Soil and lupin responses in the second year after mouldboard ploughing

Stephen Davies and Breanne Best, WA Department of Agriculture and Food
Andrew Kenny, West Midlands Group

Purpose:	To assess the second year impact of mouldboard ploughing on wetting up of water repellent soil and on lupin establishment and yield
Location:	Badgingarra
Soil Type:	Site 1: Pale deep sand; Site 2: Sandy gravel
Rotation:	Site 1: Barley 2010, Lupin 2011; Site 2: Wheat 2010; Lupin 2011
GSR:	485 mm (BRS weather station)

BACKGROUND

Inversion of sandplain soils using a mouldboard plough has been studied as a tool to bury herbicide resistant weed seeds and to overcome soil water repellence. Following promising results from this research, growers have begun to trial and tested soil inversion on their own property. These on-farm sites give both growers and researchers an opportunity to assess the weed control, productivity benefits and practical aspects of implementing and managing inverted sandplain within a 'real' farming system. Where possible we intend to continue monitoring the on-farm demonstration trials in order to assess the long-term benefits or problems associated with soil inversion, in particular crop response, so that the economic value and viability of soil inversion technique can be determined.

TRIAL DESIGN

In 2010 two large blocks of mouldboard ploughing were carried out. Alongside each of the mouldboard ploughed areas are untreated areas that act as a control. Paired comparison measurements and samples are taken along this boundary so treatment differences as a result of mouldboard ploughing can be determined. One site was highly repellent pale deep sand (Site 1) with a long history of being a blue lupin pasture up to 2010. The second site was a pale sandy gravel (Site 2) on a slope with longer cropping history. In 2010 the mouldboard plough treatments were applied and site 1 was sown to barley and site 2 was sown to wheat. In 2011 both sites were sown to lupin.

Crop details: Site 1- Mandelup lupins @ 90kg on 25 May (sown BigPhos Manganese @ 100kg)

Site 2- Mandelup lupins @ 90kg on 22 May (sown BigPhos Manganese @ 100kg)

RESULTS & DISCUSSION

Soil inversion with a mouldboard plough results in a layer of repellent topsoil being buried at depth with a layer of wettable subsoil brought to the surface. Water can readily enter subsoil brought to the surface but it can take some time for the buried water repellent topsoil to wet up.

Soil moisture measurements made just after seeding and prior to emergence indicated that at both sites the top 10cm of soil in both the furrow and the ridge was wetter in the mouldboard plough treatment compared with the control treatment (Table 1). In the 10-20

cm layer, below the seedbed, the mouldboard plough treatment tended to be similar or drier than the control except in the furrow at site 1 where repellency is so severe the furrow was effectively completely dry to depth (Table 1). This may indicate the longer time it can take for the buried repellent topsoil to wet up. Note that in the control treatment at both sites the ridge was wetter than the furrow (Table 1).

Table 1. *Volumetric soil water (%) content in mouldboard ploughed (M/board) versus untreated (Control) soil after seeding with knife points for a pale deep sand and sandy gravel site at Badgingarra measured 26 May 2011. Measurements were taken in both the furrow and the ridge.*

	Site 1 – Pale deep sand Volumetric soil water (%)				**Site 2 – Sandy gravel Volumetric soil water (%)**			
	Furrow		**Ridge**		**Furrow**		**Ridge**	
Soil depth	**Control**	**M/board**	**Control**	**M/board**	**Control**	**M/board**	**Control**	**M/board**
Surface, 0-5cm	0.0	3.2	1.8	3.4	1.2	3.6	2.4	4.2
Subsurface, 5-10cm	0.1	3.5	1.9	3.2	2.5	2.8	3.1	5.3
Subsoil, 10-20cm	0.3	3.6	2.2	2.0	3.4	1.9	3.3	2.9

Soil moisture measurements taken at the pale deep sand (Site 1) later in the season indicate that once wet the buried topsoil can actually hold water in the root zone where it is not subject to evaporation (Fig. 1). At this site, mouldboard ploughing resulted in the moisture content of the subsoil at 10-20 cm being significantly wetter than the untreated control (Fig. 1). Furthermore dry patch affected approximately 10-15% of the soil volume in the untreated control soil and this dryness extended from the water repellent surface soil into the subsoil (Fig. 1). Similar findings have been measured at another mouldboard plough trial site on pale deep sand at Mingenew which was established in 2007. At this Mingenew site the buried topsoil in the mouldboard plough treatment had a volumetric moisture content of 16% compared with 6% in the undisturbed sandy subsoil of the control. Where the soil was most strongly repellent at 5-10cm in the untreated control the moisture content was 2% whereas for at the same depth in mouldboard ploughed treatment the volumetric moisture content was 8% (data not shown).

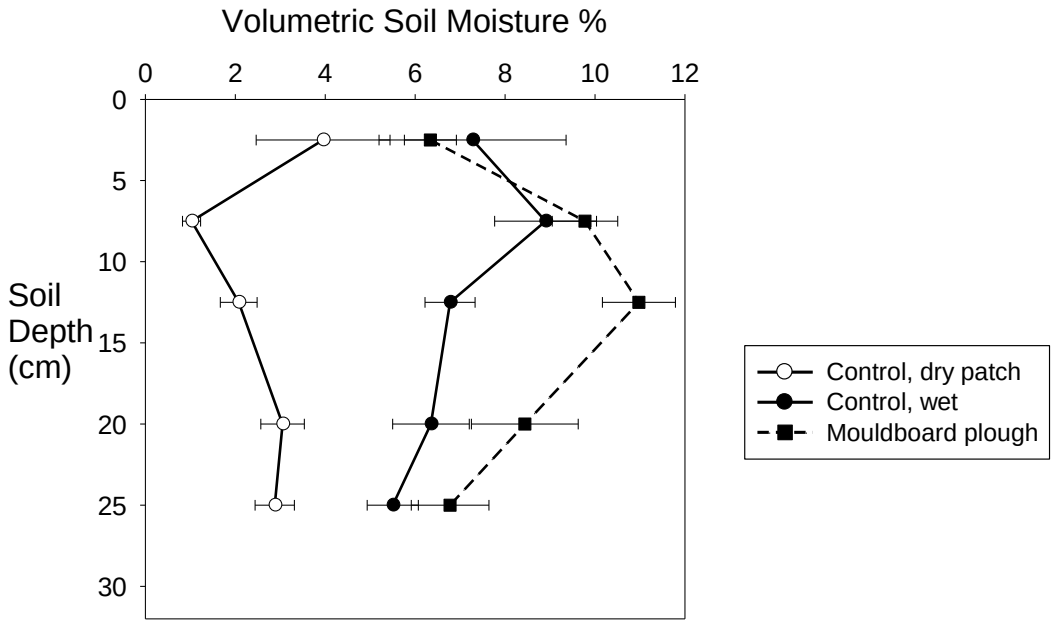

Figure 1. *Effect of inversion of pale deep sand with a mouldboard plough on volumetric soil water (%) compared with dry patch or wet soil in untreated soil at Badgingarra, measured 5 July 2011. Organic matter buried by the mouldboard plough occurred from 5-20cm in the soil profile.*

The better soil moisture conditions at seeding did result in improved lupin establishment in the mouldboard plough treated soil at both sites (Table 2). At the sandy gravel site, which sits on an east facing slope there was some wind damage of the lupins in the mouldboard plough area which reduced plant numbers. It is important to maintain and not disturb the first year's cereal cover crop stubble on mouldboard ploughed soil to help protect the second year crop from wind damage. Better crop establishment did result in significant yield improvements (Table 2). Yields in this case are estimated from the harvesters 'yield monitor' as results from paired comparison harvest cuts were not available at the time of writing. Overall the lupin yield increase on the pale deep sand was approximately 1 t/ha while the increase on the sandy gravel site was approximately 0.5 t/ha (Table 2). It should be noted that because the pale deep sand site had a long history as a blue-lupin pasture it has severe water repellence which partly explains why overcoming this problem has such large benefits. Had the lupins on the sandy gravel soil not been affected by wind erosion and sand blasting it would have been expected that they would have yielded more than they did given that this soil type has better overall yield potential and that the yield difference to the control would have been even greater.

Table 2. *Lupin establishment and grain yield estimates from the harvester yield monitor for untreated control and mouldboard ploughed soil sown with knife points at Badgingarra in 2011.*

** Note: grain yields are estimates from the header yield monitor.*

Site	Lupin establishment (plants/m2)		Lupin grain yield (t/ha)*	
	Control - poor furrow sowing	Mouldboard ploughed	Control - poor furrow sowing	Mouldboard ploughed
1: Pale deep sand	11	44	0.8	1.8
2. Sandy gravel	13	24	1.3	1.8

Overall the results from the second year response by lupins to mouldboard ploughing is encouraging particularly given that these yield improvements come on the back of yield increases of 1.2 t/ha for barley on the pale deep sand and 1.2 t/ha for wheat on the sandy gravel in the first year after ploughing.

REVIEWED: Christine Zaicou, DAFWA (Geraldton)

ACKNOWLEDGEMENTS

GRDC and DAFWA fund "Delivering agronomic strategies for water repellent soils in WA" research project. Thanks to Andrew and Gina Kenny for allowing us to access the trial sites and for lots of help and inspiration!