Ameliorating a deep repellent sand at Murlong four years ago still improved wheat performance in 2021

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Location
Murlong
Mark & Amy Siviour and family
Rainfall
Av. Annual: 332 mm
Av. GSR: 248 mm
2021 Total: 303 mm
2021 GSR: 211 mm
Yield
Potential: Barley - 2.7 t/ha (French/Schultz)
Actual: 1.0 t/ha in best treatments
Paddock History
2020: Vetch
2019: Barley
2018: Wheat
2017: Barley
Soil type
Deep white siliceous sand over clay
Soil test
Low fertility throughout for P, N and trace elements. Severely water repellent and compacted
Plot size
25 m x 6 rows x 4 reps
Trial design
Completely randomised block
Yield limiting factors
Late start, frost, Cu deficiency and low spring rainfall

Key messages

- **Deep tillage boosted crop growth and yield four years after implementation. Spading was the most effective tillage type, closely followed by deep ripping (to 40 cm) with inclusion plates.**
- **Incorporated organic and nutrient amendments have provided additional yield in some years, but with inconsistent and decreasing benefits.**
- **Only cheap sources of amendments that increase yields will be viable.**

Why do the trial?

Previous research has shown that deep tillage can deliver large yield increases in compacted sandy soils. However, uncertainty remains whether thorough mixing/dilution of the topsoil or adding amendments during this operation is effective or profitable. The development of inclusion plates attached to deep ripping tines is a low-cost option to increase mixing of surface applied amendments and/or topsoil, potentially with less risk of soil erosion compared to spading.

This trial aimed to:

- Determine if soil mixing and loosening improves yield in a sandy soil on eastern EP (using a rotary spader).
- Compare deep ripping with inclusion plates to spading.
- Identify if the addition of fertilisers or organic material provided additional benefits.

This article summarises crop growth responses from treatments in the fourth crop post amelioration and the accumulated grain yield benefit over four years. For details of past trial results, see the article in the 2020 EPFSS,: 'Ameliorating a deep repellent sand at Murlong in 2018 increased vetch performance in 2020'.

How was it done?

The trial is located on a broad sand dune at Murlong on eastern Eyre Peninsula and comprises 11 treatments by 4 replicates. Constraints at the site include severe water repellence, compaction (bulk density >1.7 at 12 cm), low organic carbon and poor nutrient fertility.

Crop performance in an unmodified control is being compared to spading to 30 cm or ripping with inclusion plates to 2 depths (30 cm or 41 cm) with and without the addition of high rates of mineral fertiliser or lucerne pellets (Table 1). All amelioration treatments were applied in 2018 and have not been re-applied.

Plant measurements included crop establishment, biomass at flowering and grain yield and quality. Data was analysed using standard ANOVA models in Statistix 8.

What happened?

The break of season at Murlong was late in 2021 and the trial was not seeded until 10 June. However, the seedbed was wet despite the repellent topsoil and the wheat established well, regardless of treatment. There was an average of 115 plants/m^2 across the trial. In previous years, severe water repellence resulted in low plant numbers where there was no deep soil disturbance.

Table 1. Trial establishment and cropping details for 2021 (trial was sown with Razor CL wheat in 2018, Scope CL barley in 2019 and RM4 vetch in 2020).

Date		
19 April 2018	Amendments applied	Organic matter: lucerne pellets at 5 t/ha Nutrient package: nutrients applied to match lucerne (nitrogen (N) 167, phosphorous (P) 14, potassium (K) 105, sulphur (S) 12, copper (Cu) 0.03, zinc (Zn) 17, manganese (Mn) 0.18 kg/ha). N, P, K and S applied as granular and trace elements as fluids. Amendments were applied evenly across the surface on spaded plots or in bands to align with ripper tine spacings, immediately prior to spading and ripping.
19 April 2018	Deep tillage details	• Spading to 30 cm at 5 km/hr • Ripped: 4 tines at 64 cm spacings, with inclusion plates positioned 10 cm below the soil surface and operated at 5 km/hr. • Shallow ripped (corresponding to the depth of spading) to 30 cm with 20 cm tall inclusion plates. • Deep ripped to 41 cm with 30 cm tall inclusion plates.
10 June 2021	Sowing, inter-row on 2020 crop rows	70 kg/ha Hammer CL wheat at 25.4 cm row spacing + DAP at 60 kg/ha and 63 kg /ha banded below seed rows (all treatments). SE14 wetter sprayed into all seed rows at 4 L/ha.

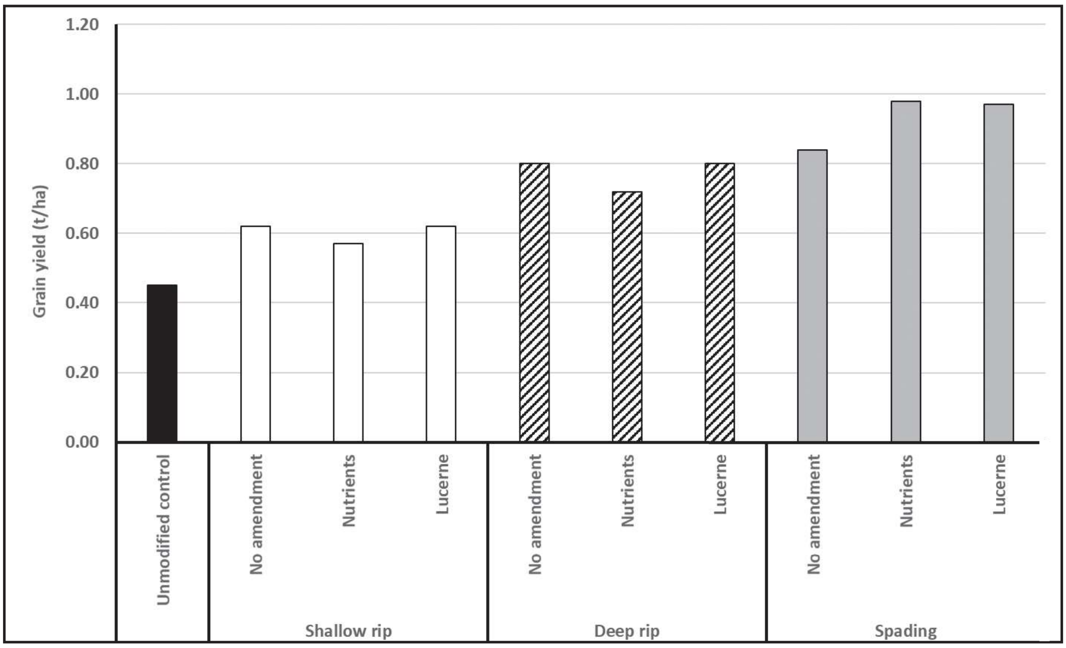

Figure 1. Effects of deep tillage and incorporated amendments on grain yield (t/ha) of wheat at Murlong in 2021 (LSD (P=0.05)= 0.09).

The spading + nutrient package provided the highest crop biomass at flowering in 2021 (3.7 t/ha compared to 2.1 t/ha for the unmodified control). However, it is not clear how incorporated nutrients boosted wheat growth because shoot analysis did not reveal any higher nutrient concentrations in this treatment compared to the controls. This was the only treatment in which an amendment improved wheat biomass at flowering. In general, the highest wheat dry matters were recorded with spading (56% higher than the unmodified controls), followed by deep ripping (42% higher than the control) and shallow ripping (21% higher).

Whilst grain yields at Murlong were generally poor in 2021, with frost, low levels of copper and zinc, a dry late winter and spring and weather damage at maturity all contributing to reduced yields, previous deep tillage still increased grain yields over the control (Figure 1). Spading more than doubled grain yield (from 0.44 t/ha in the unmodified control to 0.93 t/ha). Deep ripping with inclusion plates increased grain yields to 0.77 t/ha, and shallow ripping to 0.6 t/ha. The addition of amendments (both types) only increased wheat grain yields where they had been incorporated by spading, but only by 140 kg/ha or 16% above spading only.

Grain proteins were high, averaging 14% in the controls and 13% across the amelioration treatments. Grain quality was generally high and largely not affected by treatments; screenings were 2-3%, hectolitre weight 80-81 gm and grain weight averaged 30 gm per 1,000 grains.

The cumulative impact of amelioration strategies on four years of crop yields is shown in Table 2. All deep tillage types resulted in much better production overall, partly because the performance in the unamended soil was very poor in every year (cumulative yield of only 1.8 t/ha over the 4 years). Spading produced the highest grain totals (3.3 t/ha more than the control over the 4 years). The cost of spading is commonly between $150 and $180/ha, whereas deep ripping with inclusion plates is estimated at $55 to $120 per hectare, depending on the depth of ripping (Davies, *et al* 2019).

Given its cheaper implementation cost and lower erosion risk, with more than 2.5 t/ha of extra grain over the 4 years, deep ripping with inclusion plates was a competitive alternative to spading. Even shallow ripping resulted in 1.5 t/ha more grain over the 4 years. Amendments, especially lucerne, substantially improved crop growth and yields in the first crop but have had little or no impact since then.

In most years, the benefits of strategic deep tillage appeared to be a combination of improved crop emergence (water repellence mitigated by mixing) and improved crop growth from alleviating soil compaction. However, in 2021, crop establishment was consistently high and uniform for all treatments, suggesting that the crop was primarily responding to deeper changes that were created 4 years prior.

Table 2. Cumulative grain yield of crops (t/ha) with various amelioration strategies at Murlong from 2018 to 2021.

Deep tillage	Amendment	Wheat in 2018	Barley in 2019	Vetch in 2020	Wheat in 2021	Cumulative grain yield
None	None	0.48	0.72	0.19	**0.45**	**1.82**
	None	0.99	1.33	0.47	**0.62**	**3.41**
Shallow Ripping	Nutrients	1.20	1.37	0.52	**0.57**	**3.65**
	Lucerne	1.19	1.25	0.48	**0.62**	**3.54**
Deep Ripping	None	1.41	1.62	0.56	**0.80**	**4.38**
	Nutrients	1.90	1.52	0.49	**0.72**	**4.63**
	Lucerne	1.80	1.74	0.66	**0.80**	**5.01**
Spading	None	1.90	1.64	0.76	**0.84**	**5.13**
	Nutrients	3.22	1.83	0.72	**0.98**	**6.73**
	Lucerne	3.12	1.81	0.84	**0.97**	**6.74**
LSD (P=0.05)						***0.57***

Note: LSD for cumulative yield was calculated for a factorial analysis of disturbance x amendment (ie controls excluded).

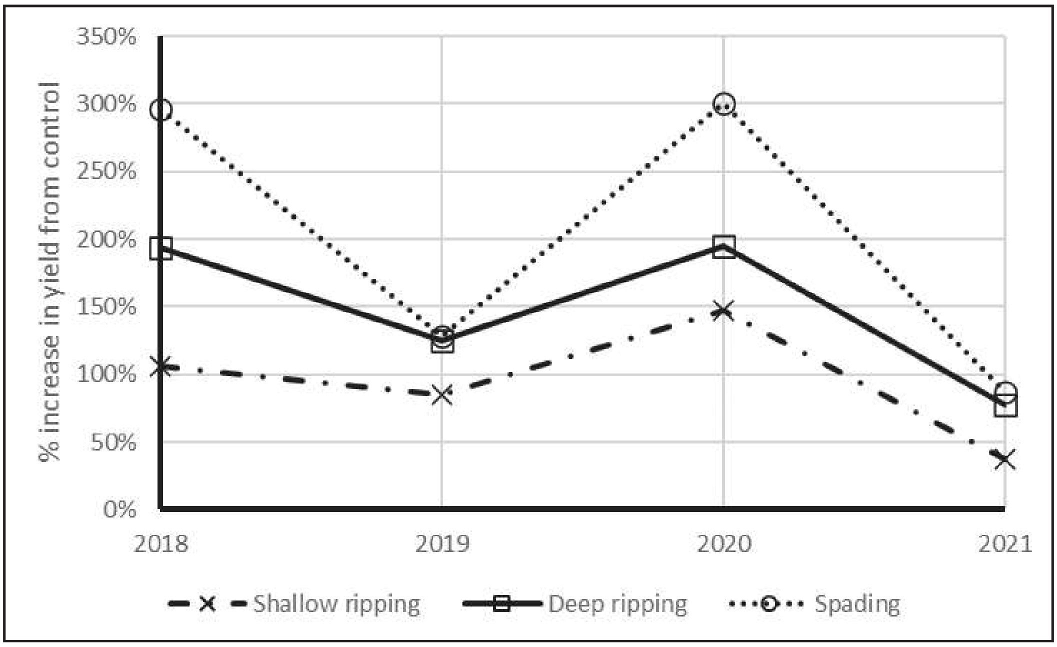

Figure 2. Benefits to grain yield of crops (% increase from unmodified controls) with 3 physical interventions at Murlong over 4 seasons; 2018 (wheat), 2019 (barley), 2020 (vetch) and 2021 (wheat) (amendments not included).

What does this mean?

Four consecutive crops have now been monitored on this deep, water repellent sand at Murlong. Figure 2 shows that there is a strong seasonal impact on responsiveness of crops to physical disturbance and no clear trend that the benefits have ceased. Deep tillage continues to deliver large production responses in crop biomass and grain yield; the prospect that benefits will continue beyond the fourth season is likely.

Spading has proven to be the most effective type of tillage for improved grain yield so far; even at a cost of $180/ha it has proven a good return on investment. Ripping to 40 cm with inclusion plates and wide rows (60 cm) is also providing very competitive economic returns. Additionally, soil erosion risk is a critical consideration when physically disturbing fragile sandy soils. Deep ripping interventions can be undertaken in a manner that does not leave the soil as vulnerable to wind erosion as can occur with operations like spading.

Deep tillage has improved early crop establishment at Murlong by disturbing and diluting surface repellent layers, leading to better crop biomass and grain production; spading is more effective than ripping in this aspect. However, seeder strategy trials conducted by the University of SA (see their articles in previous editions of the Eyre Peninsula Farming Systems Summary 2018 and 2019) have shown that there are low-cost options at seeding that can substantially improve early crop establishment on this severely repellent sand without major physical disturbance. A combination of those approaches with deep ripping could improve outcomes even further.

While incorporating lucerne hay or a multi-nutrient fertiliser package increased crop performance in 2018, the cost of these amendments will need to substantially reduce to be economically viable. They have only produced negligible grain yield benefits after the first crop.

The final year of this trial will be 2022 with the intention to deep rip one of the controls to compare against the ripping operation implemented in 2018.

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