Can DCD help reduce greenhouse gas emissions from Welsh soils?

Preserving and enhancing the storage of carbon in Welsh soils remains a major goal of current Welsh Government policy (e.g. through agri-environment schemes such as Glastir). However, it is also important that other greenhouse gases such as methane and nitrous oxide are not overlooked, particularly as increases in soil organic carbon storage can stimulate their release from soil to the atmosphere. The release of the powerful greenhouse gases methane and nitrous oxide would undermine the work undertaken to lock up carbon dioxide in soil organic matter. One potential technological solution to reduce nitrous oxide release from soils is the use of a chemical additive which can be applied to the soil (i.e. a nitrification inhibitor).

Nitrification inhibitors such as dicyandiamide, DCD, are applied to agricultural land with the aim of maintaining plant available nitrogen by reducing both nitrous oxide, N_2O, emissions and nitrate leaching from the soil. Nitrous oxide is a potent greenhouse gas with a global warming potential about 297 times that of carbon dioxide and agriculture accounts for about 75 % of the total UK emissions. The Welsh Government has a target of 80 % reduction of all greenhouse gases by 2050 and reducing nitrous oxide emissions from agriculture will play an important part in achieving this goal. Nitrate leached from soils can be detrimental to water quality and aquatic ecosystems and as such Welsh Government aims to reduce nitrate concentration in our water courses. DCD could play a role in mitigating these polluting nitrogen losses and in doing so potentially increase soil fertility.

What does DCD do?

Fertiliser application and animal urine both increase ammonium concentrations in the soil. This is important as it helps maintain plant-available nitrogen, but nitrous oxide can be emitted when microbes in the soil convert ammonium to nitrate - a process called nitrification. Nitrification inhibitors such as DCD limit the action of these nitrifying microbes; they decrease the microbial production of nitrate and its associated nitrous oxide emissions. Further conversion of nitrate by soil microbes can also emit nitrous oxide and, by lowering nitrate concentrations in the soil, DCD can also reduce emissions associated with this breakdown of nitrate. So DCD can reduce nitrous oxide emissions both directly, by reducing emissions from the nitrification process and indirectly, by decreasing the amount of nitrate available for further microbial breakdown. Lower nitrate concentrations also mean less nitrate might be leached from the soil.

Could DCD used effectively on Welsh soils?

There has been limited research into the effectiveness of DCD at reducing nitrous oxide emissions from Welsh soils, but studies from elsewhere in the world have shown that DCD could reduce nitrous oxide emissions from grazed pasture soils by between 30 and 80 % depending on soil conditions. It has been shown that DCD is most effective in more moist and cool soil conditions and this might suit typical Welsh soil conditions in the spring. One problem with the use of DCD is that it can lead to increased gaseous ammonia emissions although we predict that these would be relatively low. This also represents a loss of nitrogen from the soil and can have a negative impact on the environment. Studies have shown that gaseous ammonia emissions can be reduced by managing DCD application timings and methods. Another issue is that as yet no acceptable levels of DCD have been set for food standards and this could be an a problem since low levels of DCD can be traced in some foods where it has been used in the production process. Research undertaken under the Seren programme is currently evaluating the potential use of DCD in Welsh agricultural systems.

Figures for factsheet

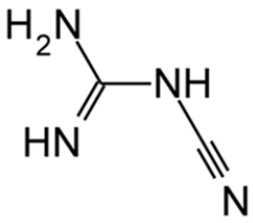

Figure 1. Chemical structure of DCD

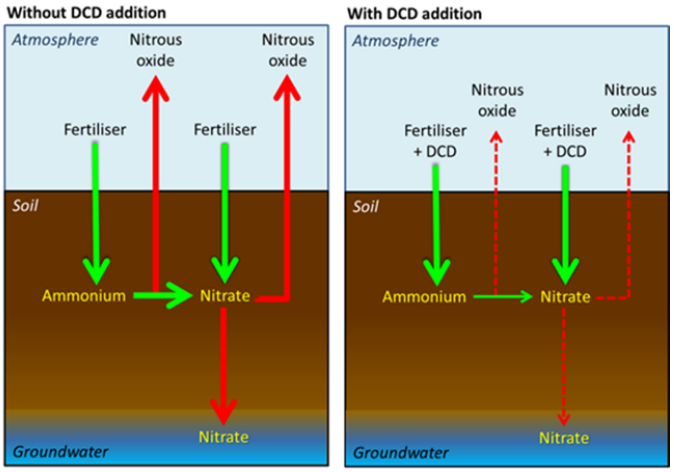

Figure 2. The left hand panel shows how nitrous oxide is produced in soil from fertiliser and how nitrate is lost to groundwater. In the right hand panel DCD has been added with the fertiliser to slow down the rate of nitrate formation either from ammonium fertiliser or from organic matter breakdown. This results in less nitrous oxide emissions and also less nitrate pollution of groundwater (a win-win scenario for farmers).