"Ripping" results from Mallee Sandy Soils trials

RESEARCH

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Key messages

- **Deep ripping resulted in a significant increase in yield at the Ouyen site for a second consecutive season.**
- **At Ouyen, annual ripping treatments resulted in a yield increase of 0.6 t/ha while treatments which were only ripped in 2017 still yielded 0.4 t/ha better than the control.**
- **At Carwarp mechanical disturbance to 30 cm by spading or deep ripping provided a yield boost of 0.5 t/ha, however deeper ripping to 60 cm did not provide any significant yield benefits.**
- **Second year yield increases following spading of organic amendments in 2017 were evident for chicken litter (+0.5 t/ha) but not for home grown hay sources (vetch, oaten) at Ouyen in 2018.**
- **Over the two seasons, spaded chicken litter has doubled the yield achieved compared to the non-spaded controls.**

Why do the trials?

Sub-optimal productivity is commonly reported for the deep sands that make up 20 to 30% of the cropping soils in the low rainfall Victorian Mallee region. There is evidence of unused soil water, despite an apparent absence of constraints commonly associated with sandy soils (e.g. non-wetting, soil acidity). Diagnosis studies of local constraints have pointed to low abiotic and biological fertility in the subsoil layers and the physical restriction of rooting depth as the most likely constraints to production on sands in the Victorian Mallee.

To explore this further, four replicated trials were established across two sites; Ouyen (2017-18) and Carwarp (2018). These trials have investigated the interactions between crop water use, physical disturbance (deep-ripping and/or rotary spading), and the incorporation of organic and inorganic amendments. These trials are part of the GRDC project: Increasing production on sandy soils in the low-medium rainfall areas of the southern region. The trials are a collaboration between Frontier Farming Systems and Mallee Sustainable Farming, CSIRO and UniSA.

How was it done?

Two research sites were established in the Victorian Mallee, at Ouyen which commenced in 2017 and at Carwarp which commenced in 2018. The sites have similar soil properties (Table 1), however the Carwarp sand is red in colour while the Ouyen sand is yellow. The annual rainfall at Carwarp is 280 mm per year while the Ouyen receives 25 mm more rainfall per year on average.

At each site two separate trials were established to investigate both mitigation and amelioration strategies to overcome constraints and improve root growth and water extraction from the sub-surface layers. Details for each trial are provided below.

Ouyen

Fertiliser placement trial

This trial compares surface banding of nitrogen (N) and other nutrients (7-8 cm deep) with deeper placement of nutrients, by pre-drilling (20 cm) or deep ripping (30 cm) ahead of seeding (Table 2). Nitrogen (N) was applied at a rate equivalent to 90 kg/ha over the life of the trial, either as urea only or as urea incorporated into a broader nutrient package (P, K, S, Zn, Cu, Mn). Additionally, these nitrogen treatments were applied either as a single application of 90 kg N/ha applied in 2017, or a split application of 30 kg N/ha annually from 2017 to 2019. All treatments also received an additional 20 kg N/ha through a combination of starter DAP and top-dressed ammonium sulphate fertiliser, thus each treatment will receive a total of 150 kg N/ha over three seasons.

Spading organic matter trial (amelioration)

Six different types of organic matter were incorporated to a depth of 30 cm depth in 2017 using a one pass spade and sow operation (Table 3). Each organic amendment was applied at a rate which supplied 2.5 t/ha of carbon, but carbon:nitrogen (C:N) ratio varied. Spaded organic matter treatments were also compared to spading only, spaded urea (supplying equivalent quantity of N as vetch hay) and a non-spaded control.

Table 1 Key soil properties at the Ouyen and Carwarp sites

Depth (cm)	Total Organic Carbon (%)	pH ($CaCl_2$)	Clay (%)	Electrical Conductivity (µ/cm)	Colwell Phosphorus (mg/kg)
Ouyen					
0-10	0.3	6.3	3.8	53.7	18
10-20	0.2	5.1	4.2	20.5	18
20-40	0.1	6.0	4.3	16.1	10
40-60	0.2	7.0	3.8	39.9	-
60-80	0.1	7.3	4.1	35.7	-
80-100	0.1	7.5	4.9	35.2	-
Carwarp					
0-10	0.2	5.7		39.0	17
10-30	-	6.7		31.8	-
30-40	-	7.3		39.3	-
40-60	-	7.6		45.4	-
60-100	-	7.8		47.3	-

Table 2 Key factors in the fertiliser placement trial at Ouyen, incorporating physical disturbance with pre-drilling or deep ripping, nitrogen rate, depth of N placement (banding) and the addition of a nutrient package (P, K, S, Zn, Cu, and Mn) applied with N fertiliser

Description	Physical disturbance	[1]Nitrogen rate (kg N/ha)			Fertiliser placement (cm)			Nutrient package (P, K, S, Zn, Cu, Mn)
		2017	2018	2019	7.5	20	30	
Control	Nil	30	30	30	✓			+/-
Pre drill control	Pre Drill	30	30	30	✓			+/-
Pre drill N (annual)	Pre Drill	30	30	30		✓		+/-
Pre drill N (1 in 3)	Pre Drill	90	0	0		✓		+/-
Deep rip control	Deep Rip	30	30	30	✓			+/-
Deep rip N (annual)	Deep Rip	30	30	30			✓	+/-
Deep rip N (1 in 3)	Deep Rip	90	0	0			✓	+/-

[1]All treatments receive an additional 20 kg N/ha per year through basal and top-dressed fertiliser inputs

Table 3 Treatments applied in 2017 in the spading organic matter trial at Ouyen

Treatment	Application rate (t/ha)	C:N Ratio	Treatment N input (kg/ha)
Spaded Vetch Hay	6.0	16:1	156
Spaded Oaten Hay	5.9	72:1	35
Spaded Vetch + Oat Hay	3.3 + 2.7	25:1	102
Spaded Chicken Litter	6.8	16:1	218
Spaded Compost	15.8	10:1	252
Urea	0.34	N/A	156
Spaded control	Nil	N/A	-
Non-spaded control	Nil	N/A	-

Carwarp

Deep ripping x rotation trial (mitigation)

Eight different three-year rotations were established in 2018. Deep ripping to 60 cm was conducted on one half of each plot prior to sowing, creating with or without deep ripping comparisons (Table 4). All treatments received 40 kg N/ha from fertiliser inputs, except for the cereal (High N) treatment which received 80 kg N/ha and lentils which received 20 kg N/ha from starter fertiliser and top-dressed ammonium sulphate.

Organic matter input incorporation x placement trial

The trial compares the incorporation and placement of organic matter (OM) inputs (6 t/ha lucerne) by deep ripping, spading or combinations of the two operations (Table 5). Where organic matter inputs were surface applied, lucerne meal was used and where organic matter inputs were direct injected into the subsoil during the ripping process the lucerne was pelletised.

Management

Low and infrequent rainfall delayed the establishment of trials at both sites in 2018.The Ouyen site was sown to Kord wheat on 31 May 2018 while Carwarp was sown on 7 June to Spartacus barley, except on the canola (Pioneer 43Y92 CL) and lentil (PBA Hurricane XT) treatments (Table 4). All trials received DAP S Z (16:17:0:8; 0.5%Zn) @ 62.5 kg/ha at seeding and 47 kg/ha of ammonium sulphate and a foliar application of copper, zinc and manganese was applied during tillering. Additional applications of N at seeding saw a total of 50 kg N/ha applied to the Ouyen site and 40 kg N/ha applied at Carwarp, except where treatments required a different rate (Table 2 and 4).

What happened?

Seasonal conditions

Growing season rainfall at both sites was sporadic and very much below average, with only 48 mm of in-crop rainfall at Carwarp and 105 mm received at Ouyen during the 2018 growing season. September was very dry, however 10 mm of rain fell during October at Carwarp and Ouyen received 20 mm which provided good conditions for grain fill.

Grain yield

In 2017 deep ripping led to a grain yield increase of 0.85 t/ha relative to the control (2.75 t/ha compared to 1.9 t/ha) (Moodie and Macdonald, 2018). In 2018, the annual ripping treatment (i.e. plots deep ripped in both 2017 and 2018) resulted in a yield increase of 0.6 t/ha more than the control yield of 0.97 t/ha, while treatments which were ripped in 2017 only still yielded 0.4 t/ha better than the control in 2018 (Figure 1).

Table 4 Rotations which commenced at Carwarp in 2018 with and without ripping

Description	2018	2019	2020	Deep rip (60 cm)
Cereal (Low N)	Barley	Wheat	Wheat	+/-
Cereal (High N)	Barley	Wheat	Wheat	+/-
L - W - W	Lentil	Wheat	Wheat	+/-
B - L - W	Barley	Lentil	Wheat	+/-
B - W - L	Barley	Wheat	Lentil	+/-
Can - W - W	Canola	Wheat	Wheat	+/-
B - Can - W	Barley	Canola	Wheat	+/-
B - W - Can	Barley	Wheat	Canola	+/-

Table 5 Organic matter input incorporation x placement trial at Carwarp

Mechanical operation	Depth (cm)	OM placement	OM placement
Nil	Surface	+/-	Surface
Spade	Surface	+/-	Surface
Deep Rip	30	+/-	30 cm
Deep Rip	60	+/-	60 cm
Deep Rip	60	+/-	30+60 cm: Split (50/50)
Deep Rip + Spading	60 + 30	+/-	Surface + 60 cm: Split (50/50)

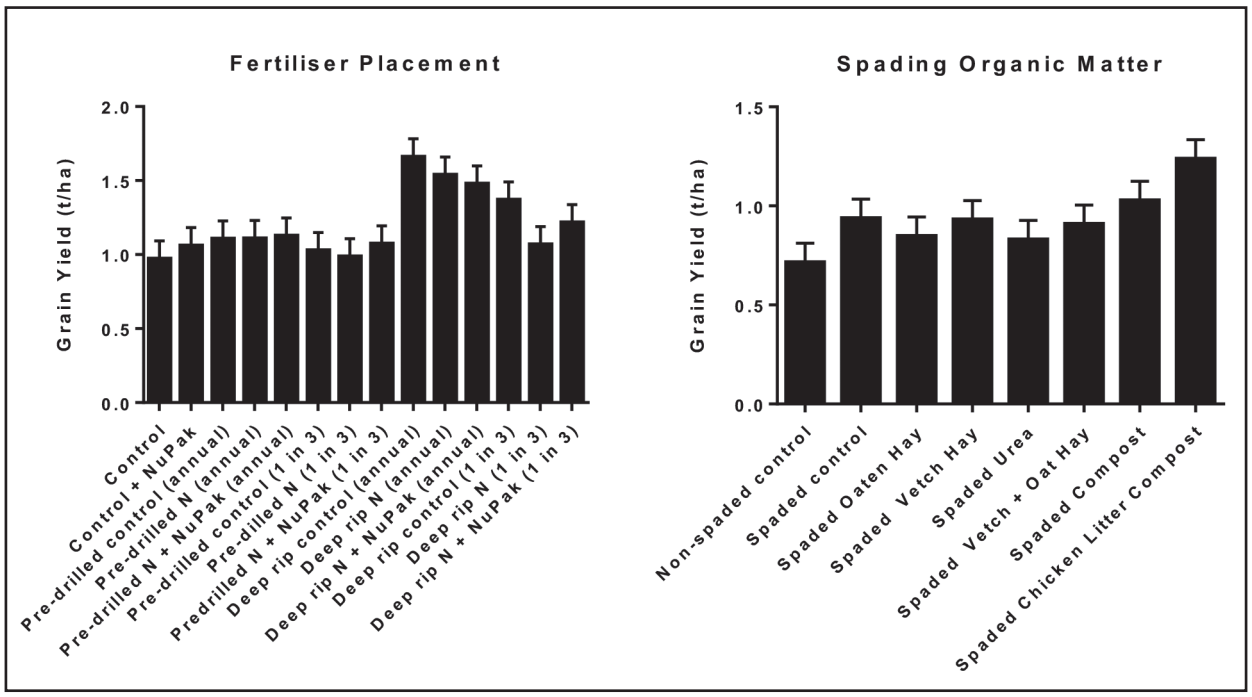

Figure 1 Wheat yields of treatments in the fertiliser placement and spading organic matter trials at Ouyen in 2018. Error bars are Standard Error of Difference.

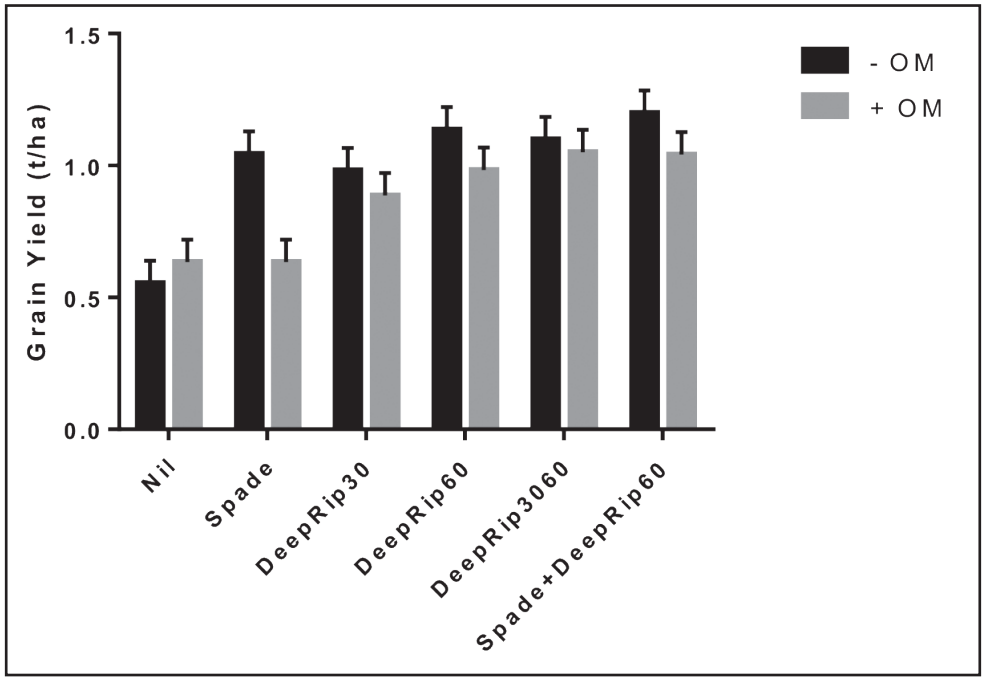

Figure 2 Barley yields of treatments in the organic matter input incorporation x placement trial at Carwarp in 2018. Error bars are Standard Error of Difference.

There were fewer second year benefits in 2018 from the spading and organic amendment treatments implemented in 2017 (Figure 1). Only the spaded compost and chicken litter treatments had significant yield increases compared to the non-spaded control (0.7 t/ha). The chicken litter treatment resulted in an extra 0.5 t/ha grain yield in 2018, which equates to a cumulative yield of 4 t/ha for the two seasons, compared to only 2 t/ha of grain from the non-spaded control. On-farm organic matter input sources such as vetch and oaten hays did not provide a yield benefit in 2018.

At Carwarp, disturbance by deep ripping and spading significantly increased grain yields however there was no positive impact from the addition of lucerne (Figure 2). There was a negative response to the addition of organic matter in the spading treatment, possibly from more vigorous early crop growth using more water in a season where low rainfall resulted in low soil moisture reserves. Mechanical disturbance to 30 cm by spading or deep ripping resulted in an additional grain yield of 0.5 t/ha compared to the control (1.05 t/ha compared to 0.55 t/ha). Deeper ripping to 60 cm did not provide any significant yield increases in 2018 over working to a depth of 30 cm only.

Both canola and lentil production were adversely affected by the poor seasonal conditions at the Carwarp site with control treatments for these crops yielding 0.45 t/ha and 0.04 t/ha respectively. Deep ripping increased canola yield by 25 percent and although lentil yield on the ripped treatments was four times that of the control, it was still low yielding (0.16 t/ha). There was no additional benefit of higher N inputs to barley with or without deep ripping at Carwarp in 2018.

What does this mean?

Alleviating physical barriers to root growth through practices such as deep ripping and rotary spading are providing the most consistent yield increase on sandy soils in the Victorian Mallee. Thus far, yield responses from physical interventions have generally been more consistent than responses from organic inputs. The chicken litter treatment at Ouyen is the exception to this, where there has been a cumulative grain yield response of 2 t/ha across two seasons. This response from the application of chicken litter demonstrates the potential to improve crop yields by increasing fertility of sandy soils. However, there were not significant yield responses from the addition of home grown biomass, such as vetch and cereal hay on the sites in 2018. Thus, addressing soil physical constraints by deep ripping or rotary spading seems to be a good place to start for farmers looking to increase production on underperforming sands in the Victorian Mallee.

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References

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