Nitrous oxide and viticulture

Nitrous oxide (N_2O) is one of the main greenhouse gases (GHGs) contributing to climate change. Over the past three years the AWRI has been working on a project to collect data on N_2O emissions from vineyards across Australia and to investigate the effects of different vineyard floor management practices on N_2O production.

WHERE DOES N_2O COME FROM?

THE MAJOR SOURCE of N_2O from soils is from the natural microbial processes of nitrification and denitrification (Bremner 1997). Agricultural N_2O emissions are mostly a result of the addition of synthetic nitrogen (N) fertilisers and animal manure to soil. Nitrifying and denitrifying bacteria in the soil convert nitrogen into different forms depending on the soil environment (Figure 1).

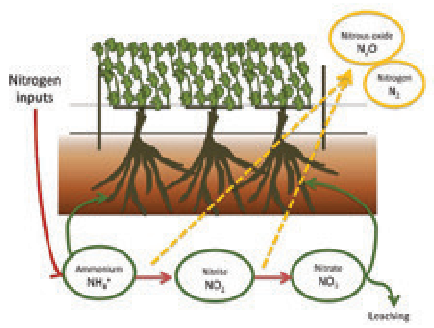

Figure 1. The nitrogen cycle in vineyards. Nitrous oxide is produced by the conversion of nitrogen in the soil.

HOW MUCH N_2O IS EMITTED FROM VINEYARDS?

Nitrous oxide emissions from the Australian vineyards studied ranged between median values of 0.6 and 9 gN_2O-N per hectare per day. These values are low compared to the typical values from other crops, e.g. dairy pasture (22 gN_2O-N/ha/day) or broccoli (72 gN_2O-N/ha/day) (Ryden and Lund 1980), reflecting the efficiency of water and nitrogen use in Australian wine-grape production.

WHICH MANAGEMENT PRACTICES CAN HELP MINIMISE N_2O EMISSIONS?

Because N_2O emissions from vineyards are very low, there is limited scope to make significant reductions. However, there may be some opportunity to reduce the total GHG emissions using alternative cover crop species or, in vineyards using high volumes of organic nitrogen, by changing management practices.

Cover crops:

Experiments at McLaren Vale, compared the use of native Wallaby grass (Austrodanthonia) grown in the vineyard midrow (Figure 2) with rye grass. N_2O emissions during the growing season (spring and summer) were found to be significantly lower from the Wallaby grass midrow cover crop than the rye grass in the same vineyard. These results suggest that the different grasses may have a differing ability to extract and use soil nitrogen and support the use of Wallaby grass as a vineyard cover crop with potential to mitigate N_2O emissions. Furthermore, the low growth habit of the Wallaby grass meant that there was less requirement for slashing compared to the rye grass. This presents further opportunity to reduce greenhouse gas emissions by using fewer tractor passes per season.

Compost use:

Many vineyard owners and managers apply compost to vineyards to improve soil nutrition, and this, like other organic amendments is also a source of nitrogen and therefore a potential contributor to N_2O emissions. At Margaret River, experiments were established to examine N_2O emissions from compost applied to a vineyard. The peak N_2O emission (800 g N_2O-N/ha/day) measured from the compost two days after application was significantly higher than any other N_2O measurement from that vineyard. This represented both a significant contribution of GHGs to the atmosphere and also an opportunity to more efficiently use the nitrogen being applied to the vines in the form of compost.

In 2014, an additional experiment was established to assess the effect of incorporating compost into the soil as a potential option to mitigate N_2O emissions. A trench was dug alongside the vine row, fresh compost was laid in the trench and it was backfilled with soil. This was compared to a bare soil control and a strip of uncovered compost located in a vine row nearby. The results of this experiment were unexpected. The N_2O emissions from the buried compost treatment were significantly higher than from the uncovered compost laid on the

Figure 2. Wallaby grass grown in the midrow of a vineyard at McLaren Vale.

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soil surface and showed major peaks on days of significant rainfall.

These results may have occurred as a result of two independent or interacting factors. When the trench was dug and the compost was covered with the backfilled soil, the increased soil surface area may have activated the soil nitrifying and denitrifying bacteria and caused the high N_2O emissions from this treatment. It is also possible that water from the rainfall events was unable to drain freely from the compost trench and that pockets of anaerobic sites in the soil remained as the soil drained. The increased activity of denitrifying bacteria in these pockets may have contributed to the higher N_2O emissions in the covered compost treatment.

The recommendation from this experiment is that when compost is applied to vineyard soils, it should occur with minimal soil disturbance to:

a) Minimise the activation of bacteria in the soil; and

b) Prevent any changes to soil drainage.

It is also critical to remember that nitrogen should be applied at the right time to maximise uptake efficiency and to prevent N_2O loss – ideally during times of active root growth. In a Mediterranean climate, this is just before flowering and post-harvest. The application of nitrogen at other times during the season will result in nitrogen leaching and loss and may also lead to higher N_2O emissions.

For more information please contact the AWRI helpdesk on (08) 8313 6600 or helpdesk@awri.com.au.

References

Bremner, J. M. (1997) Sources of nitrous oxide in soils. Nutr. Cycl. Agroecosyst. 49: 7–16.

Ryden, J.C. and Lund, L.J. (1980) Nitrous Oxide Evolution from Irrigated Land. J. Environ. Qual. 9: 387–393.