The impact of stubble treatment on soil nitrogen supply to crops

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Key points

- Soil mineral nitrogen (N) values were low across all sites, which was indicative of the wet seasonal conditions and high nitrogen losses.
- There were no significant differences in mineral nitrogen values between the stubble treatments due to high variability (likely due to transient waterlogging across the sites).
- The project has been extended to enable the research to be repeated during 2017.

Aims

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

Background

Within the GRDC-funded project *Maintaining Profitable Farming Systems with Retained Stubble in the Riverine Plains Region (2013–18)* (described on page 10), large-scale replicated trials were established from 2014–16. These trials have consistently shown 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 was due to differences in these parameters. While differences in light interception and temperature were quantified within the GRDC-funded *Stubble Project* (for light interception results see page 18 and in-canopy temperature see page 28), detailed nitrogen sampling throughout the season was outside the scope of this project.

In order to understand if the measured biomass lag of NTSR crops was due to differences in nitrogen supply between stubble treatments, during 2016 detailed nitrogen sampling was carried out at each of the Focus Farm trial sites established as part of the GRDC funded Stubble project. This sampling effort 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 may 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.

In comparison, 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.

Methods

The soil sampling was carried out on selected treatments at the Coreen, Henty, Yarrawonga and Dookie Focus Farm sites, established as part of the GRDC Stubble Project (Table 1).

TABLE 1 Selected treatments from each Focus Farm, from which soil samples were collected on specified dates during July, August and September 2016

Coreen	Henty	Yarrawonga	Dookie
Treatment			
NTSR — control	NTSR — control	NTSR — short stubble	NTSR — short stubble
Cultivate (one pass)	NTSR + 40kg N/ha	NTSR — long stubble	NTSR — long stubble
Burnt	Mulched	Cultivate (one pass)	Cultivate (one pass)
	Cultivate (one pass)	Burnt	Burnt
Soil sampling: July: 27/7/16 Sept: 6/9/16	Soil sampling: July: 20/7/16 Aug: 29/8/16	Soil sampling: July: 15/7/16 Sept: 7/9/16	Soil sampling: July: 18/7/16 Sept: 1/9/16

After the initial stubble treatments were established, sites were managed by the host farmer for the remainder of the season. The rates and timing of fertiliser applications at each site during 2016 are shown in Table 2.

The wet conditions of 2016 limited the access to the sites and soil sampling was difficult. As a result, soil sampling was only completed to 0–10cm depth during July, and to 0–10, 10–20, 30–40cm increments during September 2016 in each of the four replicates of each treatment. A set of 10 sub-samples 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 the Minitab statistical software.

Results

i) July sampling

The mineral nitrogen levels varied at each site, with the Yarrawonga site measuring the lowest range of nitrogen values for the July sampling of the 0–10cm depth (Figure 1). While there appeared to be differences in mineral nitrogen values between some treatments (i.e. the Henty cultivated treatment), these were not statistically significant due to the high variation within each treatment (Figure 1). The high variability was likely exacerbated by the wet conditions, with nitrogen losses related to transient waterlogging and associated leaching and denitrification.

ii) September sampling

The September sampling was carried out to a depth of 40cm and revealed the low nitrogen values present in the profile last year (Figure 1). At the time of sampling, about 100kg/N ha had been applied to all crops. While crops would have taken up some nitrogen, it is likely there were high losses through leaching and denitrification. While there are trends for differences in measured nitrogen at 0–10cm between treatments at some sites, the high variability negated any significant differences.

Observations and comments

The measured nitrogen values correspond well with other soil sampling conducted across the Riverine Plains region during winter 2016. Low surface mineral nitrogen values were common, with high nitrogen losses occurring as a result of leaching through the profile (measured by increased nitrogen at 60cm, and which was also observed in the *Seasonal soil moisture and nitrogen availability* project, page 86) and through denitrification due to the saturated conditions.

While the aim of this work was to determine if differences in plant growth and development under different

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

Location	Sowing (kg N/ha)	May 2016 (kg N/ha)	June 2016 (kg N/ha)	July 2016 (kg N/ha)	August 2016 (kg N/ha)	Total nitrogen (kg/ha)
Coreen	22.9		46 (15/6/16)	36.8 (21/7/16)		105.7
Henty	8	34.5 (19/5/17)		36.8 (8/7/17)		79.3
Yarrawonga	7.5		50.6 (29/6/16)	-	41.4 (10/8/16)	99.5
Dookie	8		23.1* (16/6/16) 36.8* (29/6/16)		41.4 (9/8/16)	109.3

* Split application by farmer

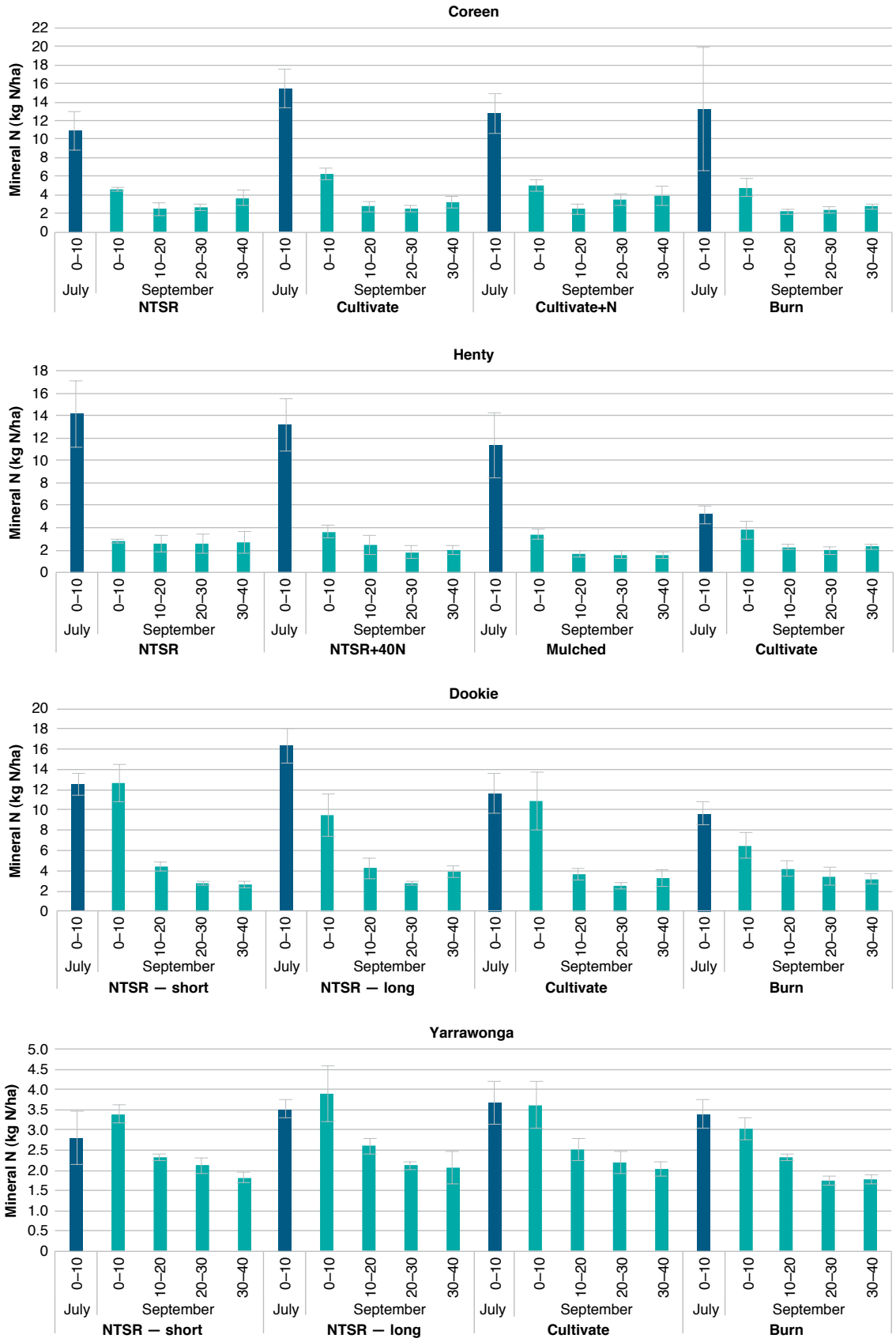

FIGURE 1 Soil nitrogen sampling at each trial site, to a depth of 0–10cm (July 2016) and 0–10, 10–20, 20–30, 30–40cm (September 2016)

Bars are measures of standard error.

stubble management regimes was due to differences in nitrogen supply through the season, the excessively wet conditions confounded the data through high movement and losses of nitrogen. Therefore, it is unclear whether the results presented truly represent treatment effects (i.e. there are no significant treatment effects), or if the results are not representative of a 'normal' year where the soil is not saturated for extended periods of time.

In order to generate more confidence around these results, this work will be repeated during the 2017 season.

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- *Dookie:* Ludeman Brothers
- *Henty:* Peter Campbell
- *Yarrawonga:* Telewonga Pty Ltd.

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