Improved productivity on sandy soils - Kybunga case study 2020

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Key Findings

- Shallow or deep ripping alone did not provide any grain yield increase, which contrasts with the previous season.
- Deep ripping with chicken litter has provided the greatest cumulative partial gross margin in 2019 and 2020.
- Spading with chicken litter applied increased grain protein by 2.8% compared to the control, whereas deep ripping plus chicken litter did not significantly increase grain protein.
- The addition of chicken litter to deep ripping and spading provided a 9% grain yield increase.

How was it done?

Trial location:	Kybunga (Blyth BOM annual rainfall 404mm, growing season 291mm)		
Plot size:	1.5 m x 20.0 m	**Fertiliser:**	27:12 @ 120 kg/ha
Seeding date:	May 15, 2020		Urea (46:0) @ 100 kg/ha on August 3
Variety:	Spartacus CL barley		

Soil constraints: Low organic carbon, low cation exchange capacity**,** mild water repellence and compaction (anecdotal, not yet measured)

The trial was a randomised complete block design with seven treatments. The trial was located on a sandhill at Kybunga with two replicates across the top of the hill and two replicates on the western slope of the hill. Chicken litter (CL) was applied to the surface of plots prior to the implementation of soil disturbance treatments.

All soil disturbance treatments were implemented on May 13, 2019. Ripping treatments were conducted using a Williamson-Agri Ripper, a bent leg low disturbance ripping machine with four tynes per plot. Ripping depth was either shallow (30 cm) or deep (50 cm). Spading was conducted with a 1.8 m Farmax spading machine operated at 5 km/h to a depth of 30 cm.

Treatments

1. District practice (control)
2. Shallow ripping (30 cm)
3. Deep ripping (50 cm)
4. Spading (30 cm)
5. Deep ripping + spading
6. Deep ripping + chicken litter @ 7.5 t/ha
7. Spading + chicken litter @7.5 t/ha

Crop measurements during the growing season included GreenSeeker NDVI measurements on July 23 and September 3. The trial was harvested for grain yield in November and grain quality was assessed post-harvest.

Results and Discussion

Yield and grain quality

GreenSeeker NDVI on July 23 showed spading, deep rip with CL and spading with CL increased NDVI value over the control (Table 1). The NDVI of spading with CL was 40% compared to the control and higher than all other treatments. GreenSeeker NDVI recorded on September 3 showed all treatments were greater than the control, except for deep rip. Shallow rip and deep rip plus spade increased from the earlier assessment to be greater than the control. Spading plus CL maintained its NDVI advantage over all other treatments and had an NDVI value 60% greater than the control. The addition of ripping with spading did not increase any NDVI readings compared to spading alone. Deep ripping was not greater than the control at both timings. However, shallow ripping was greater than the control and deep ripping on the September 3 GreenSeeker measurement.

Grain yield results show that either shallow or deep ripping alone did not provide an increase in yield (Table 1). This contrasts with the 2019 results in wheat, where both shallow and deep ripping had greater NDVI throughout the season and increased grain yield by 0.97 t/ha (23%). This suggests that these treatments were constrained by something other than compaction in 2020. The addition of CL with deep ripping increased yield by 0.38 t/ha over straight deep rip, indicating the benefit of chicken litter. Spading, rip plus spading, deep rip with CL, and spading with CL all increased grain yield by an average of 0.48 t/ha (17%). Spading with CL was the highest yielding treatment providing a 21% increase in grain yield over the control.

The grain yield benefits from the addition of CL to both deep ripping and spading was relatively consistent from 2019 to 2020. The deep ripping and spading treatments with CL averaged a 12% increase in 2019 and a 9% yield increase in 2020 over deep ripping and spading alone.

Spading with CL was the only treatment to have increased grain protein over the control treatment (Table 2). This increase was also 2.0% higher compared to ripping with CL, indicating that incorporation of the CL was important for nutrient uptake. This is supported by soil nitrogen results from samples taken from 0 – 90 cm depth on April 17, 2020 (Table 1). The spading + CL treatment was the only treatment to have higher deep soil N with an additional 26 kg N/ha compared to the control treatment. The increase in grain yield and protein in this treatment meant there was an additional 73 kg N/ha removed compared to the control treatment. This indicates that more N is likely to have mineralised from the spaded CL during the growing season, or the crop was accessing nitrogen that had leached beyond the depth of sampling.

Grain screenings (4.8%) and retention (76.5%) indicate grain size was smaller for the spading with CL treatments. However this effect was not great enough to change the grain quality classification.

Table 1. Deep soil N (kg N/ha 0 – 90cm April 17th 2020) for selected treatments, GreenSeeker NDVI and grain yield data for the Kybunga trial in 2020.

	Treatment	Deep N (kg/ha) Apr 17 2020	NDVI Jul 23 2020	NDVI Sep 3 2020	Grain yield (t/ha)
1	Control	39	0.325	0.477	2.89
2	Shallow rip		0.353	0.545	3.03
3	Deep rip	41	0.316	0.493	2.93
4	Spade	37	0.387	0.639	3.34
5	Rip + spade		0.356	0.628	3.31
6	Deep rip + CL	45	0.375	0.608	3.31
7	Spade + CL	65	0.455	0.761	3.50
	LSD (P≤0.05)	*15*	*0.035*	*0.038*	*0.34*

Table 2. Grain quality data for the Kybunga low OM trial in 2020.

Treatment		Protein (%)	Test weight (kg/hL)	Screenings (%)	Retention (%)
1	Control	13.5	66.9	3.0	83.6
2	Shallow rip	13.7	66.8	2.9	82.2
3	Deep rip	13.1	66.5	2.7	83.4
4	Spade	14.4	66.6	3.4	80.0
5	Rip + spade	14.5	65.2	3.9	78.2
6	Deep rip + CL	14.3	66.3	2.9	82.5
7	Spade + CL	16.3	64.4	4.8	76.5
LSD (P≤0.05)		*1.0*	*NS*	*1.0*	*NS*

All treatments were classified as BAR1 as per grain quality analysis.

Partial gross margin (PGM)

Despite the significant costs associated with some of these treatments the increased grain yield was achieved on this soil type means that the treatments can be paid for in two seasons. Return on investment ratios from the ripping treatments were greatest due to their lower input costs. However greatest overall returns come from the treatments that received the chicken litter and ripping or spading due to the greater yield gains. Although the cost of spading and chicken litter was high the return on investment was still 1:1.05 and 1:0.64 for deep rip + CL and spade + CL, respectively over two seasons.

Table 3. Cumulative partial gross margin analysis for seasons 2019 and 2020 for the Kybunga trial. Price assumptions include chicken litter $34.5/t, SoA $400/t, wheat ASW (2019) $310/t, wheat H2 (2019) $320/t, barley BAR1 $220/t. Cost of spading in the deep rip plus spading treatment is reduced due to pre-ripping.

Treatment	Disturbance ($/ha)	Chicken litter ($/ha)	2019 SoA ($/ha)	Total costs ($/ha)	Cumulative grain yield (t/ha)	Cumulative gross income	Cumulative PGM ($/ha)	ROI (%)
Control	$0	$0	$60	$60	7.16	$1,917	$1,857	
Shallow rip	$50	$0	$60	$110	8.09	$2,186	$2,076	144
Deep rip	$70	$0	$60	$130	8.35	$2,271	$2,141	172
Spade	$200	$0	$60	$260	8.57	$2,304	$2,044	49
Rip + spade	$250	$0	$60	$310	8.77	$2,365	$2,055	45
Deep rip + CL	$70	$260	$0	$330	9.33	$2,594	$2,264	105
Spade + CL	$200	$260	$0	$460	9.44	$2,670	$2,210	64

The treatments without CL (T1 – T5) applied have removed on average, 84% of the total N applied over the two years that the trial has been running. Compared to the two CL treatments (T6 – T7), where only an average of 51% of total N applied has been removed. The soil N results from April 2020 indicated large differences in available soil N between the two CL treatments. As the CL in the spaded treatment has been incorporated deeper into the soil profile compared to the ripping treatment it is likely that more has been mineralised. It is not clear where the additional N is in the deep rip treatments, it is possible that it is still on or near the surface in un mineralised CL and will be released over an extended period compared to the spading treatment.

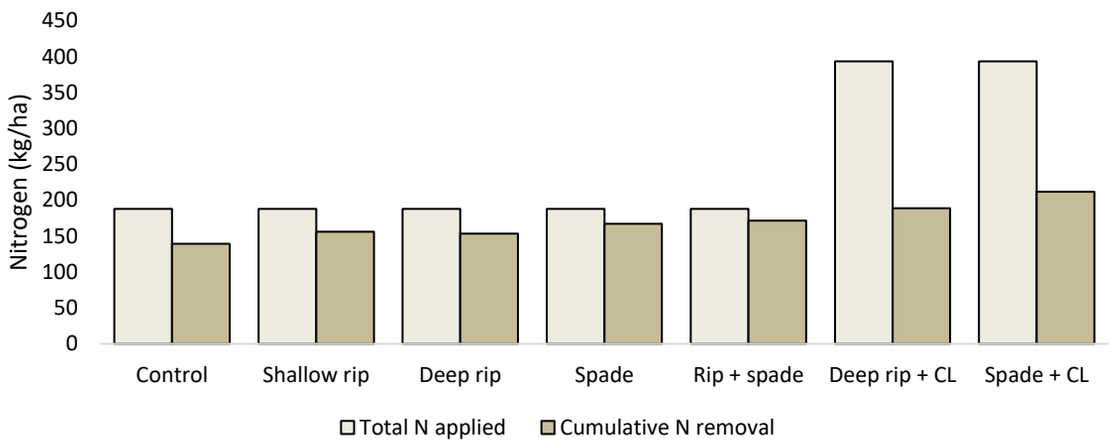

Figure 1. Total N applied through synthetic fertiliser and chicken litter for all treatments and the cumulative N removal through grain removal.

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