Claying benefits on water repellent sands sustained when clay rate is matched to incorporation method

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Purpose:	To assess the impact of the rate of application of clay-rich subsoil to water repellent sand on grain yield and the interaction with incorporation method.
Location:	Badgingarra Research Station
Soil Type:	Water repellent pale deep sand and sandy gravel
Rotation:	Wheat 2009; Canola 2010; Wheat 2011; Canola 2012; Wheat 2013

Growing Season Rainfall (April- October 2013): 446 mm (Badgingarra Research Station)

BACKGROUND SUMMARY

The spreading and incorporation of clay-rich subsoil (claying) into water repellent topsoil is known to largely overcome soil water repellence for extended periods with some reports indicating the benefits of claying can last several decades. Claying however is very expensive and high rates of poorly incorporated clay can cause surface crusting and sealing, can reduce water infiltration, increase evaporation and reduce root penetration into the subsoil. These issues can reduce or negate any establishment and yield benefits. New tools such as rotary spaders can incorporate higher rates of clay more effectively.

Due to the high expense of claying there is interest in whether lower rates of clay with shallow incorporation can overcome water repellence and still give sufficient crop establishment and grain yield benefits. This demonstration trial was established to examine the interaction between clay rate and incorporation method and try to determine the optimum clay-rich subsoil application rates for a given incorporation method.

TRIAL DESIGN

Plot size: 5 x 20m spader or 5 x 30m offsets

Repetitions: Repeated untreated control check strips to account for site variation

Seeding details: Mace wheat at 100 kg/ha

Fertiliser rates and dates: Sown with 100 kg/ha MacroPro; 100 kg/ha NS51 applied 25 July and 50 L/ha Flexi-N in 3rd week of August.

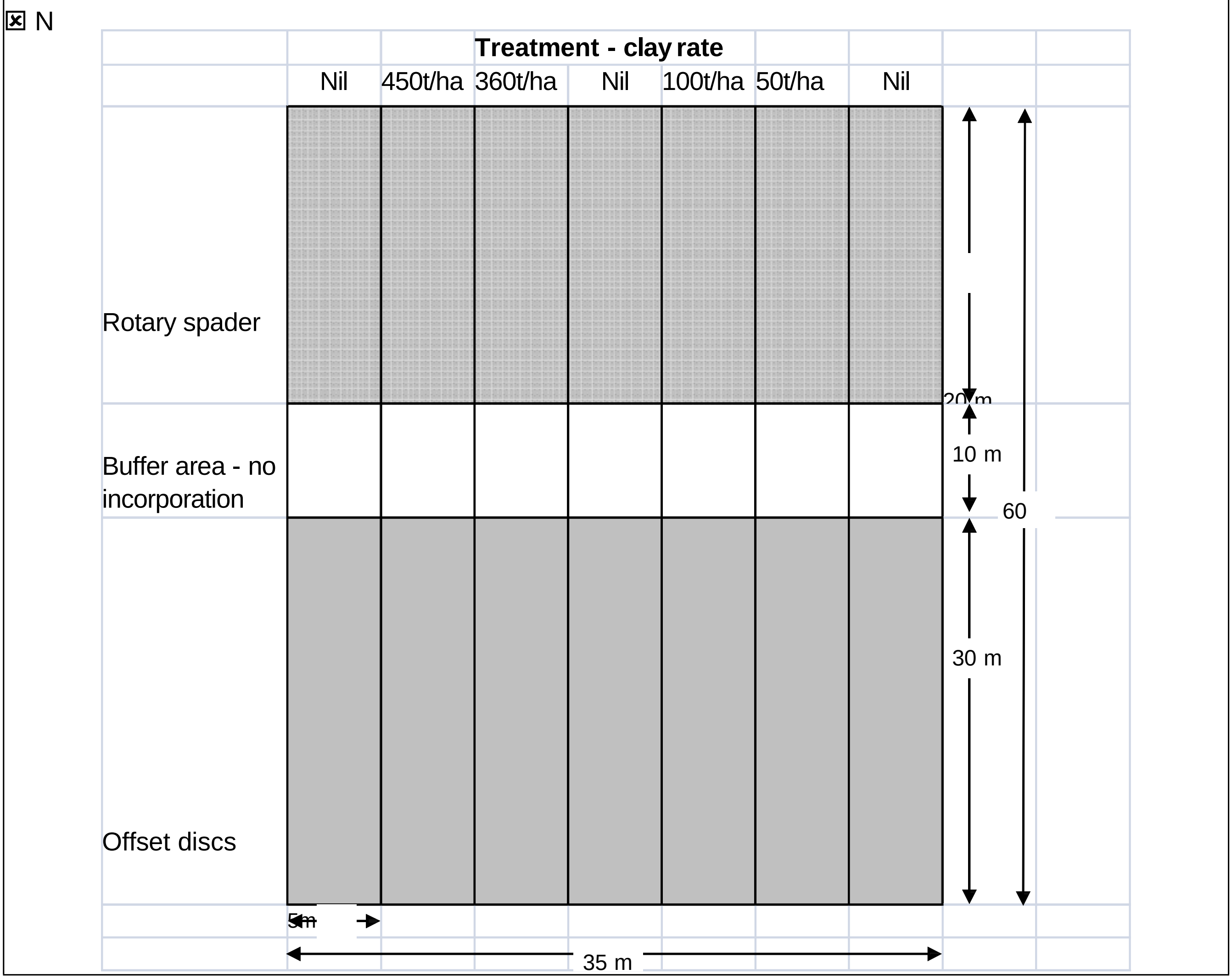
Soil amelioration treatments: Clay spreading and incorporation was undertaken in 2009 (see Trial Layout).

Analysis of Clay-rich Subsoil used for Clay Spreading in 2009:

Table 1. Analyses of clay-rich subsoil spread in clay rate demonstration trial at Badgingarra Research Station in 2009.

pH	mg/kg				EC	Particle size %		
$CaCl_2$	K	S	P	B	mS/m	Sand	Silt	Clay
5.8	54	20	2	1	20	64	5	31

TRIAL LAYOUT



RESULTS and DISCUSSION

The trial has been running for 5 seasons. Due to limitations in the trial design and site variation it is not possible to directly compare the yields of the offset discs and the rotary spader. The offset disc treatments are located on deeper pale sand over gravel while the spaded treatments are located on better performing sandy gravel which has higher yield potential.

No yield was obtained from canola in 2012 because of hail damage prior to harvest.

In 2013 wheat yields were good. In the deeper sand over gravel the wheat on offset disc plots without clay yielded 3.2 t/ha, incorporation of 100 t/ha of clay-rich subsoil increased the yield by 400 kg/ha to 3.6 t/ha (Fig. 1). Wheat on the sandy gravel that was spaded without clay yield 4.0 t/ha and the lower clay rates had no impact on grain yield (Fig. 1). Incorporation of 360 t/ha of clay-rich subsoil increased the grain yield by 400 kg/ha to 4.4 t/ha (Fig. 1).

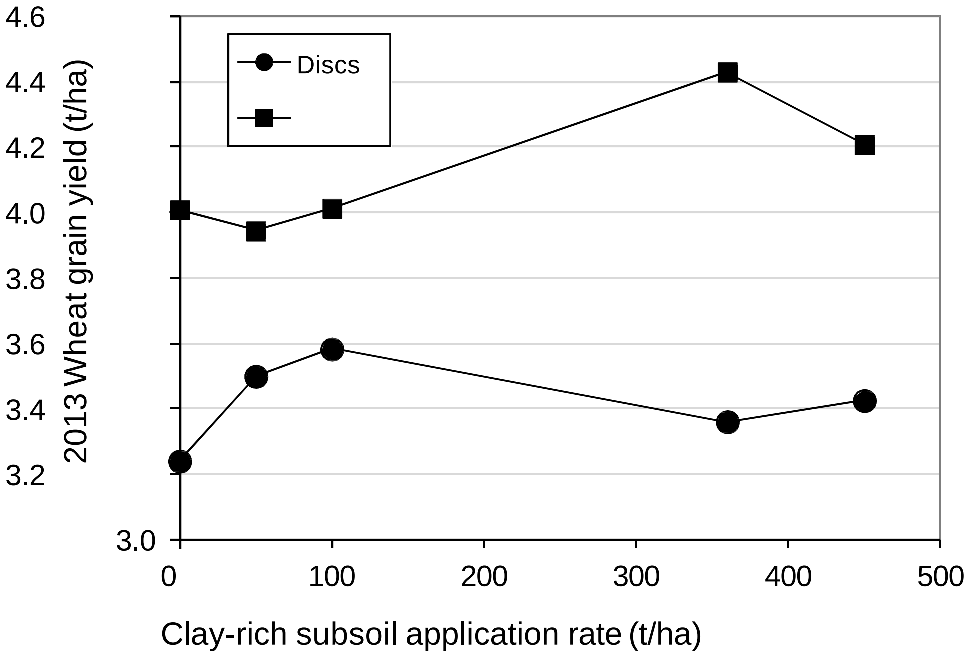


Figure 1. Machine harvest grain yields of Mace wheat in 2013 in response to increasing rates of applied clay-rich subsoil which contained approximately 30% clay and was spread and incorporated in 2009. Note the rotary spader (Spader) plots are located on sandy gravel which has a higher yield potential than the deeper sand over gravel where the plots that have been treated with offset discs (Discs) are located, therefore a direct comparisons of yield between the incorporation methods is not possible only the impact of clay rate for a given incorporation method.

Table 1. Change in grain yield (t/ha) for a range of clay-rich subsoil application rates and two incorporation methods compared to control plots that have not been clayed. Largest yield increases (or smallest decreases) for each season are highlighted in bold and italicised.

Clay Rate (t/ha)	Offset Discs					Rotary Spader			
	2009	**2010**	**2011**	**2013**		**2009**	**2010**	**2011**	**2013**
	Wheat	**Canola**	**Wheat**	**Wheat**		**Wheat**	**Canola**	**Wheat**	**Wheat**
50	***0.48***	***-0.01***	0.48	0.26		-0.23	0.21	-0.27	-0.06
100	0.42	***-0.01***	***0.54***	***0.34***		-0.42	0.26	-0.28	0.00
360	0.07	-0.22	0.49	0.12		0.21	***0.45***	***0.43***	***0.42***
450	0.14	-0.26	0.48	0.19		***0.49***	0.34	0.26	0.20

Over the three wheat years 100 t clay subsoil/ha has been the best performing treatment when incorporated with offset discs, yielding an additional 1.3 t/ha of wheat grain in total across all three seasons (Table 1), however there was no yield advantage in the year the canola was grown. For the incorporation with spading the 360 t clay subsoil/ha was the best performing treatment growing an additional 1.1 t/ha of wheat in total over the three seasons and 0.45 t/ha of canola in 2010 (Table 1).

This is also reflected in relative yields (Table 2) with wheat yield increased by 11-16% with application of 100 t/ha of clay incorporated by offset discs and by 6-11% with 360 t/ha of clay incorporated with the spader (Table 2). Incorporation of clay by spading had a large apparent benefit to canola grain yield in 2010 but clay incorporation with offset discs in the same season showed no benefit to canola yield (Tables 1 and 2).

Looking at the relative grain yields (Table 2) for each of the seasons where yield was obtained it is clear that with shallow incorporation the optimal yield was achieved at a lower application rate of 100 t/ha. Canola appears more sensitive to shallow (poor) incorporation of high rates of clay but 2010 was also a drier season which would have exacerbated the negative effects of poor incorporation (Table 2). In 2011, a wetter season, there was no significant penalty with shallow incorporation of the higher clay rates but nor was there any benefit of the higher rate. With deep incorporation the higher clay rates give higher yields, with 360 t subsoil/ha being the optimum in this trial (Table 2). Given about 1/3 of the subsoil contains actual clay this is about 120 t/ha clay. Deep incorporation tended to negate any benefit of claying at the lower rates. Canola seemed to respond particularly well to deep incorporation of higher rates of clay. This may be due to better soil water retention and availability in the drier 2010 season (Table 2).

Table 2. Relative grain yields for a range of clay-rich subsoil application rates and two incorporation methods compared to control plots that have not been clayed. Largest increases in relative yield (or smallest decreases) for each season are highlighted in bold and italicised. GSR = growing season (Apr-Oct) rainfall at Badgingarra Research Station.

Clay Rate (t/ha)	Offset Discs				Rotary Spader			
	2009	**2010**	**2011**	**2013**	**2009**	**2010**	**2011**	**2013**
	Wheat	**Canola**	**Wheat**	**Wheat**	**Wheat**	**Canola**	**Wheat**	**Wheat**
0	100	100	100	100	100	100	100	100
50	***118***	***99***	114	108	94	115	93	98
100	116	***99***	***115***	***111***	89	119	92	100
360	103	73	114	104	106	***133***	***111***	***111***
450	105	69	114	106	***114***	124	107	105
GSR (mm)	**447**	**300**	**485**	**446**	**447**	**300**	**485**	**446**

SUMMARY

This trial clearly demonstrates the importance of matching clay application rate and incorporation method when clay spreading for water repellence. For subsoils with a clay content of about 30% using a rate of 100-150 t subsoil/ha incorporated with offsets to a depth of 120-150 mm was sufficient to overcome the repellence and given wheat yield increases of 11-18%. Alternatively subsoil application rates of 250-350 t/ha are probably required if the clay is to be incorporated to 250-300 mm with a rotary spader and this gave similar yield increases of 11-14% on what is a better soil type with higher inherent yield potential. The main benefit of higher clay application rates and deeper incorporation seemed to be in the canola year, although more seasons with canola need to be assessed to confirm the validity of this finding.

PEER REVIEW

Christine Zaicou, DAFWA Geraldton

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