Refining deep soil nitrogen testing to reduce environmental losses

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Key points

- While there was some movement of nitrogen (N) to depth (60–100cm), the concentrations were low and likely to be accessed by plant roots in subsequent seasons.
- Under current agronomic practice there is low risk of nitrate leaching to groundwater in these soils.
- While pre-sowing sampling gives an idea of 'what is in the bank' at the start of the season, a late June sampling would better account for fertiliser applied at, or after, sowing, enabling a more precise determination of nitrogen required to achieve a target yield.
- Nutrient sampling within zones (as determined by electromagnetic [EM] surveys) can provide a more accurate understanding of nutrient requirements given variations in soil type also equate to variations in nutrient storage and movement.

Background

Many grain growers carry out deep soil nitrogen (DSN) testing annually to understand how much nitrogen is stored in the soil and how much additional nitrogen will be needed as in-crop fertiliser to meet the demands of the growing crop and target yields. This sampling is generally done by collecting multiple soil cores across a paddock down to a depth of 60–100cm and bulking the cores together into one sample to produce a single stored-nitrogen value for each paddock.

However, this approach does not provide an understanding of how potential nitrogen storage varies across a paddock, and where the nitrogen is stored in the soil (i.e. whether it is all accumulated in the top 10cm, or whether there is a bulge of nitrogen at, say, 90cm, beyond the reach of most roots and at risk of leaching to groundwater).

Furthermore, the actual timing of this deep soil nitrogen (DSN) testing can vary, as sampling can occur at sowing, late autumn, or during late winter-early spring. This variability can result in large variations in the final nitrogen test results from the laboratory. Given test results are used to calculate the amount of nitrogen fertiliser to be applied to the crop, there is potential for large over-supply of fertiliser, potentially resulting in nitrate leaching to groundwater or the production of nitrous oxide (N2O) — a potent greenhouse gas.

The *Refining deep soil nitrogen testing to reduce environmental losses* project, supported by Goulburn Broken Catchment Management Authority (CMA) through funding from the Australian Government's National Landcare Program, was conducted to better understand in-paddock variability of nitrogen supply through the season, as well as the impact of sampling time on soil nitrogen results.

Aim

This project aims to illustrate the value of considering paddock variation when sampling for nitrogen as well as undertaking depth-incremented sampling to understand where the nitrogen is distributed through the soil profile.

Method

The consistently wet weather during 2016 delayed the start of this project from 2016 until 2017, when two demonstration sites were established at Burramine and Yundool–St James in Victoria. Both sites were sampled at key stages throughout the season to determine DSN levels, nutrient movement to depth, and soil spatial variation to understand the variation in soil nitrogen in time and space.

Soil sampling occurred in locations across each site based on zones determined by electromagnetic (EM) mapping. High and low EM zones were identified at each site, with soil sampling occurring within these zones.

Sampling was undertaken during February, May, June, August and September 2017, with final post-harvest sampling taking place during January 2018.

Deep soil nitrogen sampling consisted of one core sample, split into increments (0–10, 10–20, 20–30, 30–60 and 60–100cm), and analysed for mineral nitrogen (nitrate + ammonium) and total nitrogen (includes organic and inorganic forms — i.e. the total nitrogen soil bank).

The mid-season DSN sampling was timed to coincide with the typical programs of the region's growers, who use the results to identify how much nitrogen they need to apply to meet crop demand through spring. The post-harvest samplings provide a measure of post-crop residual nitrogen, while the post-sowing sampling provides information on the amount of nitrogen lost or mineralised during the summer months.



Results

Burramine

Deep soil nitrogen testing

High nitrogen concentrations were retained in the surface soil (0–10cm depth) in the high EM zone at the Burramine site due to fertiliser input (Figure 1). However, there was more movement of nitrogen to depth in the low EM zone, especially during August–September 2017, due to the presence of lighter soils with more capacity for nutrient transfer (Figure 2). While total nitrogen levels were similar between the zones, nitrogen was more evenly distributed through the soil profile in the low EM zone.

Post-harvest sampling showed that similar amounts of nitrogen were mineralised during summer, with surface soil (0–10cm) values of around 20kg N/ha in both zones. While nitrogen levels at depth were slightly higher in the low EM zone, this represented a relatively low value of nitrate moving through. Based on related sampling in other projects, it is highly likely plant roots will pick up the nitrogen at the 60–100cm depth during the following season.

Yundool

Deep soil nitrogen testing

The Yundool site (near St James) showed lower nitrogen values than the Burramine site due to differences in fertiliser management (Figure 3, Figure 4). There was a trend to greater accumulation of nitrogen at depth at the Yundool site, particularly in the low EM zone. This suggests nitrogen can move more freely in this profile, likely due to a higher sand content in this zone (Figure 4).

Similarly to the Burramine site, the levels of nitrogen measured in the 60–100cm zone was not high and likely to be extracted by roots of the following crop.

Observations and comments

The use of EM zones for DSN testing was useful in understanding the range of soil nitrogen values across the paddock, with the different zones likely reflecting differences in soil texture. As the high EM zones are potentially associated with higher clay content, these

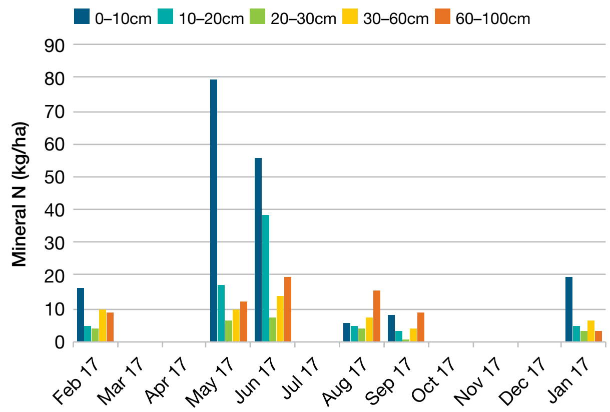

FIGURE 1 Mineral nitrogen across the season at incremented depths from the Burramine site, in the high EM zone, 2017

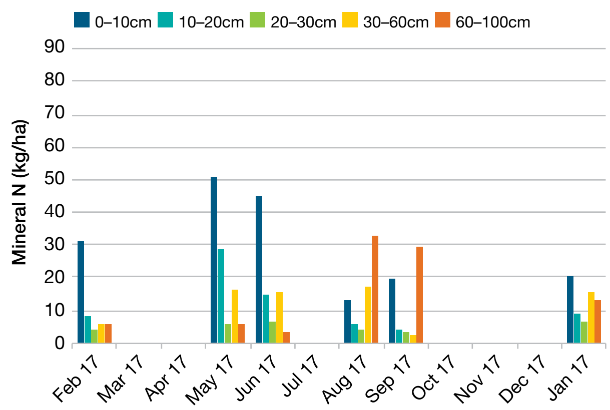

FIGURE 2 Mineral nitrogen across the season at incremented depths from the Burramine site, in the low EM zone, 2017

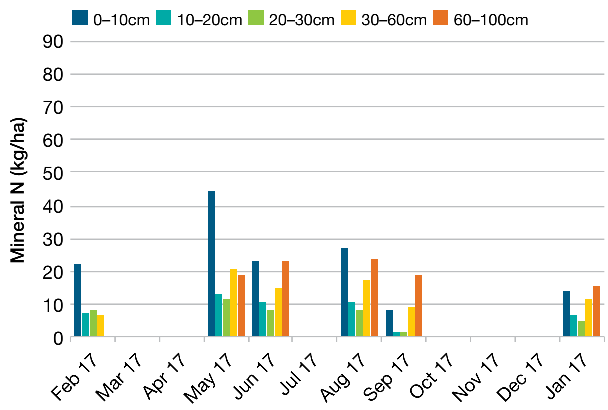

FIGURE 3 Mineral nitrogen across the season at incremented depth from the Yundool–St James site, in the high EM zone, 2017

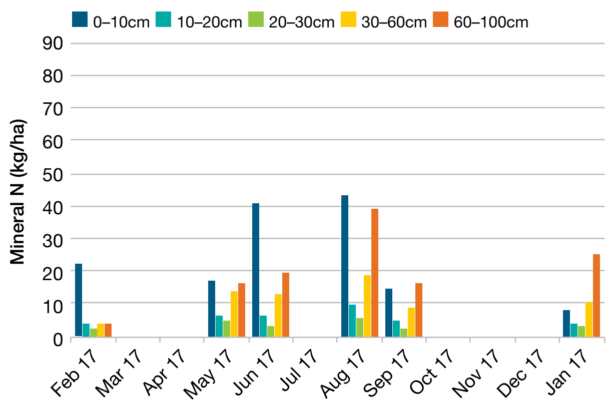

FIGURE 4 Mineral nitrogen across the season at incremented depths from the Yundool–St James site, in the high EM zone, 2017

areas will have less capacity for water and nitrate to move to depth, compared with a higher capacity for water and nitrate movement to depth in the low EM zone.

A key part of this project was to understand the likelihood of nitrate leaching to groundwater in the dryland cropping zone of the Goulburn Broken region. While only two paddocks were measured through this project, the results obtained suggest that under current agronomic practice there is low risk of nitrate leaching to groundwater in these soils.

The timing of DSN sampling has a large impact on the results obtained. While pre-sowing sampling gives an idea of 'what is in the bank' at the start of the season, a late June sampling would better account for nitrogen mineralisation through the summer and autumn, and the amount of residual fertiliser nitrogen that was applied at or after sowing; enabling a more precise determination of nitrogen required to achieve a target yield.

Acknowledgements

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