STUBBLE TYPE EFFECT ON SOIL NUTRITION

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Take home messages

- In 2016, a Decile 10 season, stubble load had no effect on soil mineral nitrogen or soil water.
- The presence of stubble resulted in higher soil mineral nitrogen over the summer fallow period.
- Wheat yields were higher following peas or fallow than they were after wheat or canola in 2016.

Background

The presence of stubble has long proven to have beneficial effects on winter grain production, particularly in low rainfall environments. Cereal grain yields determine the stubble loads, which in turn, influence the amount of plant available moisture stored in the soil.

The presence of stubble acts as a barrier over the soil surface, harbouring soil moisture and reducing transpiration efficiency. However, in field-based experiments, it can be difficult to identify differences in soil water and nitrogen due to paddock variability; hence a large degree of sampling is required.

Stubble also provides a source of carbon and nitrogen for microbial activity in Australian agricultural soils that are typically low in organic matter, and helps to protect the soil, which in turn, leads to an increase in soil microbes.

The nutrients contained in the stubble could be a valuable food source for the following crop. In low rainfall years such as 2015, different stubble management practices had no effect on soil microbes and N supply (Gupta et al. 2015). Previous experiments, however, have not investigated the effect of different crop types and their stubble load on soil water and nutrient levels at sowing and the performance of the subsequent crop.

Aim

To determine the effect of stubble type (wheat, peas and canola) and load (from Decile 2, 5 and 8 seasons) on subsequent soil and crop nutrition.

Paddock details

Location:	Kalkee
Annual rainfall:	2015 – 148mm 2016 – 462mm
GSR (Apr-Oct):	2015 – 148mm 2016 – 374mm
Soil type:	Clay
Paddock history:	2014 wheat, 2015 wheat, peas, canola and fallow

Trial details

Crop type:	Derrimut wheat
Treatments:	Refer to Table 1
Target plant density:	140 plants/m^2
Seeding equipment:	Knife point press wheels, 30cm row spacing
Sowing date:	24 May
Replicates:	Four
Harvest date:	21 December
Trial average yield:	5.5t/ha

Trial inputs

Fertiliser:	Granulock Supreme Z + Impact® @ 50kg/ha at sowing	
	19 July	25kg/ha of urea applied at GS13
Herbicide:	24 May	Triflur X® @ 1.5L/ha + Sakura® @ 118g/ha + Roundup PowerMAX® @ 2L/ha
	7 July	Lontrel® @ 100mL/ha + MCPA LVE @ 350mL/ha + Velocity® @ 670mL/ha + Uptake™ @ 0.5%
	9 September	Paradigm® @ 25g/ha + MCPA LVE @ 600mL/ha + Uptake @ 0.5%
Insecticide:	9 September	Fastac® @250mL/ha + Lorsban® @200mL/ha + BS 1000 @ 0.25%
Fungicide:	27 September	Prosaro® @ 300mL/ha + BS 1000 @ 0.25%
	10 October	Prosaro @ 300mL/ha + BS 1000 @ 0.25%

Seed treatment/inoculant: Raxil®

Weeds, pests and diseases were managed according to best management practice.

Method

The trial was sown using a complete randomised block trial design. The trial was set up in 2015 with wheat, peas and canola plots sown and chemical fallow plots established. Yields in 2015 were: wheat 0.6t/ha and canola 0.1t/ha. The peas were unable to be harvested in 2015.

The density of the three crop types were the same between plots. Additional 'nursery' plots of each crop type were sown for the purposes of stubble collection to later simulate stubble loads produced by Decile 2, 5 and 8 seasons. Crop yields were estimated based on production that the respective Decile year and then multiplied by 1.5 to calculate stubble produced.

Stubble measurements were undertaken to determine how much stubble (kg/ha) remained on the plots. The difference between what remained and what would be produced under the Decile season being simulated was achieved by collecting stubble from the 'nursery' plots and spreading on the appropriate plots according to the trial design (Table 1).

The stubble loads were concentrated in four metre sections in the middle of each 12 metre plot and held down by wire mesh from 14 December 2015 through the summer fallow period.

Stubble samples were taken on May 3, 2016 and tested for carbon to nitrogen ratio (results not available at the time of publication).

Prior to sowing (May 16), two soil cores per plot (segmented into layers – 0-10, 10-40, 40-70 and 70-100cm – to a depth of one metre) were collected and analysed to determine soil moisture and nitrogen. The trial was then sown to Derrimut wheat.

In season assessments included emergence counts, tissue tests at mid-tillering (GS22), NDVI at flowering (GS65) and biomass cuts at maturity (GS92).

Biomass data was analysed using a general ANOVA and the soil data was analysed using a REML (residual maximum likelihood) due to an unbalanced design analysis in GenStat.

Table 1. 2015 crop type, Decile year and amount of stubble added to the plots.

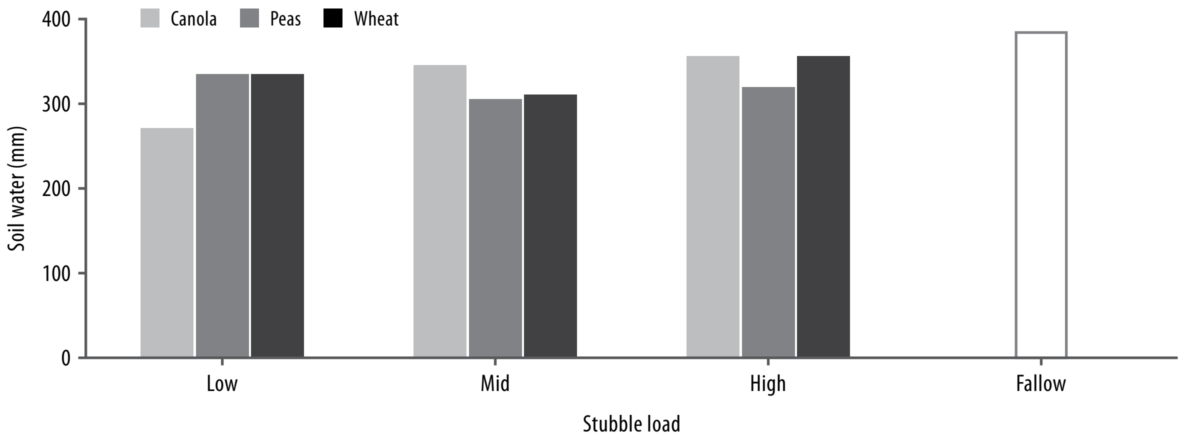
2015 Crop type	Decile year being simulated	Stubble load	Expected stubble load, produced in a Decile year (t/ha)	Stubble added in Dec 2015 (t/ha)
Fallow				
Wheat	2	Low	3.5	Nil
Wheat	5	Mid	5.3	2.1
Wheat	8	High	7.6	3.6
Peas	2	Low	1.9	Nil
Peas	5	Mid	3.2	1.0
Peas	8	High	4.7	2.0
Canola	2	Low	1.9	Nil
Canola	5	Mid	2.9	1.1
Canola	8	High	4.2	2.0

Results and interpretation

During the summer fallow period (December 2015 to May 2016) the site received 102mm (Decile 9) of rain. As 2015 was a Decile 2 growing season, there was no difference in soil water in December 2015.

Pre-sowing soil moisture results (Figure 1) showed higher soil water under the fallow treatment than there was under the different stubble treatments (P=0.045). The 'low canola stubble load' treatment returned the lowest soil water data but no systematic stubble load effects were observed from the other stubble types (REML P=0.201).

Figure 1. Soil water May 2016 for different stubble types and stubble loads. (Fallow was not compared statistically and is just for visual).



Mineral nitrogen in the soil profile following the summer period differed under the four stubble treatments. The pea, wheat and canola treatments had higher amounts of soil nitrogen with 159kg N/ha, 211kg N/ha and 128kg N/ha, respectively (Table 2). The fallow only had 99kg N/ha.

The stubble load did not affect soil profile mineral N levels at sowing.

These results indicate that crop stubble provided a source of energy for microbial functions better than the fallow resulting in greater N mineralisation during summer irrespective of residue quantity.

The increased N mineralisation under the wheat stubble could be attributed to the higher amount of stubble added. This would have provided a critical carbon source for microbial activity for longer periods, in particular after the Decile 2 cropping season.

Soil water

Table 2. Soil nitrogen and water in May 2016 (pre-sowing) to one metre depth. Soil water is presented as total water in the soil and not plant available water. Analysis for this data is a REML (residual maximum likelihood) as design was unbalanced.

Crop type	May 2016 soil N (0-100cm) (kg N/ha)	May 2016 water (0-100cm) (mm/ha)
Wheat	211[a]	332
Peas	159[a]	317
Canola	128[a]	316
Fallow	99[b]	383
Sig. diff.	P=0.015	NS (P=0.085)
LSD (P=0.05)	0.22	0.09

Note: Letters next to average values indicate significant differences based on LSD values for specific comparisons.
(Note: CV is not produced in a REML analysis).

An average of 145 plants/m^2 emerged in the trial and no differences between the stubble treatments occurred. The unexpected even emergence despite the high stubble load in some treatments could be attributed to possible stubble losses over the fallow period due to the wire mesh not fully holding down the concentrated stubble. There were no seeder blockages at sowing time through the various stubble loads.

Wheat biomass taken at flowering (GS65) showed significant differences between stubble type (Table 3). Wheat grown over the pea treatment produced the highest amount of biomass which was attributed to its higher amount of soil N at sowing (135kg/ha).

The trial only received 25kg/ha of urea (18 July) so the majority of the plant growth from nitrogen supplied by the N mineralised from the pea stubble and soil organic matter.

Stubble load did not show an interaction with previous stubble type on total biomass at flowering or harvest assessments (Table 3). This finding is reasonable, due to the fact that over the summer period there may have been some stubble loss. This potential stubble loss means that the nitrogen coming from the stubble did not reach its optimum.

Table 3. Wheat biomass from previous crop type and stubble load at flowering (GS65) and at harvest (GS99).

Crop type and stubble load	GS65 biomass (t/ha)	GS99 biomass (t/ha)
Canola low	6.7	12.9
Canola mid	7.2	11.2
Canola high	5.8	12.5
Fallow	7.1	13.4
Peas low	7.5	13.5
Peas mid	7.6	13.1
Peas high	8.6	13.6
Wheat low	5.7	10.6
Wheat mid	5.7	11.4
Wheat high	5.7	9.9
Sig. diff.	P<0.001	P<0.001
LSD (P=0.05)	1.2	1.5
CV%	12.1	8.8

The mean wheat yield in 2016 was 5.6t/ha. Irrespective of stubble load, wheat grown after peas yielded higher than wheat on wheat and wheat on canola (Figure 2). Similarly, wheat grown after fallow yielded the same as peas. Stubble load had no effect on grain yield (P=0.297, data not presented).

The fallow treatment and the pea stubble contributed an additional 1.4t/ha and 0.9t/ha of yield, respectively. Stubble loads did not impede emergence or help the crop get out of the ground faster. It is possible that the Decile 9 season that followed the Decile 2 season meant that the stubble residues added were not large enough for such differences to be observed.

These trends around cropping sequences follow similar trends from previous research (Browne, Hunt and McBeath 2011) which showed that wheat yields increased for up to two years after a break crop.

Grain protein was low in this trial as only 25kg N/ha was applied in season to assess the true effects of the stubble on soil N and moisture retention following the previous crop type. Fallow and peas had the highest grain protein, due to more N being available in the soil and subsequently converted into protein. Wheat and canola proteins were the same, however the mean protein was seven per cent – a result of the high grain production year (meaning all treatments were too low for APW grade).

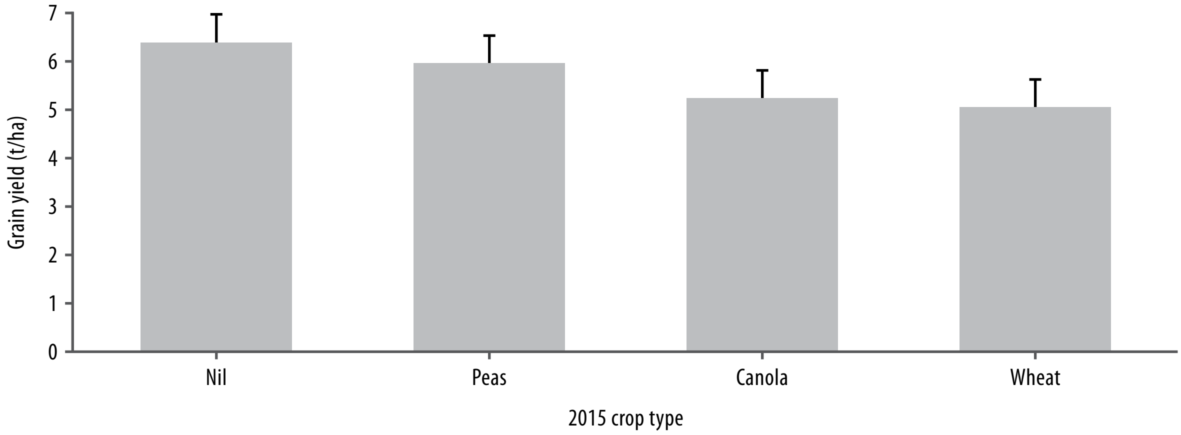


Figure 2: Mean grain yield (t/ha). Stats: Crop type P=0.002, LSD=0.57t/ha, CV=6.3%, crop type x stubble load NS, P=0.297.

Commercial practice

The results found that the presence of stubble resulted in higher soil nitrogen prior to sowing in 2016. However, stubble load (high, mid and low) did not alter the soil nitrogen and did not affect final grain yield in 2016.

In a Decile 10 season, following a Decile 2 season, summer stubble load had no effect on pre-sowing soil water and nitrogen. Stubble management starts at harvest time and the stubble height is particularly important for the subsequent crop type (ie. lentils and chickpeas prefer a taller stubble to act as a trellis).

On-farm profitability

The additional mineral nitrogen from the stubble presence over summer meant an extra 60kg N/ha from the pea stubble compared to the fallow. Using a 2016 urea price of $412/t, this results in extra $54/ha (worth of soil mineral N). In essence, it is a twofold effect – increased N and then supplementary nitrogen available.

The load of stubble is not an issue but how well you spread the stubble is an important factor, beneficial to handling and subsequent nitrogen management.

References

Browne C, Hunt J and McBeath T., 2011, *2011 BCG Season Research Results*, 'Break Crops for the Mallee' pp27-32.

Gupta V.V.S.R., McBeath T., Browne C. 2015, *2015 BCG Season Research Results*, 'Tracing the amount of Nitrogen coming from the previous wheat stubble' pp97-100.

Acknowledgements

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