Assessing clay rates and incorporation methods for amelioration of water repellent sandplain soil at Bolgart

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Purpose:	To assess the interaction between clay rate and incorporation methods to overcome soil water repellence and improve crop establishment and productivity.
Location:	Bolgart WA
Soil Type:	non-wetting grey loamy sand
Soil Tests:	No clay, no incorporation (Nil)- pH 5.8 ($CaCl_2$)& 0.69 %OC (low) at 0-10cm and pH 5.3 ($CaCl_2$) & 0.39 %OC (too low) at 10-20cm
Rotation:	2009 Lupins; 2008 Barley; 2007 Wheat
GSR:	161 mm

BACKGROUND

The nature of non-wetting sands makes retaining ground cover difficult under marginal moisture conditions and leads to the poor germination and crop growth. This limited yield potential drives down the sustainability of cropping these soil types and poor establishment/biomass makes paddocks susceptible to wind erosion. Claying is the most successful long term solution to overcoming non-wetting soils but can be highly expensive, relying on growers having a nearby source of clay. This highlights the importance of firstly applying the right tonnage of clay and secondly, mixing the clay through the soil profile for optimal water entry and storage. Recently techniques, such as rotary spading, rotary hoeing have been tested to improve the incorporation and effectiveness of clay additions to non-wetting paddocks compared with the traditional method of using offset discs. These techniques were assessed in this trial.

TRIAL DESIGN

A clay contractor spread clay in replicated strips in January and the farmer spread lime and gypsum in March. Incorporation methods were applied across replicated clay strips (Criss cross design) in April and the bulk area was sown after the first rain in late May.

Table 1: *Treatments*

Clay rate	Incorporation method
0 t/ha*	No incorporation*
260 t/ha**	Offset discs, single pass
520 t/ha	Offset discs, double pass**
	Rotary spader, 7 km/hr
	Rotary spader, 2 km/hr
	Rotary hoe, 4 km/hr
	Rotary hoe, 2 km/hr

** Nil treatments   ** Grower practice*

Plot size: varied due to machinery widths, 5m x 6-12m (total area: 45m x 72m)

Repetitions: 3

Crop details: Fortune wheat at 70 kg/ha on 29th May 2010

Treatments: **pre-seeding:** 1 t/ha lime; 0.5 t/ha gypsum

Post: 14 units P; 14 units K; 8.25 units S; 48 units N

RESULTS

Soil moisture

As expected soil disturbance caused by the incorporation methods reduced the bulk density of the soil. The site received 40 mm after sowing. All the clayed and incorporated had an improvement in moisture retention, though generally plots applied with 520 t clay/ha had the highest moisture content (Fig. 1).

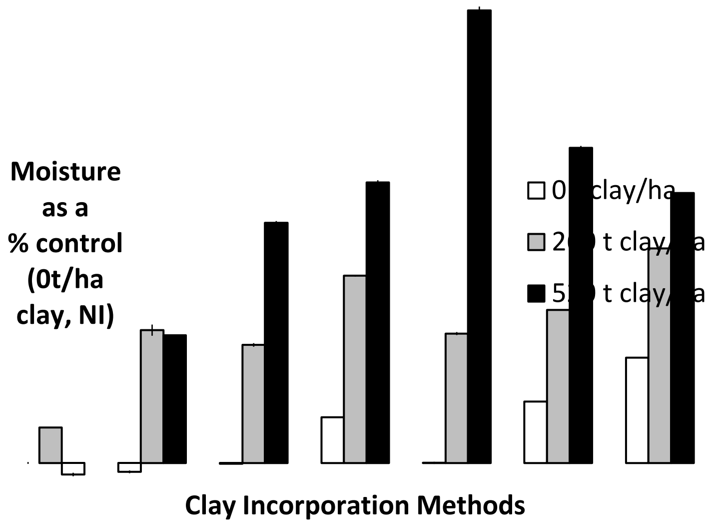

Figure 1. *Soil moisture recorded on the 1st July 2010 using 10cm deep soil cores*.

Crop Establishment

Cultivation with the offset discs, rotary hoe, or rotary spader did not improve crop establishment in the absence of clay (Fig. 2). In fact cultivation using the rotary hoe without the addition of clay decreased crop establishment (Fig. 2). Addition of clay-rich subsoil at either the 260 or 520 t/ha rates coupled with incorporation by any of the tillage tools improved establishment. Incorporation of clay-rich subsoil with the rotary hoe was still less effective at increasing establishment than incorporation with the offset discs which in turn were less effective than the rotary spader. The softness of the soil within the rotary hoe treatments caused issues with seeding depth. Seeding depths ranged from 4.3 to 5.3 cm for the rotary hoe, compared to 3.0 to 4.8 cm for the rotary spader. Addition of the high 520 t/ha rate of clay-rich subsoil was not significantly better than the more moderate rate of 260 t subsoil/ha (Fig. 2).

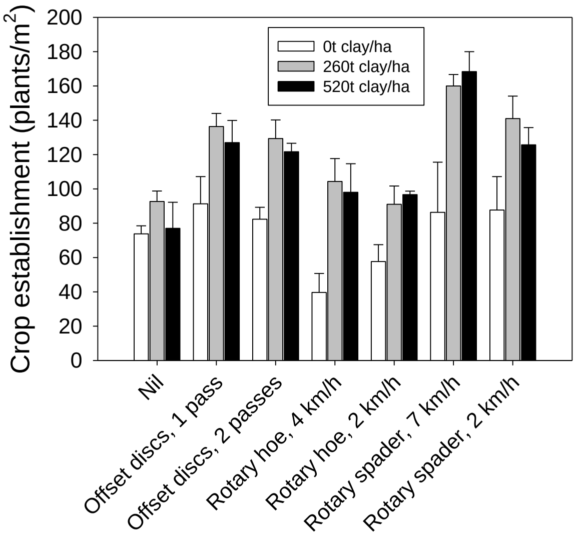

Figure 2. *Impact of clay rate and incorporation method on wheat establishment on water repellent sand at Bolgart WA in 2010. Bars show standard error of the mean of 3 replicates.*

Grain yields

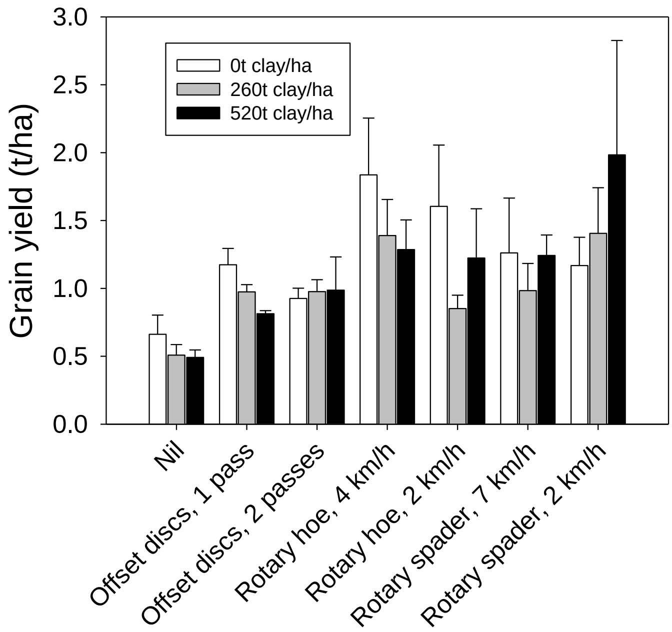

***Figure 3**. Impact of clay rate and incorporation method on grain yield of mature wheat growing on water repellent sand at Bolgart WA in 2010. Bars show standard error of the mean of 3 replicates.*

Grain yields were also increased by cultivation (Fig. 3). Cultivation using the rotary hoe and to a lesser extent the rotary spader increased yields the most but the increases were somewhat inconsistent hence large errors associated with these. Addition of clay-rich subsoil tended to decrease the grain yield when incorporated with only a single pass of the offset discs or with a rotary hoe (Fig. 3). Yield responses to spading of clay were inconsistent but given the high variability of these responses no conclusions can be made for the 2010 season.

FINANCIAL ANALYSIS

Growers estimate of costs for clay spreading and incorporation on the 120ha paddock surrounding the trial.

Operation	Cost
Sourcing and spreading of clay (varies)	~ $700/ha
Smudging	~ $30/ha
Ridging (cultivator)	~ $15/ha
Spreading	~ $10/ha
Deep ripping	~ $25/ha
Spading	~ $100/ha

TOTAL: ~$880/ha

Trevor Syme has seen productivity gains from previously clayed paddocks, indicating yields on non-wetting sands to be about 1.5t/ha versus 3-3.5t/ha on clayed paddocks. In this dry season yield advantages from claying were also evident.

DISCUSSION

Addition of clay-rich subsoil improved crop establishment at this site in 2010. There was a very dry finish to the growing season with <15 mm in total for September and October so those cultivation and claying treatments with increased biomass and higher yield potential would have been more prone to haying off. Poor incorporation of surface applied clay-rich subsoil can also hold more moisture near the surface which is then subject to evaporation and competes with the roots for water with small rainfall events. Despite these factors cultivation with or without the addition of clay-rich subsoil did increase grain yields from <700 kg/ha in the uncultivated situation to an average yield of 1.3 t/ha for the rotary hoe and rotary spaded treatments combined. Ongoing monitoring of this trial will be required to see the longer-term benefits of these cultivation and clay incorporation treatments on establishment and yield in seasons with a better finish.

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