Addressing constraints in post amelioration sandy soils: Clay spreading

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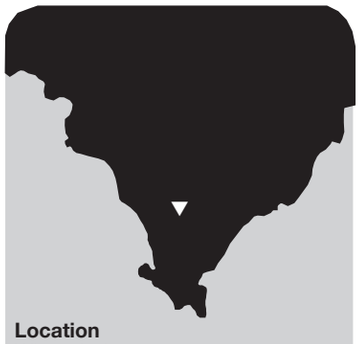

Location
Wharminda
Rainfall
Av. Annual: 341 mm
Av. GSR: 252 mm
2024 Total: 205 mm
2024 GSR: 128 mm
Paddock History
2023: Canola
2024: Wheat
Soil type
Modified sand over sodic clay
Soil test
High pH with low to moderate carbonate presence, adequate N & P, low Mn
pH ($CaCl_2$): 7.9 0-10 cm, 8.0 10-20 cm, 8.3 20-30 cm, 8.6 30-100 cm
Plot size
24 m x 2 rows x 4 reps
Yield limiting factors
Moisture, hostile sodic subsoil, heavy unincorporated clay, pH

Key messages

- **In 2024, spading soils that had previously been broadcast with unincorporated clay to remedy non-wetting sandy soils improved the yield of wheat by 500 kg/ha, compared to untreated controls.**
- **Using passive inclusion deep ripping didn't translate to a yield increase but improved plant access to moisture at 10–20 cm.**
- **Spading had a small penalty on early biomass but showed a significant improvement over untreated controls as the season progressed.**

Why do the trial?

Water repellent sands cover a significant portion of cropping regions within the Eyre Peninsula and other Southern Australian cropping regions. For many of these water repellent sands, clay spreading was a widely used practice to address this constraint. The rates of clay spreading have varied significantly over time with the current common application rates ranging between 100–200 tonnes per hectare, followed by some form of incorporation. However, much of the early clay spreading work utilised rates that were 2–3 times higher than the current rates and lacked any form of incorporation, resulting in a human caused clay layer burying the water repellent sand. This has helped alleviate the water repellency issues but has introduced new constraints, with heavily clayed soils usually establishing well, but experiencing reduced yields and higher susceptibility to root diseases. Past research has shown that clay spreading without any form of incorporation often has reduced yields and greater susceptibility to haying off, particularly in drier seasons. The aim of this trial was to test if current amelioration strategies could be applied to previously modified soils to reduce the negative impacts of heavy, unincorporated clay spreading, whilst maintaining its original benefits.

How was it done?

The trial was established on an alkaline sand over sodic clay soil at Wharminda. Three different amelioration treatments were applied prior to seeding: spading, deep ripping and rip + spade. Additionally, two different amendments were applied prior to amelioration; gypsum and organic matter (mulched lucerne hay). The trial was sown using a plot seeder with AGT Tomahawk wheat at 78 kg/ha with 50 kg/ha DAP on 7 June, targeting a plant population of 180 plants/m^2. An additional 100 kg/ha of urea and 50 kg/ha of SoP (sulphate of potash) were applied in season.

Measurements taken included plant emergence and establishment, Greenseeker NDVI readings, grain yield and quality, and soil gravimetric moistures. Statistical analysis was performed using Genstat Version 24.

Table 1. Early season NDVI.

Treatment	2/07/2024	12/07/2024	1/08/2024	9/08/2024	14/08/2024
Control	0.19 c	0.25	0.37	0.51	0.59 a
Rip	0.19 c	0.27	0.36	0.52	0.63 b
Spade	0.16 b	0.24	0.39	0.57	0.65 b
Rip + Spade	0.15 a	0.23	0.36	0.54	0.63 b
Significance	*P = <0.001*	*ns*	*ns*	*ns*	*P = 0.004*

Table 2. Summary of harvest data at Wharminda in 2024.

Treatment	Yield (t/ha)	Protein (%)	Screenings (%)	Biomass (t/ha)	Harvest Index
Control	2.42 a	10.18 a	3.46	6.47	0.53
Deep Ripping w/inclusion	2.40 a	10.30 a	3.03	6.39	0.52
Spading	2.85 b	10.65 a	3.13	6.64	0.48
Spade + OM	2.93 bc	11.50 b	2.79	5.97	0.52
Spade + Gypsum	2.77 b	10.40 a	3.34	6.39	0.51
Spade + OM + Gypsum	2.98 bc	11.30 b	2.82	6.56	0.51
Deep Rip + Spade	2.81 b	10.58 a	2.89	6.54	0.52
Deep Rip + Spade + OM	2.89 bc	11.30 b	2.26	6.73	0.53
Deep Rip + Spade + Gypsum	2.82 b	10.53 a	3.08	6.27	0.51
Deep Rip + Spade + OM + Gypsum	2.96 bc	11.65 b	2.55	6.72	0.52
Significance	*P = <0.001*	*P = < 0.001*	*ns*	*ns*	*ns*

What happened?

Crop establishment

Crop establishment was not affected by any of the amelioration treatments or applied amendments. Mean plant population was 177 plants/m^2. Initial Greenseeker NDVI readings (used as a substitute for biomass cuts), four weeks after sowing showed a small significant difference in early biomass between the control and ripping treatments compared to those utilising spading (Table 1). However, over the following four weeks each of the amelioration treatments showed a significant (P = 0.004) improvement over the control with the spading providing the highest increase.

Grain production

The trial was harvested with a small plot harvester on 19 November and plot yields were extrapolated to grain yield (t/ha). All treatments experienced average yields despite the season. Yield increases were observed in any treatment where spading was used, with spading plus organic matter and gypsum having the highest yield average of 2.98 t/ha. This resulted in a 560 kg/ha increase over the untreated control. The usage of ripping alone showed no significant improvement over the control nor in the paired ripping and spading treatments.

The addition of organic matter resulted in a further small yield increase, with a small increase in grain protein. Whereas the addition of gypsum to the amelioration treatments had no significant effect.

Harvest index cuts

In addition to grain production data collected via harvesting, harvest index biomass cuts were taken. Despite the delayed start to the season with below average rainfall (124 mm below average growing season rainfall) all treatments produced substantial biomass with a site average of 6.5 t/ha. There was no significant difference in biomass across the treatments.

Gravimetric moisture

Following harvesting of the trial, soil sampling was undertaken to assess residual gravimetric moisture prior to any summer rainfall. This was done to assess any changes in plant water usage between treatments. Across the different amelioration techniques there was very little significant difference. However deep ripping did have significantly lower (P=0.04) gravimetric moisture at 10–20 cm.

Table 3. Post harvest gravimetric moisture (%), sampled on 21 November 2024.

Treatment	Sampling depth (cm)				
	0-10	10-20	20-40	40-60	60-100
Control	3.24	5.04 b	13.73	14.24	18.78
Deep Ripping	3.57	1.51a	16.74	15.67	18.58
Spading	2.81	7.62 b	17.88	15.29	17.55
Rip + Spade	4.24	5.40 b	18.57	16.51	19.47
P = LSD F Prob (0.05)	*ns*	*0.036*	*ns*	*ns*	*ns*
Pre-sowing baseline	1.4	3.2	24.2	21.3	18.6

What does it mean?

The focus of this project was to assess the ability of current amelioration strategies to improve the effectiveness of amelioration implemented several years earlier. Which due to techniques at the time, might have had less benefits than current practices. Despite the challenging season there were significant crop responses to the usage of spading to incorporate the surface broadcast clay layer.

Amelioration didn't have a significant impact on emergence and had a small negative impact on early establishment. However, as the early part of the season progressed the amelioration treatments began to show a significant improvement in biomass over the control.

Treatments involving spading to incorporate the surface clay layer resulted in a significant grain yield increase. Deep ripping alone provided no yield benefit over the control treatment, despite the fact that deep ripping treatments utilised more shallow subsurface soil moisture. Additionally, pairing deep ripping with a spading treatment didn't result in a significant yield increase over the corresponding spading treatments.

The addition of organic matter to the treatments resulted in a small additional increase in grain yield on top of the amelioration treatment, whilst also providing some benefits to grain quality. The addition of gypsum had no significant impact on yield, however with limited rainfall following application there may not have been enough water for the gypsum to dissolve and have an effect.

Where to next?

In the dry 2024 season, a significant yield increase was observed at the Wharminda site when high rates of previously broadcast spread clay were incorporated. This suggests that growers could benefit from spading (mixing) clay-spread soils that were either never incorporated or applied at rates exceeding current recommendations. However, given the record dry conditions, this response must be validated across multiple seasons and environments to better understand the mechanisms driving the yield increase.

Recent clay spreading research indicates that haying off is more prevalent when clay is broadcast spread without incorporation, particularly in drier seasons. Although 2024 met these conditions, with significantly below-average growing season rainfall, the harvest index (the ratio of grain yield to plant biomass) was not significantly different. As a result, the hypothesised haying off in untreated controls did not translate into a significant yield difference. Further soil physics measurements and analysis are needed to identify the key drivers behind this yield response, so that it can be extrapolated across other situations.

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