STUBBLE NUTRIENT LOSS FROM SUMMER RAINFALL

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TAKE HOME MESSAGES

- Rainfall over the summer fallow period will cause nutrient leaching from stubbles.
- Stubble crop type determines initial value of stubble and what may be leached due to rainfall.
- It is important to consider other loss pathways such as microbial breakdown and volatilisation as well as leaching when calculating stubble nutrient value following the summer fallow period.

BACKGROUND

There is a long history of measuring the influence of microbes on the 'tie-up' (immobilisation) and/or release (mineralisation) of nutrients when large stubble loads are retained. However, there is not as much understanding about the transfer of nutrients from stubble following rainfall by means of leaching. When stubble is retained on the soil surface in no-till systems which are becoming more widely adopted, there is less physical contact with the soil and subsequently, the microbes that are present in soils. For this reason, it is important to understand the role of water in the movement of nutrients from retained stubble.

Nutrients will differ in their mobility in soil and water. Often, growers in the Wimmera and Mallee will receive isolated thunderstorms during summer, which begs the question how will this change nutrient availability from stubbles following a summer fallow period, and thus management in the coming season?

A simple pot trial conducted by BCG in 2015 showed that following a rainfall event on stubble there was a substantial amount of nutrients washed through wheat stubble to be found in the water located in catchment buckets beneath. This has prompted further investigation to determine whether a better understanding of the interaction between rainfall and nutrient availability/cycling in different stubble crop types for growers and advisers could be developed.

Birchip historical rainfall data defines a decile 1 summer fallow rainfall as 14mm over the January to March (inclusive) period, decile 5 as 55mm and 9 as 123mm. This spread in rainfall amounts could have a significant impact on the amount of nutrients washed out of stubble on to the soil surface. Understanding this nutrient movement for different crop type stubbles may aid in decision making for stubble management at harvest and sowing around the potential for stubble to contribute to the nutrition of subsequent crops.

AIM

To determine the nutrient loss from stubbles of various crop types following summer rainfall.

TRIAL DETAILS

Stubble crop types:	Wheat, canola and field peas
Treatments:	Refer to Table 1.
Stubble load:	Equivalent to 1t/ha per treatment
Stubble collection date:	Canola and peas - 8 November 2017, wheat - 14 November 2017
Replicates:	Four
Watering dates:	11, 15 and 18 December 2017

METHOD

A completely randomised trial was run in Birchip with treatments arranged in a circular design equidistant from a central sprinkler. Stubble was collected at maturity, heads and pods removed and dried at 70˚C for 48 hours. Stubble was weighed to the equivalent of 1t/ha and placed on top of a catchment bucket in a mesh casing. Rainwater was pumped to the sprinkler setup to water all treatments at a rate of 6mm per hour. Three rainfall events were simulated with treatments receiving the determined amount of rainfall according to their treatment (decile). The first 'rainfall' event was 14mm (decile 1), the second 41mm (remaining to reach decile 5) and the final event was 68mm (remaining required to reach decile 9). Stubbles were air dried between events. Analysis of water and stubble was carried out according to standard lab procedures.

Table 1. Treatment outline. Each crop type had decile 0, 1, 5 and 9 amounts of 'rain' applied over 0, 1, 2 or 3 'rainfall' events respectively.

Crop type	Rainfall amount (decile)	Rainfall amount (mm)
Wheat (Yitpi)	0	0
Canola (Hyola 474)	1	14
Field peas (Kaspa)	5	55
No stubble	9	123

RESULTS AND INTERPRETATION

Water results

What was captured in runoff?

Runoff, captured in buckets below stubble showed a general trend that more rainfall results in more nutrient loss (Table 2.). Although dependent on a number of other factors including soil type and microbial activity, some of these nutrients may become available to plants in the years to follow.

When it comes to the different crop type stubbles tested, the nutrient concentration was lowest in wheat stubble runoff, likely the result of having lower initial nutrient levels. Canola runoff had the highest sulphur concentration, while peas had the highest phosphorus runoff concentration matching higher respective initial stubble concentrations of sulphur and phosphorus. All crop types leached more phosphorus from decile 5 and 9 rainfall compared to decile 1. Potassium levels were higher in runoff than any other nutrient tested and this was consistent across all three stubble types (Table 2).

Nitrogen (ammonium and nitrate) concentration of runoff was significantly higher from pea and canola stubble when compared to wheat stubbles (Table 2). The amount of rainfall did not influence the concentration of nitrogen in runoff which suggests that the majority of nitrogen that is going to be lost from stubble will be washed out in the first rainfall event.

Sulphur and potassium results showed a significant interaction between crop type and rainfall decile with canola stubble losing more sulphur with each rainfall amount. Potassium leached from all crop type stubbles was significantly more from decile 5 and 9 rainfall than decile 1 (Table 2).

Table 2. Nitrogen, phosphorus, sulphur and potassium concentration (mg/L) of catchment water (runoff) under different stubble crop types and rainfall amounts (decile). * LSD calculated from transformed data.

Stubble crop type	Decile	Nitrogen (mg/L)	Phosphorus (mg/L)	Sulphur (mg/L)	Potassium (mg/L)
Wheat	1	0.1	0.1	4.8^{abcd}	133.6^{b}
	5	0.1	0.2	7.8^{bcde}	203.9^{c}
	9	0.1	0.2	9.3^{def}	234.2^{cd}
Pea	1	8.2	3.4	8.0^{cde}	318.0^{e}
	5	18.2	5.6	12.7^{ef}	457.4^{f}
	9	19.1	5.9	14.5^{f}	499.1^{f}
Canola	1	13.2	0.7	36.6^{g}	271.5^{de}
	5	9.3	1.2	57.4^{h}	451.5^{f}
	9	17.7	1.2	66.7^{i}	514.8^{f}
No stubble	1	0.1	0.0	1.2^{a}	2.8^{a}
	5	0.1	0.0	2.3^{ab}	5.6^{a}
	9	0.4	0.0	3.1^{abc}	7.8^{a}
Sig. diff.					
Crop type		P<0.001	P<0.001	P<0.001	P<0.001
Decile		NS	P=0.007	P<0.001	P<0.001
Crop type x decile		NS	NS	P<0.001	P<0.001
LSD (P=0.05)					
Crop type		*0.23	*0.06	3.22	37.38
Decile		*0.2	*0.05	2.79	32.38
Crop type x decile		*0.4	*0.11	5.57	64.75
CV%		52	26.5	20.8	17.5

Stubble results

What is the value of stubble after summer rain in different seasons?

Total nitrogen remaining in the stubbles following the rainfall events only differed between crop type and not rainfall amount, supporting the idea that the majority of nitrogen is leached from the stubble during the first rainfall event (Table 3).

Phosphorus levels were highest in pea stubbles and lowest in wheat. There was less phosphorus in pea stubble following decile 9 rainfall compared to no rainfall or a decile 1 rainfall amount (Table 3).

Table 3. Nitrogen and phosphorus (kg/t) in stubbles of three crop types following exposure to different amounts (decile) of simulated rainfall. *LSD calculated from transformed data

Stubble crop type	Amount of rainfall (decile)	Nitrogen (kg/t)	Phosphorus (kg/t)
Wheat	0	3.05	0.20
	1	2.90	0.21
	5	3.95	0.22
	9	3.10	0.18
Pea	0	10.33	0.70
	1	9.40	0.64
	5	9.75	0.56
	9	9.08	0.53
Canola	0	6.45	0.30
	1	5.78	0.30
	5	5.05	0.24
	9	4.65	0.20
Sig. diff.			
Crop type		P<0.001	P<0.001
Decile		NS	P=0.012
Crop type x decile		NS	NS
LSD (P=0.05)			
Crop type		0.95	*0.0599
Decile		1.17	*0.0691
Crop type x decile		19.06	*0.1198
CV%		21.7	3.4

Potassium and sulphur levels remaining in stubbles after different rainfall amounts are a reflection of the trend found in runoff concentrations. With greater rainfall, more sulphur is lost from canola stubbles. Potassium remaining in the stubbles was significantly lowered by increasing rainfall amounts (Figure 1).

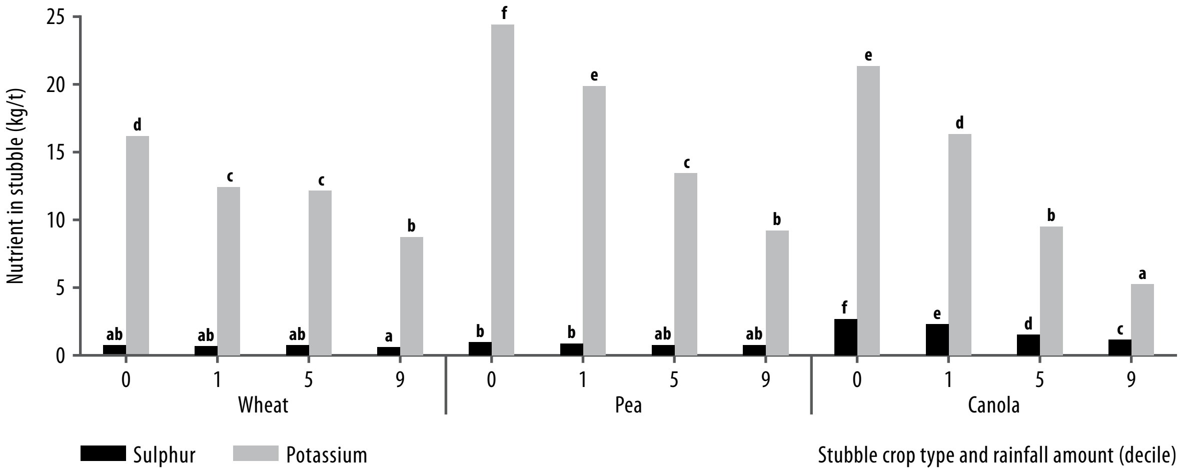

Figure 1. Sulphur and potassium (kg/t) remaining in stubbles following simulated rainfall events (deciles). Stats: Sulphur crop type x decile P<0.001, LSD=0.22, CV=14.7%. Potassium crop type x decile P<0.001, LSD=2.4, CV=11.9%.

What about the rest?

This research is helpful in gathering an understanding of nutrient movement through stubbles as a result of rainfall. The duration between harvest and sowing will see some stubble breakdown and nutrient loss via other pathways without any rainfall. As this experiment was carried out over a short time period, this needs to be noted. Nitrogen (including ammonium and nitrate) is the most volatile of those nutrients tested. These values are likely to be highly variable following longer periods of exposure.

COMMERCIAL PRACTICE

This research gives an indication of the trends of nutrient loss from summer rainfall events. Understanding the value of your stubble at harvest and following summer rainfall can help with management decisions at these times.

The first step to understanding the value of stubbles is to know how much stubble is present. This can be calculated from the below equation:

Amount of stubble (t/ha) = grain yield (t/ha) / harvest index

Harvest index refers to the grain produced by a crop as an index of the total biomass. It is seasonally dependant but general harvest index values are listed below (Table 4).

Table 4. Average harvest index for different crop types. This will differ between seasons but is given as an indication.

Crop type	Average harvest index
Wheat, barley, lentils	0.4
Canola, field peas	0.3

Once stubble load has been estimated, calculations can be made to estimate the value of that stubble. Using the results of this experiment as an example, the value of wheat, pea and canola stubbles following a decile 5 amount of rainfall was calculated using an average stubble load for the Mallee (Table 5).

Table 5. Example potential nutrient value of stubbles calculated from average yields in a Mallee following decile 5 summer rainfall. *Caution: these values were calculated from stubble from one paddock in one year. Values will vary dependant on a number of factors including in-season management, seasonal conditions and soil type.

Crop type stubble	Average grain yield (t/ha)	Estimated stubble load (t/ha)	Total N (kg/ha)	Phosphorus (kg/ha)	Sulphur (kg/ha)	Potassium (kg/ha)
Wheat	2.5	6.25	24.68	1.38	4.38	75.63
Peas	1.5	5.00	48.75	2.80	3.40	67.15
Canola	1.0	3.33	16.82	0.80	4.76	31.40

These values can help to understand the nutrient value of stubbles following summer rainfall. The amount of nutrients in stubble at harvest will differ from season-to-season and depends on crop type, soil type and fertility, nutrient management in the season and removal in grain.

Stubbles of different crop types have different nutrient values (Norton and Sandral 2017). Nutrient losses from rainfall were found to be different between stubble of different crop types that were tested. Understanding the value of a stubble prior to rain by crop type will help to give a more accurate starting point to estimate what might be lost as a result of rainfall. The majority of phosphorus, potassium and sulphur in crop residue is present in soluble forms (Norton and Sandral 2017). When these nutrients are washed from the stubble they react with the soil and may become available to plants in the subsequent season depending on soil type. Controlling summer weeds is important to aid in retaining these nutrients in the soil for the coming season/s.

While this research carried out has shown there are significant quantities of nutrients in stubbles, the transfer of these nutrients from the stubble to the crop in the following year can be limited due to a range of factors. BCG research based at Horsham as part of the GRDC stubble initiative found that only 2-11% of nitrogen from wheat stubble was transferred to the crop in the following year (Browne et al. 2018) and that only about 6% of the N required by a crop at Temora was derived from N in retained wheat stubble (Kirkegaard et al. 2018). Long term research into legume residues, on the other hand has highlighted the potential of nitrogen transfer to subsequent crops. Legume stubbles have shown to return up to 9kg/ha of mineral nitrogen to the soil for every tonne of residue or 29% of the total nitrogen remaining in the crop (Peoples et al 2017). This highlights the potential differences in the value of stubbles of different crop types.

This trial looked to investigate the nutrient loss over different amounts of total simulated rainfall applied at 6mm per hour. Research carried out by Schreiber and McDowell (1985) suggests that rainfall intensity also plays a role in determining the amount of nutrients leached from stubble. Generally, the lower the rainfall intensity, the greater amount of time the water has to soak the stubble and remove nutrients whereas a short, heavy shower will see water hit the stubble surface and drip off. Intensity was kept constant throughout this trial.

This trial presents data from stubble remaining after the 2017 season. Results give an indication of the difference in the value of stubbles of different crop types and the loss of certain nutrients from various amounts of rainfall. It can be concluded that nutrients are being leached from stubbles in summer rainfall events however, there are a number of questions remaining to be answered to determine the true change in stubble value including those from microbes, different rainfall intensities and stubble architecture.

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