrations in drainage waters (2004/5)

- In 2004/05, heavy rainfall soon after both the winter (21 mm 1-2 days following application) and spring (30 mm 6-7 days after application) slurry applications to 'wet' soils resulted in peak NH_4-N and TDP concentrations of 6.3 mg/l NH_4-N and 7.0 mg/l TDP from the grassland plots, and 1.0 mg/l NH_4-N and 2.0 mg/l TDP from the arable plots (Figures 1 & 2).

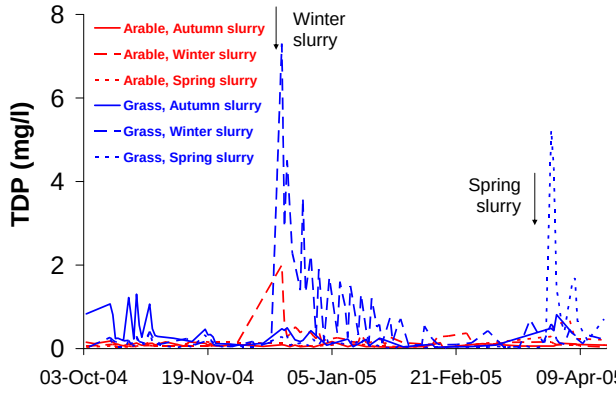

Fig 2. TDP concentrations in drainage waters (2004/5)

- The highest drainflow NH_4-N and TDP concentrations were measured where slurry was applied to 'wet' soils (soil moisture deficit <20 mm) and significant rainfall (typically >10 mm) followed, usually within 10-20 days of slurry application (Fig. 3).

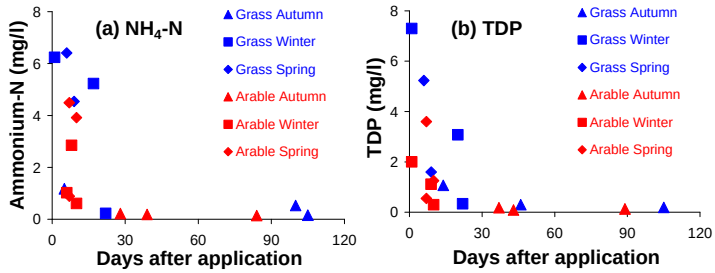

Fig 3. Relationship between peak (a) NH_4-N and (b) TDP concentrations in drainage waters and number of days after slurry application

Conclusions

- Winter slurry application timings are likely to pose the greatest risks of elevated NH_4-N and TDP concentrations in drainage waters, as during this period soils are typically 'wet', and slurry derived NH_4-N and TDP can be transported rapidly from the soil surface to field drains, via cracks/mole channels.
- Autumn and spring slurry application timings to soils with a moisture deficit >20mm (when significant rainfall does not occur in the following 10 days) are not likely to results in elevated drainage water NH_4-N and TDP concentrations.

Acknowledgements

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