The impact of stubble treatment on soil nitrogen supply to crops

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Key points

- While significant differences in mineral nitrogen (N) values were measured between stubble treatments, these differences were small and unlikely to elicit a plant growth response.
- No consistent trends were observed between trial sites.
- Delayed plant growth and development under no-till stubble retained (NTSR) systems in the Riverine Plains region is unlikely to be due to decreased mineral nitrogen availability as a result of immobilisation.

Aims

The aim of this work was to determine if differences in the early growth and development of crops under different stubble management strategies were due to differences in early-season nitrogen (N) supply.

Background

Within the GRDC investment *Maintaining profitable farming systems with retained stubble in the Riverine Plains region (Stubble)* project *(2013–18)* (described on page 10), large-scale replicated trials were established from 2014–17. These trials have consistently demonstrated that no-till stubble retention (NTSR) treatments show a *biomass lag*, with slower early growth and dry matter (DM) production compared with treatments where stubble was removed.

As early crop establishment and growth is largely driven by nutrient supply, light and temperature, it is likely this biomass lag can be attributed to differences in these parameters. While differences in light interception and temperature were quantified within the *Stubble Project* (for light interception results see page 1220–21 and in-canopy temperature see page 3030–36), detailed nitrogen sampling throughout the season was outside the scope of this project.

In order to understand whether the measured *biomass lag* of NTSR crops was due to differences in nitrogen supply between stubble treatments, detailed nitrogen sampling was carried out at each of the Focus Farm trial sites established as part of the *Stubble Project* during 2016. This sampling showed that during the wet seasonal conditions of 2016, mineral nitrogen values were low and highly variable across stubble treatments, with no resulting differences between treatments. To establish if this lack of difference was due to the excessively wet conditions, or whether these results are representative of a 'normal' year, the sampling program was repeated during 2017.

This additional in-crop nitrogen sampling (2016–17) was carried out under the *Sustainable Agriculture Victoria: Fast-Tracking Innovation Initiative*, which has been made possible with the support of the Foundation for Rural and Regional Renewal (FRRR) together with the William Buckland Foundation.

Stubble impact

The presence or absence of stubble can impact nitrogen availability to the crop. When stubble is retained from the previous crop, it continues to be broken down by microbes and converted into soil organic matter (OM) throughout the following cropping season. As cereal stubbles are high in carbon compared with nitrogen (carbon:nitrogen ratio of 100:1), soil microbes need to 'borrow' nitrogen from the soil in order to balance their nutrient requirements while they break down the cereal stubble. This in turn can lead to nitrogen *immobilisation*, or *tie-up,* which reduces the total amount of soil nitrogen available to the growing crop.

This 'tie-up' effect is most evident early during the season when microbial activity accelerates with increased soil moisture following the autumn break.

As soil microbes break down the stubble during the growing season, they gradually release, or *mineralise*, nitrogen back into the soil.

However, if the stubble is burnt, microbes do not require soil nitrogen to support the stubble decomposition process and, as a result, more soil nitrogen is readily available to the early crop. While this may aid crop establishment and early growth, on the other hand there is no slow release of nitrogen throughout the season.

While the processes of nitrogen immobilisation and mineralisation under NTSR systems are significant, it is unknown if they result in measurable differences in nitrogen supply to crops when nitrogen fertiliser is applied through the season. This project aimed to quantify the impacts.

TABLE 1 Selected treatments from each Focus Farm, from which soil samples were collected on specified dates during July and August 2017

Coreen	Yarrawonga	Dookie
NTSR — control	NTSR — short stubble	NTSR — short stubble
Cultivated (one pass)	NTSR — long stubble	NTSR — long stubble
Burnt	Cultivated (one pass)	Cultivated (one pass)
	Burnt	Burnt
Soil sampling:		
July: 10/7/17	July: 11/7/17	July: 12/7/17
Aug: 15/8/17	Aug: 17/8/17	Aug: 14/8/17

Methods

The soil sampling was carried out on selected treatments at the Coreen, Yarrawonga and Dookie Focus Farm sites, established as part of the GRDC *Stubble Project* (Table 1). The Henty site was discontinued after the 2016 season due to high spatial variability and was not sampled in 2017.

After the initial stubble treatments were established, the host farmer managed the sites for the remainder of the season. The rates and timing of fertiliser applications at each site during 2017 are shown in Table 2.

The soil sampling was completed to 0–10, 10–20, 20–30cm depth increments during July and August 2017 in each of the four replicates of each treatment. A set of 10 subsamples was collected from each plot and combined into one composite sample per replicate.

When soil sampling was completed, soils were analysed for mineral nitrogen (nitrate + ammonium), with results analysed using analysis of variance (ANOVA) with Genstat® statistical software.

Results

July sampling

The mineral nitrogen levels varied at each site. Sampling during July showed the Dookie site had the lowest range of nitrogen values in the 0–10cm depth (Figure 1), with the cultivated treatment measuring the lowest (4kg N/ha) and the NTSR – short stubble measuring the highest (9kg N/ha).

There were significant differences in mineral nitrogen levels between treatments at the Dookie site, as indicated by the July sampling, however, given the low values involved, a plant response to this reduction in available nitrogen is unlikely.

The Coreen site did not show any treatment effect on mineral nitrogen supply at the July sampling.

The Yarrawonga site showed increased mineral nitrogen levels at the 10–20cm depth with the NTSR treatments compared with the cultivated and burnt treatments. However, the range of mineral nitrogen varied from 4.2–7kg N/ha, which is again unlikely to elicit any plant response.

August sampling

While there were differences in the amount of mineral nitrogen measured in the August sampling compared with the July sampling at 0–10cm depth, there were no consistent trends between sites (Figure 1).

The Coreen site showed increased mineral nitrogen values in the burnt treatment at 0–10cm depth compared with the other treatments, while the Dookie site showed the greatest 0–10cm mineral nitrogen in the NTSR — short stubble treatments and the least in the NTSR — long stubble treatment. No differences between treatments were measured at Yarrawonga at any depth, nor in the 10–30cm depths at the Coreen or Dookie sites.

Observations and comments

In-crop mineral nitrogen sampling during 2016 showed no difference between treatments. However, due to the excessively wet conditions of 2016, it was unclear if the lack of treatment response was an accurate reflection of the treatments imposed, (i.e. whether there was no effect, or if the wet conditions had confounded any response).

The 2017 mineral nitrogen measurements show that some treatment effects were measured at the 0–10cm depth at Coreen and Dookie, as well as at the 10–20cm depth at Yarrawonga. However, the low absolute mineral nitrogen values and the small relative change between treatments, means any effect would be unlikely to be great enough to cause a change in plant biomass and development.

TABLE 2 Rates and timing of nitrogen fertiliser applications at each of the *Stubble Project* Focus Farms

Location	Sowing (kg N/ha)	May 2017 (kg N/ha)	June 2017 (kg N/ha)	July 2017 (kg N/ha)	August 2017 (kg N/ha)	Total nitrogen (kg/ha)
Coreen	5		46 (17/6/17)	46 (10/7/17)		97
Yarrawonga	7.5			46 (2/7/17)	46 (11/8/17)	99.5
Dookie	10.5	41.4 (29/5/17)	41.1 (22/6/17)	41.4 (22/7/17)		134.7

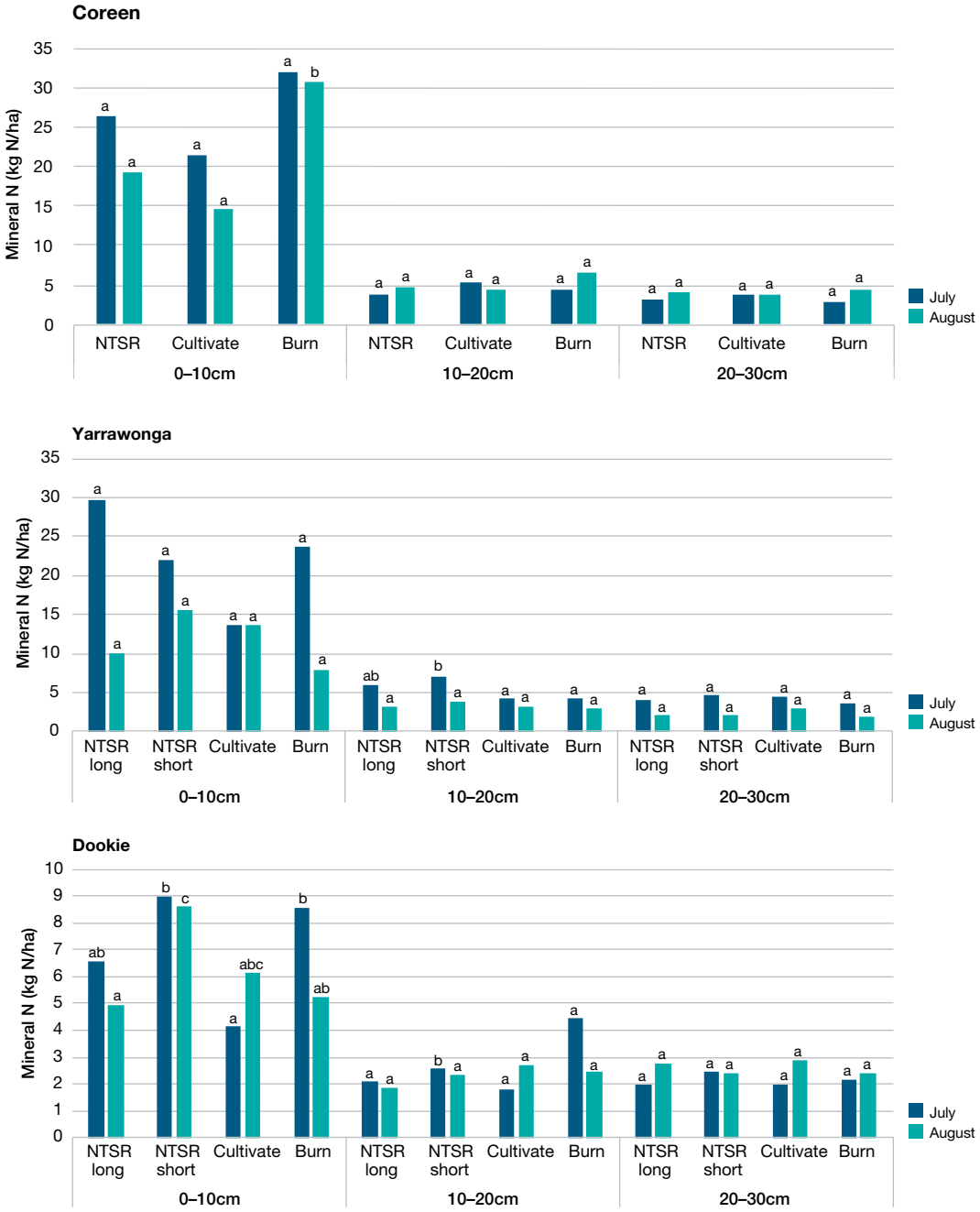

FIGURE 1 Soil nitrogen sampling at each trial site, to a depth of 0–10, 10–20, 20–30cm (July and August 2017)
Figures followed by different letters for the same sampling time, at the same depth, are regarded as statistically different.

Moreover, the aim of this work was to determine if the measured lag in early plant growth and development under NTSR systems was due to a reduction in near-surface mineral nitrogen, as a result of immobilisation of nitrogen by soil microbes as they break down stubble. For this to be the case, the mineral nitrogen measurements in the NTSR treatments would need to be consistently lower than those measured in the cultivated and burnt treatments. This was not observed, suggesting that differences in nitrogen supply was not a key driver of the measured *biomass lag* in crops sown into NTSR treatments throughout the four years of *Stubble Project* trials.

A key element of these systems is the provision of adequate fertiliser nitrogen through the season. While significant fertiliser nitrogen was applied to each trial through the season, these inputs are not reflected in the measured mineral nitrogen values, implying that uptake of applied fertiliser was relatively efficient.

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- Yarrawonga: Telewonga Pty Ltd.

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