Canola responds to amelioration of water repellent and acidic yellow sand using soil inversion and lime

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Purpose:	To demonstrate how soil inversion using a mouldboard plough could be used incorporate lime into acidic subsoil, overcome soil water repellence and control weeds and to measure its impact on crop yield.
Location:	**'**Glenruff', North West Road, Moora
Soil Type:	Deep yellow sand
Soil Results:	pH_{Ca} = 5.6 at 0-10 cm; 4.9 at 10-20 cm; 4.5 at 20-30 cm
Rotation:	Wheat 2008, Wheat 2009, Canola 2010
GSR:	221 mm (BOM Moora West)

BACKGROUND

Subsoil acidity, topsoil water repellence and herbicide resistant weeds are often found in combination on sandplain soils in Western Australian wheatbelt. One-off soil inversion using a mouldboard plough is being investigated as a way to decimate herbicide resistant weed seed banks, bury water repellent topsoil and incorporate lime into acid subsoils. In 2009 Aglime established a demonstration site to assess the impact of soil inversion on deep yellow sand at West Moora.

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, site was then packed with land packers. All subsequent seeding and management operations have used standard farm machinery as per the rest of the paddock.

Repetitions: Unreplicated demonstration with 2 replicate plots of mouldboard plough without lime treatment.

Crop details: Scorpion (RR) Canola at 4.5 kg/ha on 19th May 2010

Treatment rates and dates:

- 80 kg MAP + 25 kg Potash at seeding;
- top up 80kg urea on 6/7/10;
- 2 post sprays of glyphosate 14/6/10 and 12/7/10.

RESULTS

The soil at the site is moderately repellent with a standardized laboratory test giving a water droplet penetration time of 180 seconds (3 min). Following inversion ploughing the water entered instantly with no evidence of repellence. Despite this difference in water repellence visually the canola establishment did not appear to be markedly different between the ploughed and unploughed plots in 2010.

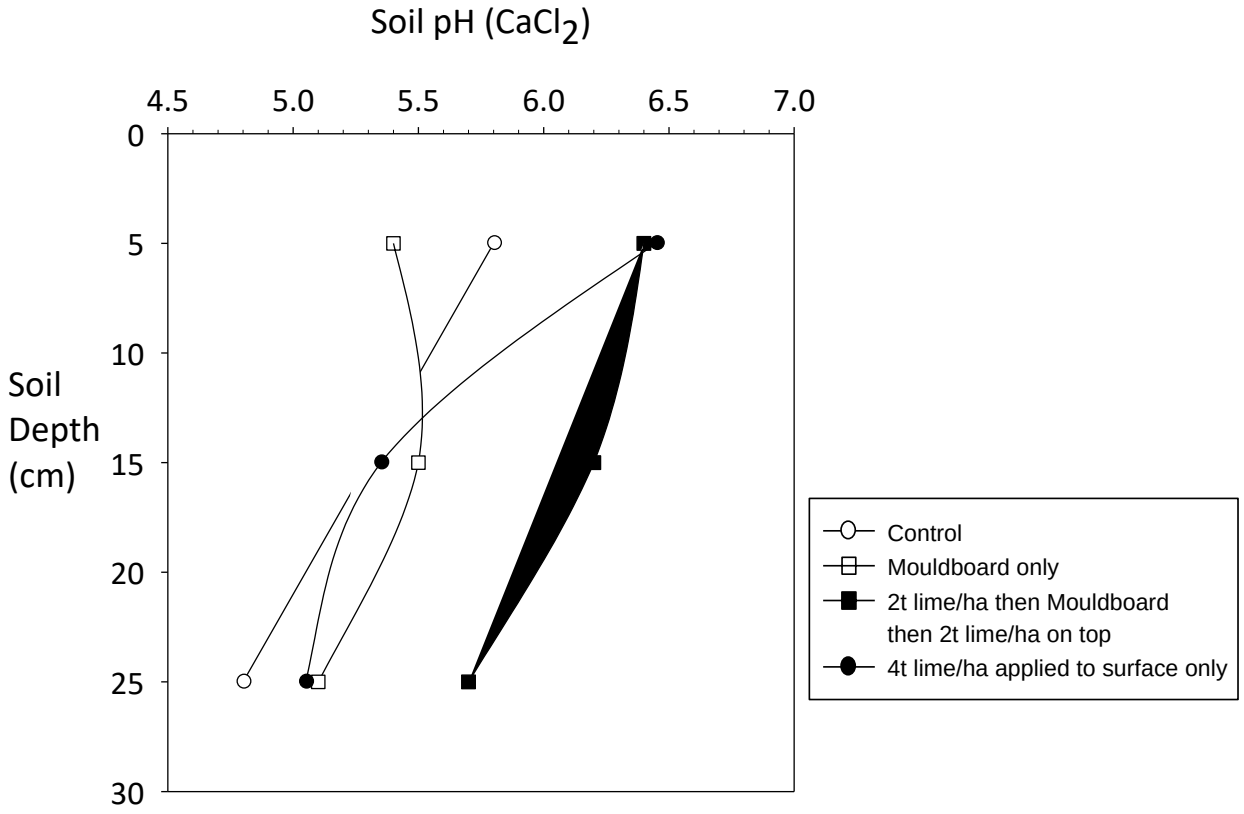

Figure 1. *Soil pH profiles measured in summer 2010 in response to various mouldboard ploughing and lime application treatments applied in 2009, on a deep yellow sand west of Moora, WA.*

Subsoil acidity at the site was not severe enough to be causing an aluminium toxicity problem at this site yet (Fig. 1). The untreated soil had a topsoil pH of 5.8, above the target level for topsoil of 5.5 and the subsoil pH for 10-30 cm was above the subsoil target of 4.8 (Fig. 1).

Addition of lime to the surface only increased the topsoil pH but did not significantly change the subsoil pH (Fig. 1). Mouldboard ploughing without lime resulted in an increase in the pH of the 10-20 cm layer due to the burial of the higher pH topsoil but the 0-10 cm pH declines with the lifting of the more acidic subsoil (Fig. 1). Applications of 2 t/ha lime before mouldboard ploughing and 2t/ha after mouldboard ploughing very effectively increased the pH for the entire 0-30 cm of the soil profile (Fig. 1).

Grain yield trends in canola in 2010 (Fig. 2) were very similar to those achieved 2009 for wheat (see 2009 WMG research annual). In both years mouldboard ploughing increased yield with lime having little apparent impact on crop yields at this stage.

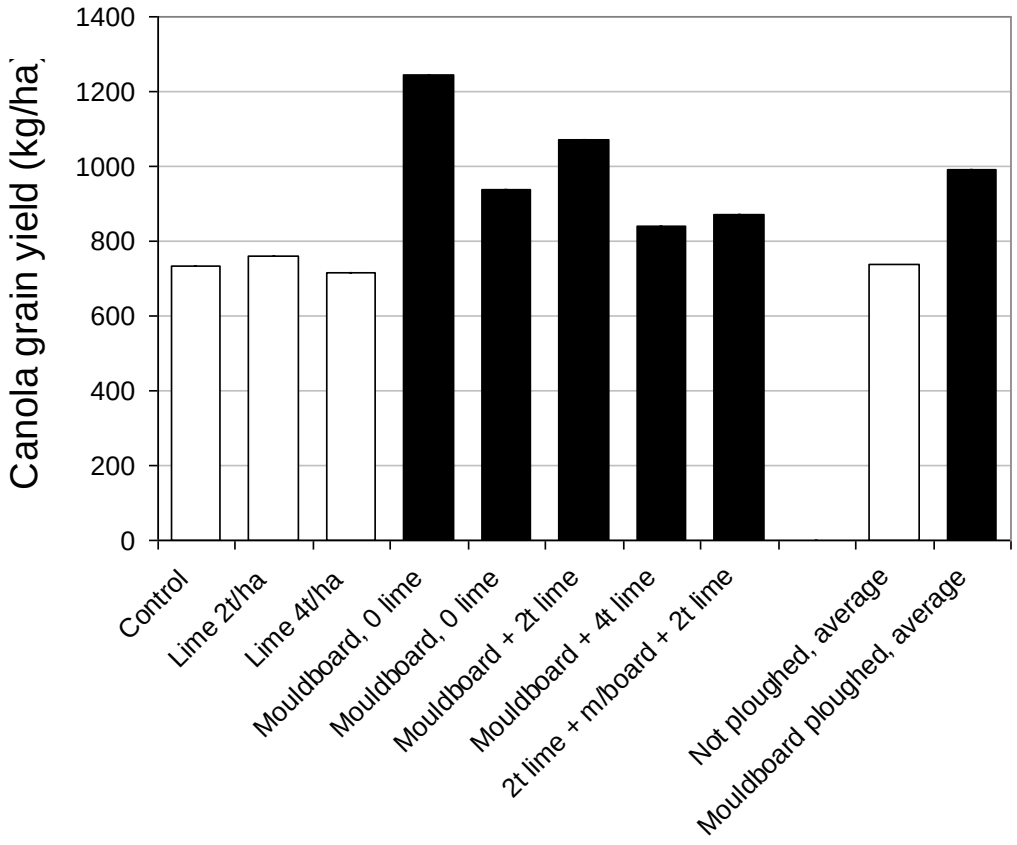

Figure 2. *Grain yields of Scorpion canola in 2010 in response to various mouldboard ploughing and lime application treatments applied in 2009, on a deep yellow sand west of Moora, WA.*

DISCUSSION

- In 2009 the average grain yield increase for late-sown Calingiri wheat was from 1.38 to 2.10 t/ha, a 730 kg/ha (53%) yield increase in response to inversion ploughing regardless of lime. In 2010 grain yield of Scorpion canola increased on average from 737 to 993 kg/ha, a 256 kg/ha (35%) yield increase. This site comprising of a water repellent topsoil but with reasonable quality loamy sand subsoil is an excellent soil type for inversion. The soil has reasonable water holding capacity and hence yield potential provided a crop can be established effectively. Other research shows that inversion of pale deep sands can result in improved crop establishment and increased crop biomass but the grain yield responses may be less due to the poor water holding capacity of these soils.
- Subsoil acidity at the site, at least for the top 30 cm, is not severe enough to cause an aluminium toxicity problem yet. Aluminium toxicity tends to increase when the soil pH falls below 4.5. This may explain why there has been no yield response to application of lime so far but as the untreated soil continues to acidify over the coming years yield responses to lime may occur. Applying lime prior to and after ploughing has been very effective in raising the pH to a depth of 30 cm. Other research shows that often in can take 5 years for surface applied lime to have any significant impact on pH below 10 cm, so incorporation of lime directly into the subsoil could fix a subsoil acidity problem much more quickly. In addition this buried lime will now allow more rapid amelioration of acidity deeper in the soil profile below the 30 cm incorporation depth. This demonstrates how effective incorporation of lime can be to ameliorate subsoil acidity.

- Visually the weed control benefits of ploughing have been large but no counts have been made to quantify this.

FINANCIAL ANALYSIS OF RESULTS

The cost of mouldboard ploughing can vary depending on size and efficiency of the plough used and also on whether costs such as depreciation, interest, fuel, wear-and-tear and labour, for example, are taken into account. Growers who own larger 9-14 furrow mouldboard ploughs generally put the cost at $70-100/ha while contract rates are generally in the order of $100-130/ha. Grain yield increases at this site were 730 kg/ha for wheat in the year of ploughing and an additional 250 kg/ha canola in the second year after ploughing. A number of other mouldboard plough trials in the NAR have given yield responses for at least 3 years although several sites have also been unresponsive. Growers who have inverted entire paddocks almost always report that they have been able to reduce the number of herbicide applications they apply to the crop which is a further cost saving.

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