Assessing the benefit of clay-spreading for overcoming soil water repellence in the northern agricultural region

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Incorporating **11WMG17**

Purpose:	Assess what clay-rich subsoil application rates are required for overcoming soil water repellence and how this interacts with method of incorporation.
Location:	Badgingarra; Bolgart; Binnu; Balla
Soil Type:	Pale and yellow water repellent deep sands

BACKGROUND

The spreading and incorporation of clay-rich subsoil into pale sands to overcome soil water repellence was first tested by South Australian growers in the late 1960's. Since then 'claying' has developed as a recognised technique for overcoming water repellence in sandy soils with some grower experience and long-term trials suggesting that it can have productivity benefits that can last well in excess of 10 years. Grower experience with claying, however, can be mixed and productivity can be reduced by claying if high subsoil application rates are used and this is not incorporated adequately, particularly in drier seasons. High rates of poorly incorporated clay can cause surface sealing and crusting that can reduce establishment. Furthermore poorly incorporated clay can hold a lot of water at the soil surface where it is subject to evaporation and crop root growth can be concentrated in the surface soil with poor subsoil exploration making these crops very vulnerable to haying off at the end of the season. Good incorporation of the applied clay-rich subsoil encourages root development into the profile however sufficient clay needs to be retained in the soil surface to overcome water repellence in the long term.

Traditionally offset discs have been used to incorporate clay but they have a limited working depth and so are not usually effective for incorporating high clay-rich subsoil application rates in excess of about 200 t/ha. Rotary hoes and rotary spaders that can incorporate clay to depths of 20-35 cm provide an opportunity for incorporating higher rates of applied subsoil. Given the high cost of claying it is necessary to determine how it can best be implemented to achieve productivity gains and it is important to ensure that these benefits are long lasting and are maintained across a range of seasons and locations.

METHOD

Over the past 3 years a total of 6 trial and demonstration sites that include claying as a treatment have been established in the northern agricultural region. All sites include an untreated control and at least one claying treatment, although several sites have various clay-rich subsoil application rates and a number of incorporation methods. In each instance the clay-rich subsoil was excavated from a local on-farm source and clay was spread using a multi-spreader which do a better job of spreading the clay than carry graders, thereby requiring less smudging and leveling. In this paper we summarise the wheat yield responses in these recently established claying trials, where multiple rates were present at a particular site we have used the more moderate rates of between 100-260 t subsoil/ha (Table 1). For the majority of subsoils the clay contents ranged from 30-40% (Table 1) so these rates represent actual clay application rates of between 30-100 t clay/ha. The spread subsoil was incorporated with either several passes of offset discs or a single pass with a rotary spader, operating shallow at around 15-20 cm (Table 1).

RESULTS

Table 1. *Summary of wheat yield responses to spreading of moderate rates of clay–rich subsoil in claying trials and demonstration sites established from 2009-2011 in the northern agricultural region. GSR = Apr-Oct growing season rainfall; * = unreplicated demonstration sites.*

Location	Clay-rich subsoil application rate (t/ha)	Clay % in applied subsoil	Incorporation method	Year	GSR (mm)	Years after claying	Wheat Yield response (kg/ha)
Bolgart	260	38	offset discs	2010	161	1	250
				2011	324	2	550
Badgingarra	150	31	offset discs	2009	447	1	270
				2011	485	3	460
Badgingarra*	100	31	offset discs	2009	447	1	410
				2011	485	3	536
Badgingarra*	120	-	combine tynes	2011	485	1	358
Binnu	125	26	spader (shallow, ~15cm)	2009	283	1	200
				2011	321	3	310
Balla	150	52	spader (shallow, ~10cm)	2011	252	1	21

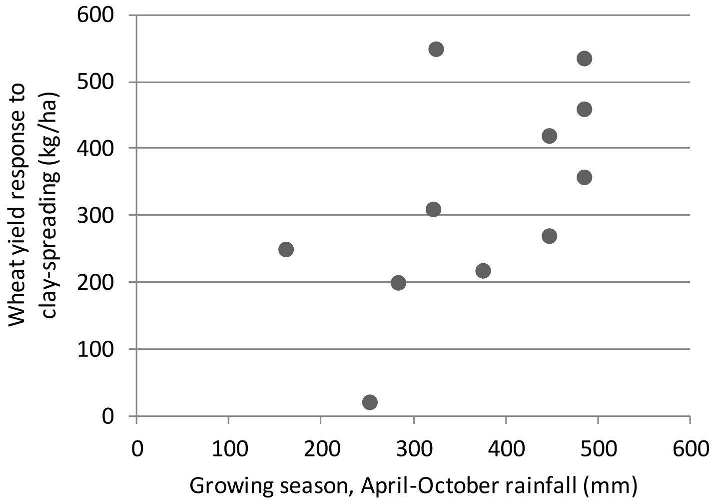

Figure 1. *Wheat grain yield (kg/ha) response to clay-spreading (claying) of moderate rates (100-260 t/ha) of subsoil versus growing season (Apr-Oct) rainfall for claying trials and demonstration sites established from 2009-2011 in the northern agricultural region of WA.*

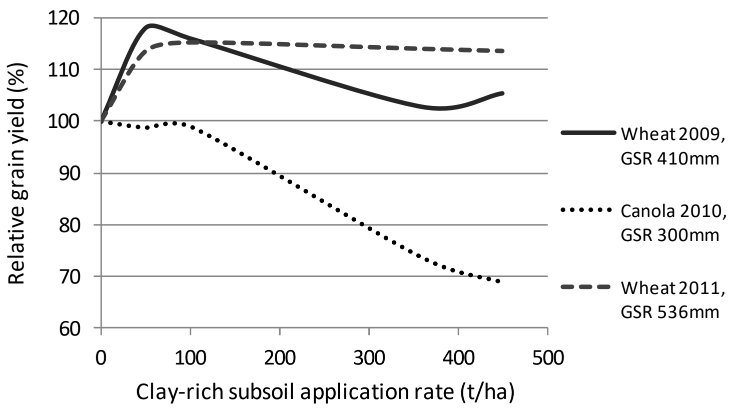

Figure 2. *Relative crop grain yield (%) responses to clay-rich subsoil application rates incorporated with offset discs on water repellent pale deep sand at Badgingarra. The trial was established in 2009 and data shown are for the 2009, 2010 and 2011 growing seasons. GSR = growing season (Apr-Oct) rainfall (mm).*

DISCUSSION

Despite these trials being recently established, growing season rainfall across the sites and seasons has varied considerably ranging from 161 to 485 mm (Table 1). Wheat grain yield responses to clay spreading have ranged from effectively no response up to 536 kg/ha (Table 1). In these trials there have been no negative yield responses so far when subsoil has been spread at moderate rates, <260 t/ha with good mixing and incorporation to depths of 10-20 cm. At higher clay-rich subsoil application rates of 300 t/ha or more there have been negative yield responses particularly when incorporation has been inadequate or where canola has been grown (Fig. 2). For all but one of the sites and years the wheat yield increases have been 200 kg/ha or more (Table 1) for the moderate application rates.

Despite the limited data set and many other variables in these trials, in general the wheat yield responses have been lower in years with lower growing season (April-October) rainfall <300 mm (Fig. 1). Grower observation and other trial data appear to support this. In general we believe that in drier seasons, at drier locations, and at higher clay-rich subsoil application rates wheat yield responses to claying tend to be lower or even negative.

Clay-rich subsoil application rates have been tested at several sites, usually with several incorporation methods. When incorporating clay-rich subsoil with offset discs relative grain yields are typically improved for wheat or unchanged for canola at the lower subsoil application rates up to 100 t/ha (Fig. 2), equivalent to 31 tonnes actual clay/ha. However, in drier seasons higher subsoil application rates >100 t/ha have reduced the relative yield benefit for wheat in 2009 or significantly reduced canola yields in 2010 to less than 70% of the unclayed yield (Fig. 2). Canola tends to perform poorly on pale deep sands and yields ranged from 0.61 to 0.83 t/ha in 2010. At a trial site at Balla in 2011 subsoil application rates ranged from 40 to 150 t/ha, actual clay application rates of 20-75 t/ha, but there was no wheat grain yield benefit regardless of the application rate.

Taken together these results confirm that claying can be beneficial but because of its effect on water relations, with more water being held in the surface and its potential impact on root architecture with more shallow roots there is a risk that crops on clayed soils can hay off due to water shortage at the end of the season. For this reason claying may be too risky and the returns not large enough in warmer, drier and shorter season environments that can be found in the northern part of the agricultural area or in the eastern parts of the wheatbelt. Use of moderate clay-rich subsoil application rates of between 100-250 t/ha with adequate incorporation to a depth of 10-20 cm will reduce the risk of negative impacts and may give good long-term returns in higher rainfall areas, although benefits may be less or non-existent in dry seasons. More moderate clay-rich subsoil application rates of 100-150 t/ha are less costly to apply, can be easily incorporated, can still improve crop establishment and productivity and importantly can reduce some of the risks associated with crops haying off due to water shortage during grain filling in dry seasons.

Testing of the subsoil for clay %, pH, salt and nutrients is still essential before spreading so any toxicity issues associated with high salt, high boron or high and low pH can be identified and application rates determined. Some clay-rich subsoils can contribute significant amounts of K and S to the soil and a stabilised soil surface with reduced wind erosion risk is a significant benefit of clay-spreading on erosion-prone sands.

KEY MESSAGE

- More moderate clay-rich subsoil application rates of 100-150 t/ha are less costly to apply, can be easily incorporated, can still improve crop establishment and productivity and importantly can reduce some of the risks associated with crops haying off due to water shortage during grain filling in dry seasons.

- Clay-spreading is likely to be more beneficial in higher rainfall, longer season environments and in wetter seasons where the risk of water shortage at grain fill and haying off is reduced.

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