TRACING THE AMOUNT OF CROP NITROGEN COMING FROM THE PREVIOUS WHEAT STUBBLE

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Take home messages

- Only 31 per cent of the applied urea nitrogen (N) was taken up by the wheat crop in 2014. This low fertiliser use efficiency may be partly related to the season; unused N in the soil can benefit the following crop.
- In a decile 1 season, different stubble retention practices had no effect on microbial biomass and N supply potential (avg. 58kg N/ha).
- Labelling a wheat crop with 15N allows researchers to quantify the fertiliser use efficiency and trace the N from stubble to the subsequent crop.

Background

Crop residues are one of the major sources of carbon (C) for soil biota in low fertility agricultural soils in southern Australia. As a result, stubble retention can provide benefits from changes in the soil's physical, chemical and biological properties. However, the method of stubble management used by the grower could have a significant impact on the potential benefits to be gained from the activity of soil biota which influences carbon turnover, nutrient generation and subsequent availability of nutrients to crops.

Research at Horsham, Karoonda (SA) and Temora (NSW) is being undertaken as part of a GRDC project (CSP00186) which aims to improve knowledge about seasonal changes in the biological value of stubble, mineralisation, immobilisation balance (ratio) and the direct supply of N from stubble to crops as influenced by stubble management.

In 2014, BCG established a wheat trial at Horsham examining the mineralisation and immobilisation of N under different stubble management practices. To establish how much N was transferred from stubble to the following crop, 15N was applied to the trial. 15N is an isotope of nitrogen brought in from China that can be used to mark the fertiliser so that it can be traced.

Aim

To ascertain the amount and availability of N under varying stubble management practices and soil environments.

Trial details

Location:	Horsham
Soil type:	Heavy clay (vertosol)
GSR (Apr-Oct):	125mm
Crop type:	Mace wheat
Sowing date:	2 June
Seeding equipment:	Knife points, press wheels, 30cm row spacing
Target plant density:	100 plants/m^2
Harvest date:	16 November

Trial inputs

Fertiliser:	MAP @ 46kg/ha plus Granulock Supreme Z @ 34kg/ha (these rates were to balance nutrients).

Pests and weeds were controlled to best management practice.

Method

In 2014 wheat was fertilised with 15N labelled urea at sowing with 35kg N/ha and at GS32 with 35kg N/ha.

The stubble load remaining from the 2014 harvest was 4t/ha. For the standing and incorporated stubble treatments, a mixture of 15N labelled stubble and chaff was applied (in 5-10cm pieces) soon after the 2014 harvest. This was spread onto 1m^2 micro-plots at a rate of 2.5t/ha. The 15N label was used to directly measure the amount of N transferred from wheat stubble into organic matter and the crop in 2015.

In 2015, Mace wheat was sown into four key stubble treatments:

- nil above ground stubble (removed by raking off)
- standing stubble
- stubble incorporated to 10cm depth
- stubble cut low and retained on the surface

Surface soil samples were collected during the summer (2014/15), at sowing and post-harvest in 2015. They were analysed for microbial biomass and activity, mineral N and N supply potential (the amount of N that could be supplied through the combination of the mineral N pool and in-season mineralisation).

Soil and crop residue samples from the micro-plots were analysed for 15N in the mineral N, decomposing residues and total soil N pools. Crop biomass was measured during the growing season at key growth stages; first node (GS31), anthesis (GS65) and grain maturity (GS99). Grain yield and quality parameters were also measured.

Results and interpretation

Grain yield and total plant biomass data collected in 2014 indicated significant differences in the harvest index between the lower rainfall Karoonda and Horsham sites and the higher rainfall Temora site (Table 1).

Table 1. Crop performance, N uptake and N fertiliser use efficiency from the 2014 wheat crop.

Location	Yield (t/ha)			N uptake (kg N/ha)		C:N ratio stubble	Fert N uptake*
	Grain	Stubble	HI	Total	Stubble		
Karoonda	2.51	3.31	0.41	66	16	95	35%
Horsham	2.19	4.70	0.32	97	38	56	31%
Temora	3.29	8.38	0.28	142	55	57	40%

HI – Harvest Index. *Estimate of fertiliser 15N uptake which doesn't include N in roots.

Crops at all three sites experienced dry spring and grain filling periods which had a significant effect on the overall crop performance. These conditions are a probable cause of lower than expected fertiliser urea 15N recovery, especially at Horsham and Karoonda.

In 2014 the wheat crop received 41kg N/ha at early tillering. At the Horsham site, 31 per cent of the applied N (urea) was taken up by the plant. This is a reflection from the 15N micro-plots on plant, stubble and grain and does not include the roots, denitrification or what is left in the soil.

While surface mineral N did accumulate between the 2014 harvest and 2015 sowing, there were no significant treatment effects on the 2015 sowing soil mineral N values (Figure 1), even in the top 30cm of the soil profile.

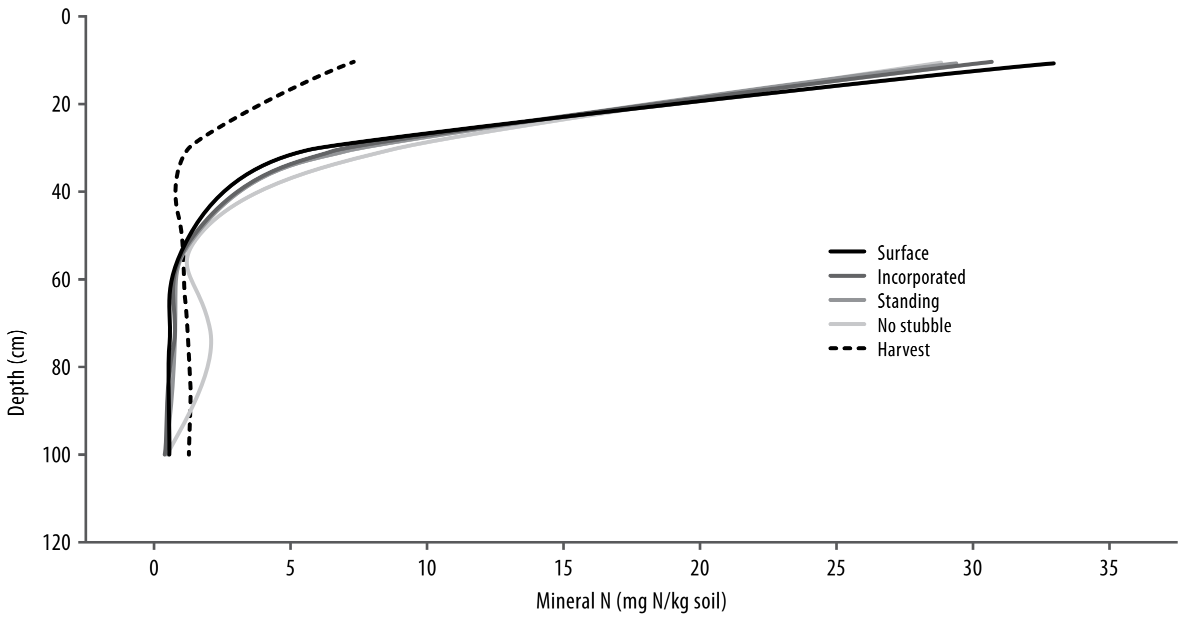

Figure 1. Soil profile mineral N to 100cm depth at harvest 2014 and at sowing in 2015 following in-fallow implementation of treatments.

Stubble decomposition during the 2014 summer was limited mainly by the less than average rainfall. Therefore the effect of stubble removal in the no-stubble treatment was not seen. In this experiment, in the no-stubble treatment, only the above-ground stubble was removed and the below ground root component would have provided sufficient carbon (C) inputs for microbial activity.

Lack of rainfall meant there were no periods in which the soil was wet for an extended time to promote biological activity. This is also reflected in the lack of treatment effect on the microbial biomass levels in soil (average 710mg C/kg soil). Similarly, there was no stubble treatment effect on the N supply potential in soils at the time of sowing (average 58kg N/ha/growing season). However, the above ground stubble in the stubble-retained treatments can provide a valuable carbon source to microbial activity and lead to associated benefits in terms of nutrient availability to the plant.

The Karoonda site experienced some differences between treatments, mainly between stubble and no stubble treatments. In Temora, where an 8t/ha stubble load was present, soil mineral N values showed differences at sowing under stubble treatments.

The nil stubble treatment consistently produced the lowest amount of biomass and, as a result, lower grain yield (Table 2). This can be attributed to moisture loss through evaporation.

Analysis of wheat plants collected at GS31 in 2015's crop showed the presence of 15N from the previous year both in the surface applied and incorporated stubble treatments. This provides direct evidence that the availability of the 15N from the applied stubble was available for the wheat crop in the 2015 season.

It is interesting that the nil stubble treatment resulted in the lowest grain yield (Table 2) in the extremely low rainfall conditions of 2015. This could be attributed to the other stubble retention based benefits related to plant health and overall nutrient availability.

Table 2. Crop biomass at first node and anthesis and grain yield and protein at maturity.

Variety	First node biomass (t/ha)	Anthesis biomass (t/ha)	Yield (t/ha)	Protein (%)
Nil stubble	0.7[c]	1.6[b]	0.24[c]	14.6
Standing stubble	1.3[a]	2.8[a]	0.50[ab]	14.2
Stubble incorporated	1.1[ab]	2.4[a]	0.44[b]	14.8
Stubble surface	1.0[b]	2.6[a]	0.57[a]	14.8
Sig. diff.	P=0.006	P=0.012	P<0.001	NS
LSD (P=0.05)	0.26	0.65	0.10	
CV%	25	25	38	5

Commercial practice

Labelling the stubble with 15N provided us a tool to quantify the amount of fertiliser N that was used by the 2014 crop and also enables us to track the release of N from the wheat stubble to subsequent crops. Analyses of soil samples for the N tie-up in soil organic pools are in progress.

This type of experiment does not result in a commercial application for growers to adopt on farm. However it is more about gaining a greater understanding of the impact of stubble management systems and the end results on the fate and potential value of N in the system. Thus enabling growers to track the fate of N fertiliser efficiency and breakdown.

Acknowledgements

This research was funded by the GRDC as part of the Maintaining profitable farming systems in retained stubble project– Component 1 project (CSP00186) and BWD00024. Thanks to Bill Davoren, Paul Adkins, Stasia Kroker, Steve Szarvis, Drew Ernakovich CSIRO for the provision of technical assistance.

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