Impact of mouldboard ploughing and lime on deep yellow sand with acid subsoil

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Purpose:	To measure the impact on crop productivity of combinations of lime and mouldboard ploughing on acidic deep yellow sand
Location:	West Moora
Soil Type:	Deep yellow sand
Soil Results:	pH_{Ca} = 5.6 @ 0-10cm; 4.9 @ 10-20cm; 4.5 @ 20-30cm (in 2010)
Rotation:	Wheat 2008; Wheat 2009; Canola 2010; Wheat 2011
GSR:	347 mm (nearby BOM site)

BACKGROUND

Subsoil acidity, topsoil water repellence and herbicide resistant weeds are often found in combination on deep sands in Western Australia. Surface applied lime can be used to treat subsoil acidity but it can take many years before it significantly increases the subsoil pH. One-off soil inversion using a mouldboard plough provides an opportunity to incorporate lime into the subsoil rapidly treating subsoils acidity and can also ameliorate soil water repellence and bury herbicide resistant weeds. In 2009 Aglime established a demonstration site to look at the impact of liming, soil inversion and burial of lime on crop yields over time.

TRIAL DESIGN

Plot size: 30m x 100m

Machinery: Site was ploughed in 2009 using a 3-furrow Kvernerland mouldboard plough with skimmers at a working depth of 30-35 cm. The ploughed soil was then firmed with land packers. All subsequent seeding and management operations have used standard farm machinery as per the rest of the paddock.

Repetitions: Unreplicated demonstration trial; 2 replicate plots of mouldboard plough without lime treatment only.

Crop details: Magenta wheat @85kg/ha on 25 May

Fertiliser: **At seeding:** Mapsc & MOP blend (70% Mapsc, 30% MOP) @ 55kg

Post: Urea split application early July and mid August @ 120 kg

Herbicide: Treflan @2 L/ha Sprayseed @1 L/ha, Logran @ 35 Grams (29 May);

500ml Paragon, 500ml Bromicide, 5 grams Glean (8 July)

RESULTS

Crop yields have been monitored since the trial was established in 2009. Approximate growing season rainfall (Apr-Oct) taken from nearby weather stations was 343 mm in 2009; 221 mm in 2010 and 347 mm in 2011.

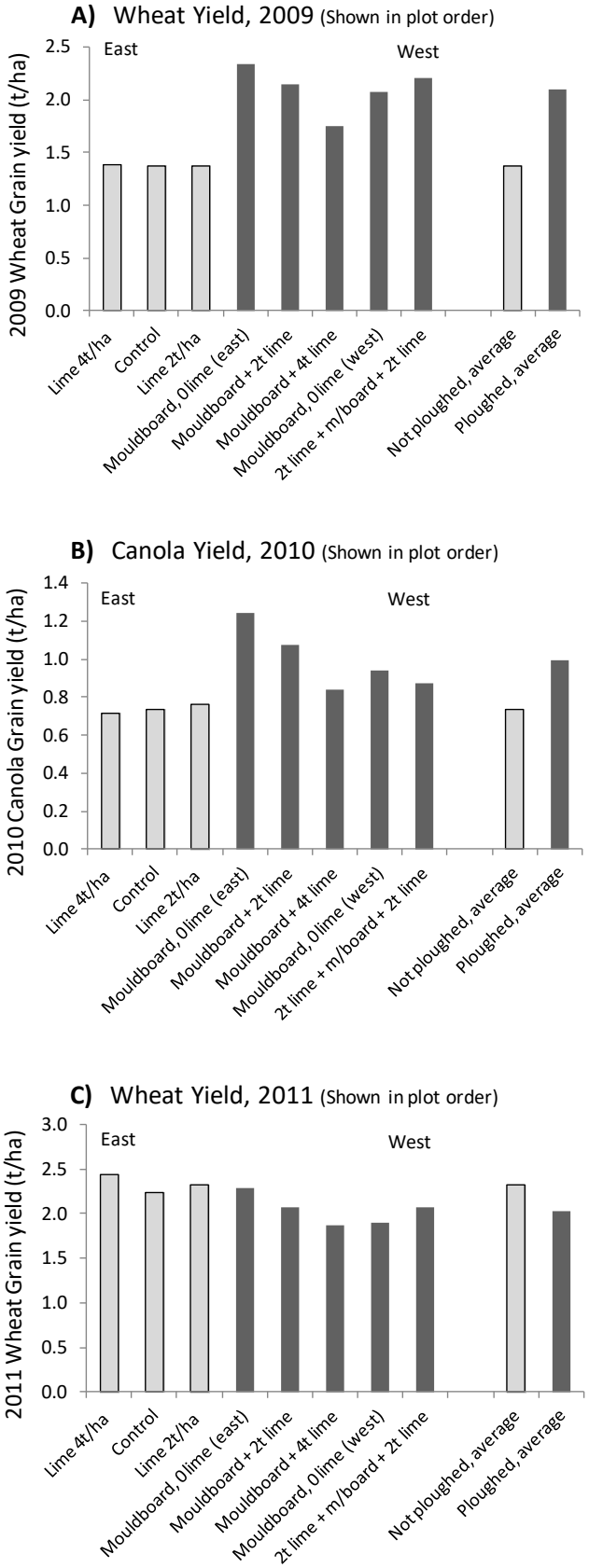

Figure 1. *Crop yields in response to various lime and mouldboard plough treatments applied in 2009 to deep yellow sand, West Moora. A) Wheat in 2009 season; B) Canola in 2010 season; and C) Wheat in 2011 season. Treatments are shown in plot order. Average yields for unploughed plots versus those mouldboard ploughed once in 2009 are shown also.*

DISCUSSION

In the first two seasons, 2009 and 2010, there was a strong and consistent yield increase in response to mouldboard ploughing (Fig. 1A, B). In wheat grown in 2009 the mouldboard plough plots yielded 730 kg/ha (53%) more on average than the unploughed plots (Fig. 1A) while in 2010 canola on the ploughed plots yielded, on average, 256 kg/ha (35%) more grain than the unploughed plots. This occurred regardless of lime treatment and differences were large enough and consistent enough to be confident in these differences despite this trial being unreplicated.

In 2011 (Fig. 1C) the mouldboard plough plots on average yielded 300 kg/ha (13%) less than the unploughed plots (Fig. 1C). This trial is an unreplicated demonstration so it's hard to tell if the negative response is real or not. There is evidence for a yield trend at the site which may be having an impact. The mouldboard ploughing with no lime treatment has been replicated in the trial and in every year the eastern plot has yielded more than the western plot (Fig. 1A-C). In 2009 the difference between these two was 270 kg/ha; in 2010 it was 306 kg/ha and in 2011 it was 393 kg/ha, always in favour of the plot nearer the eastern end of the trial (Fig. 1A-C). In 2011 the eastern mouldboard plough plot yielded 2.29 t/ha, the same as the 2.33 t/ha average yield for the unploughed plots. This suggests that there may be a yield trend at the site with the eastern side of the trial tending to be higher yielding than the western side. It is not clear whether the apparent yield decline due to mouldboard ploughing in 2011 is real or not but it is clear that mouldboard ploughing gave no yield advantage in 2011. If the trend for lower yields in the mouldboard plough plots continues for more seasons and for various crops it may suggest that this is a real treatment effect. It appears, from this trial, as though the soil inversion treatment may give a greater advantage in drier seasons than in wetter ones.

Regardless of these issues the trial does demonstrate that if the treatment differences are large enough and consistent enough treatment effects can be observed, as was the case in 2009 and 2010, but unreplicated designs work less effectively where treatment differences are small and less consistent. At some other trial sites mouldboard ploughing has continued to show benefits for 3 or 4 years and further time and analysis is required to understand the long term impacts of soil inversion more fully. Recompaction of sands that have been inverted is a significant risk and could impact on subsequent crop yields, reducing productivity benefits. It was observed that the mouldboard plough treatments in this trial still had significantly fewer weeds but this benefit was not quantified.

There has been little impact, if any, of lime. While the subsoil at the site is acidic it may not be low enough to be limiting grain yields, although without ongoing liming acidification will continue and productivity will likely decline. When this occurs the lime treatments may start to show greater productivity benefits. There was a trend towards increasing yield in the unploughed plots with yields of 2.24, 2.32 and 2.44 t/ha for the no lime, 2 t/ha lime and 4 t/ha lime plots, respectively, but these differences are too small to be significant. The incorporation of lime with the mouldboard plough has largely corrected the subsoil acidity with the split lime application treatment, with some buried by ploughing and some spread on the ploughed surface being most effective at improving the soil pH of the profile.

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