Fact sheet

LOCAL LAND SERVICES

July 2021

Wet weather and denitrification in cropping soils

Cereal grain crops require large amounts of Nitrogen (N) to produce high yields and protein. Much of the readily available N in soils is held in the Nitrate (NO_3^-) and to a lesser extent Ammonium (NH_4^+) forms. Both forms are produced from fertilizer N and the decomposition of soil organic matter (organic N). Waterlogged soils are rapidly depleted of oxygen (O_2) by soil microbes, after which denitrifying bacteria use NO_3^- as an alternative source of oxygen for cell metabolism. The series of denitrification reactions converts the NO_3^- into N gases – first nitric oxide (NO), then nitrous oxide (N_2O), then dinitrogen (N_2). Once produced, these gases escape to the atmosphere and represent a net loss of N from the soil-crop system and crops may be left with insufficient N for the original yield and protein target.

Emissions of these N gases during denitrification are difficult to measure in the field - especially emissions of N_2 against an existing background of 70% N_2 in the air. Measurements of N_2O emissions are more straightforward and have often been used as a “marker” for denitrification events, although there is no set ratio of N_2O: N_2 gases in the total of N losses by denitrification. Denitrification is also highly variable even within a paddock making it difficult to predict the extent of losses in a particular situation. What is known is that the rate at which denitrification occurs like many soil processes is dependent upon the temperature with the rate increasing with higher soil temperatures in summer. A food source (organic matter) is also required for the denitrifying bacteria. The vertosols of the northern cropping region have limited drainage, which favours the denitrification process. Lower soil temperatures at present will slow the rate of denitrification but will not stop the process. Previous research-trial observations have found that prolonged waterlogging/flooding can rapidly deplete soil N from the upper parts of the soil profile—less denitrification occurs lower in the profile due to less available organic matter and lower microbial populations at depth.

Remember that N (as NO_3^-) is highly mobile and recent rains may have moved plant-available N down the profile as well as or instead of causing denitrification. This N may not be accessed by the crop until later in the season resulting in a protein benefit more than a yield benefit. N budgeting needs to take account of deeper N reserves. However, if wet conditions continue, then crop roots may have limited access to deep N in the profile.

The only way to determine the impact of waterlogging on soil N is to soil sample in crop to the full depth of root exploration once waterlogging ceases and determine if there is sufficient N to fulfil yield and protein targets. For cereal crops that are still in early growth stages growers can then make an informed decision if additional N fertilizer is needed or justified. This decision will need to take account of several factors:

- Crop growth stage – as crops progress the yield benefit will decline as any additional N fertiliser is used by the plant to boost grain protein,
- The current high cost of N fertilizer- this will reduce the economic gains of additional N,
- Grain price and protein premiums – will also influence the profitability of additional N.

For paddocks going to summer crop there may also be value in reassessing soil N status to determine the amount and location of N after waterlogging.

More information

Click here for further information from the GRDC on denitrification. Growers are advised to seek assistance from an agronomist where required.

Or contact:

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