# Soil amelioration trial at Badgingarra – claying benefits come to the fore in a wetter season

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| **Purpose:** | Long-term assessment of water repellence amelioration techniques |
| **Location:** | Badgingarra Research Station |
| **Soil Type:** | Pale deep sand |
| **Rotation:** | Lupins 2008; Wheat 2009; Canola 2010; Wheat 2011 |
| **GSR:** | 485 mm |

## BACKGROUND

There are numerous options available for managing soil water repellence in cropping systems. Well designed furrow sowing or use of soil wetting agents are examples of mitigation options that do not remove or alter the water repellent material on the soil but simply help water entry and crop establishment in the short term. Mitigation options are relatively cheap to implement in any given year but in general they need to be repeated each year to be effective. Amelioration management options are ideally implemented once with the aim of overcoming or removing the water repellent topsoil for a significant length of time, 5-10 years or more but are relatively expensive to implement. Clay spreading, rotary spading and soil inversion with a mouldboard plough are examples of amelioration strategies. In order to assess the effectiveness, economic viability and practical feasibility of the amelioration options it is necessary to conduct long-term experiments over a number of seasons. In 2009 DAFWA with support from GRDC and in collaboration with the West Midlands Group established a long-term soil amelioration trial site on deep pale sand to assess some of these options at the Badgingarra Research Station. Clay- spreading was chosen because it can be a very effective long-term option for overcoming water repellence but incorporation can be an issue and the range of cultivation methods provided an opportunity to assess different degrees of clay-rich subsoil incorporation. Similarly there was also an opportunity to look at lime incorporation into the subsoil plus higher pH has been shown to favour those soil microbes that degrade the waxes which may be able to partly reduce the severity of water repellence. The range of cultivation treatments used in the trial not only provided a range of different levels of amendment incorporation but also allowed varying levels of dilution, mixing and burial of water repellent topsoil to be assessed.

## TRIAL DESIGN

The experiment was established in 2009 as a long-term trial to look at the following soil amelioration treatments on water repellent pale deep sand: no amendment (nil); 3 t/ha limesand; and 150 t/ha clay-rich (31% clay) subsoil spread with a mullti-spreader. Across these amendment strips 6 cultivation treatments were applied: no cultivation (Control); deep ripping; offset discs; mouldboard plough; rotary hoe; and rotary spading. The trial was seeded and treated as normal with the rest of the paddock. The plots were harvested with the plot header.

**Plot size:** 4 m x 20 m for each cultivation x amendment combination with 4 replicates

**Crop details:** Mace wheat seeded at 100kg/ha on 11 June 2011

**Fertiliser:** **At seeding:** 100 kg/ha K Till Plus

**Post:** 85kg/ha NS (27 June); 85kg/ha NS (25 July); 40 L/ha Flexi N (12 August)

## RESULTS & DISCUSSION

### Crop establishment

In 2011 there was a 95% chance of real differences between any of the amendment or cultivation treatments on crop establishment but there was no significant interaction between the two types of treatment. Therefore the main effects of cultivation (Figure 1) and amendment (Figure 2) are shown separately.

Crop establishment was similar for most of the cultivation treatments but in the 2011 season the rotary spading plots had significantly fewer plants than the control, deep ripped, mouldboard plough or offset disc treatments (Fig. 1). This is surprising given that in previous seasons the spader treatment had higher crop establishment than many of the other treatments. However, despite this difference the 149 plants/m2 that established on the spaded plots is a sufficient plant population to achieve yields of up to 3 t/ha so establishment would not have limited grain yield on this soil type.

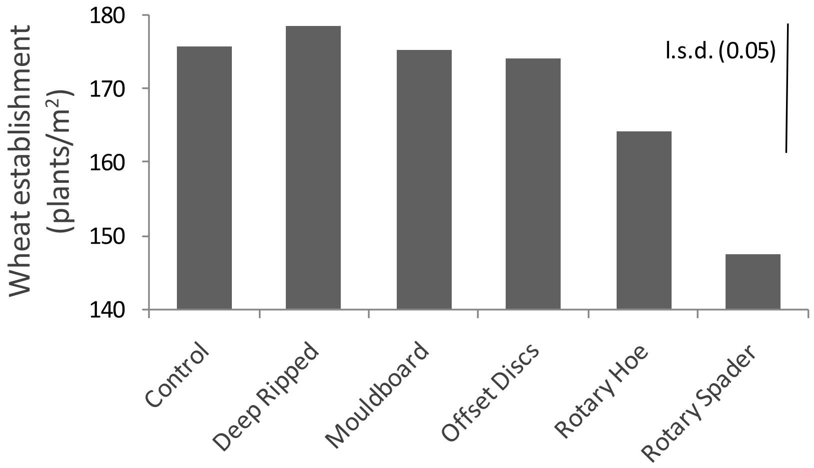


***Figure 1.*** *Wheat establishment at Badgingarra Research Station in 2011 in response to cultivation treatments applied in 2009.*

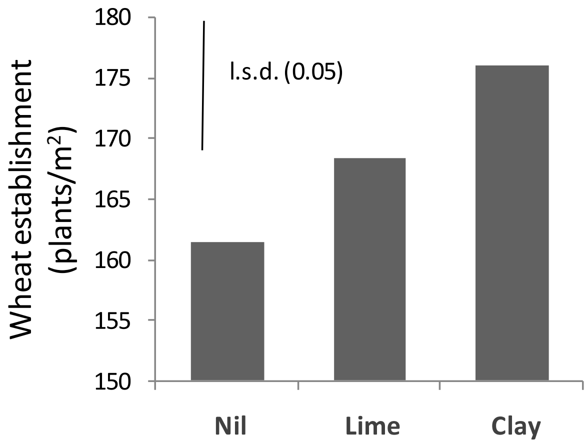


***Figure 2.*** *Wheat establishment at Badgingarra Research Station in 2011 in response to soil amendment treatments applied in 2009.*

The reason for poorer establishment on the spaded plots is unclear. There is a trend for both the rotary tillage implements to have lower establishment in 2011 (Fig. 1). Rotary tillage is quite an aggressive mixing action which would disrupt any pre-existing preferential flow pathways for water entry. In the case of the spader however the lifting of subsoil seams to the surface appears to re-introduce pathways for water entry. Further assessment is required in 2012 to establish whether these subsoil seams are still effective in the 4 year after the spading was done.

Application of clay-rich subsoil had a positive impact on wheat establishment in 2011 compared with the treatments that received no amendment (Fig. 2). Overall clay-spreading improved the plant population by 15 plants/m2 but establishment was more than adequate in all the treatments to achieve the crop yields possible with this soil type.

**Wheat grain yield**

Clay spreading was the only treatment to significantly increase grain yield  at 95% confidence in the 2011 season by an average of 410 kg/ha (Fig. 3).

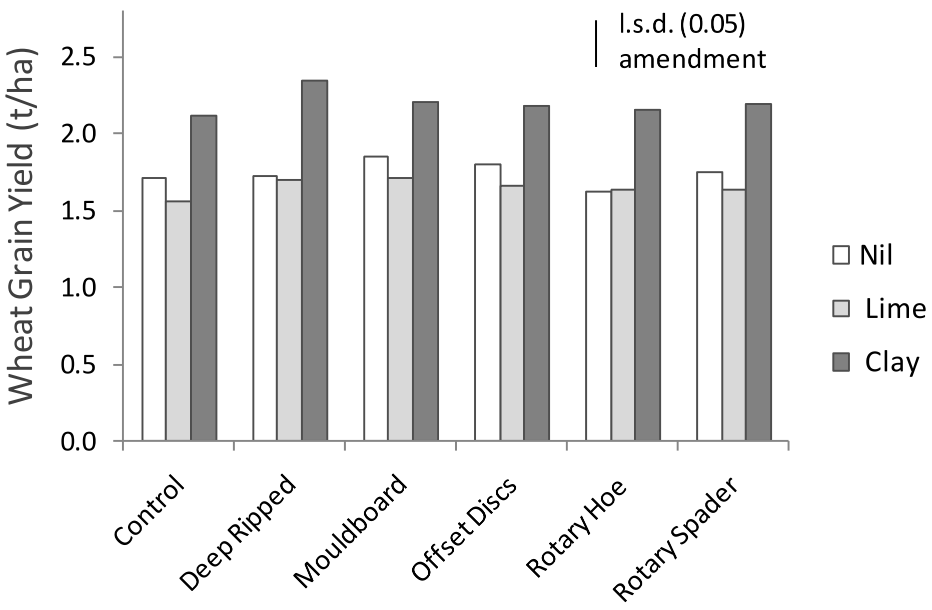


***Figure 3.*** *Wheat grain yields at Badgingarra Research Station in 2011 in response to cultivation and soil amendment treatments (Nil, Lime, Clay) applied in 2009. There was no significant response to cultivation at 95% confidence.*

Cultivation had no significant effect of on grain yield. The lack of a cultivation response may be because the effects of cultivation have reduced in the 3 years since they were applied to the point where there is now no measureable difference. While this could well be true for the more shallow one-off offset disc and rotary hoe cultivation treatments the changes in the soil profile brought about by spading and mouldboard ploughing, in particular, are much bigger and long lasting. In other mouldboard plough trials productivity responses have been measured up to 4 years after it was done suggesting that longer lasting impacts are possible. Additional soil measurements including water repellence, soil strength, carbon, nutrient and pH profiles in 2012 should help clarify the extent of the soil differences that still remain. Alternatively it may be that the seasonal conditions in 2011 were not conducive to showing differences between the cultivation treatments with good soil moisture conditions at establishment and regular rains through most of the season minimising any significant drought stress.

As well as no response to cultivation there was also no significant effect of the interaction between cultivation and amendment application on grain yield. This is interesting because it suggests that at the moderate subsoil application rates used in the trial, in a wetter season, the degree of incorporation is less critical. It may also be true that over time the disturbance from seeding, and the impact of rainfall is helping the clay incorporate into the topsoil even in the control treatment. Perhaps more surprising is the fact that even where the clay has been inverted as a layer in the subsoil using a mouldboard plough the yield benefit from the clay-spreading persists (Fig. 3). It has often been observed that crop roots proliferate in the organic layer buried by mouldboard ploughing and combined with clay-rich subsoil this layer may help retain nutrients and some water that is then available to the crop. It was clearly observed during the season that the clayed areas were staying a darker green than the rest of the treatments suggesting that nutrient retention and reduced leaching were an important factor in the yield responses seen in 2011. Similar growth and nutrition response to clay application were seen in the warmer climate at Balla (100km north of Geraldton) in 2011; however, the crop did not yield better due to August and September drought stress causing the topsoil to be exhausted of plant available water. The good spring growing conditions with minimal water deficit allowed the clay-spread treatments to ‘finish’ and produce a yield benefit at Badgingarra.

## SUMMARY

- Good soil moisture conditions at sowing reduced the impact of repellence on establishment; all treatments established a healthy number of plants
- Claying improved crop establishment, growth and grain yield in 2011; this appears to be driven by better seedbed moisture retention and reduced nutrient leaching, especially nitrogen
- Good soil moisture conditions during grain fill minimised any water shortage (haying off) effects from claying
- Cultivation treatment had no impact on grain yield, possibly because seasonal conditions were not conducive to showing differences or because the cultivation impacts are reducing over time, ongoing assessment should clarify this
- Drier conditions at seeding and harder finishes would be expected to result in greater impact from the repellence management treatments

**REVIEWED:** Paul Blackwell, DAFWA


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