

Soil amelioration in the southern Mallee



The aim of this long-term trial is to investigate different soil management options to reduce the negative effect of sub-soil limitations on crop yield.

Summary

In 2000, the BCG-WFS established a long-term soil amelioration site in the southern Mallee (25km southwest of Birchip). The treatments included deep ripping (70cm), shallow ripping (35cm) and no ripping; in combination with 0, 2.5 and 5.0 t/ha of gypsum. Over the last three seasons - wheat, lentils and canola have been grown on the site in rotation.

The results so far (after three dry seasons) indicate that:

- deep ripping has resulted in significantly lower yields, and
- gypsum has had no affect on yield.

Before farmers attempt to ameliorate either physical or chemical sub-soil limitations with ripping and/or gypsum they should try these practices on a small area. These practices are too expensive to undertake over a large areas which then either have no benefit (ie. gypsum) or a possible negative effect (ie. deep ripping).

The trial site will be maintained for another season to see whether there are longer term benefits of deep ripping and/or gypsum on crop yield.

Background

Sub-soil limitations caused by either physical (compaction) or chemical (high boron, salt, sodicity etc) factors are known to influence the ability of plants to access water and nutrients in the root zone – which can result in lower than expected yields.

Managing sub-soil limitations can take one of three forms:

- Try to ameliorate sub-soil limitations with practices such as deep cultivation and gypsum
- Do not grow crops which are known to be more sensitive than others to sub-soil limitations
- Focus a breeding program on developing crops which are tolerant to sub-soil limitations (at least to the chemical factors affecting sub-soil limitations)

The BCG-WFS established a sub-soil amelioration trial site in 2001 and intend to maintain this site over the next few years to investigate the short- and long-term benefits (or otherwise) of the practices designed to ameliorate the sub-soil through physical (ripping) and chemical (gypsum) practices. The site is located at Wilkur (25km southwest of Birchip) on the property of John and Jim Boyle.

Methods

In October 2000 the site was established and plots laid out in a replicated design (x3). Physical practices included deep ripping (to 70cm); shallow ripping (35cm) and equal number of plots were not ripped. In March 2001, gypsum was applied at 0, 2.5 and 5.0t/ha.

Since 2001, wheat, canola and lentils have been sown on the plots in rotation. Crop management (sowing, fertiliser, and weed and disease control) follow normal practice.

Results

Table 1. Sub-soil conditions at the trial site.

Depth (cm)	pH (water)	EC dS/m	B mg/kg	ESP %
0 – 10	8.6	0.23	5.0	5
10 - 40	9.4	0.42	13	17
40 – 70	9.5	0.48	15	19
70 - 100	9.8	0.76	31	33

Yields

2001 was a dry season (185mm growing season rainfall) and wheat yields ranged between 1.5 and 2.3t/ha. There was no affect of gypsum on yield and deep ripping decreased yields significantly (2.2 → 1.5t/ha). Similarly for canola, yields were poor and decreased significantly with ripping (0.6 → 0.3t/ha) and gypsum had no affect. The lentil crop was very poor and could not be harvested.

2002 was a drought year (with only 112mm of growing season rainfall) and no crops were harvested.

2003 was another dry year with only 201mm growing season rainfall. The results of the soil amelioration practices (gypsum and ripping) on crop yield were the same as for 2001. In wheat, canola and lentils there was no affect of gypsum. Deep ripping resulted in reduced yields in wheat (1.7 → 1.4t/ha) and had no affect on canola or lentil yield (Table 1).

Table 1. Crop yields resulting from deep ripping (D), shallow ripping (S) and no ripping (N) and gypsum applications in wheat, canola and lentils. Note in 2001 the lentils could not be harvested (very poor yield) and in 2002 no crop was harvested at all due to the drought.

Gypsum t/ha	Wheat (t/ha)			Canola (t/ha)			Lentil (t/ha)		
	D	S	N	D	S	N	D	S	N
	2001			2001			2001		
0	1.5	1.9	2.2	0.2	0.5	0.6			
2.5	1.5	2.1	2.2	0.3	0.5	0.7			
5.0	1.7	2.1	2.3	0.3	0.4	0.5			
LSD gypsum	NS			NS					
LSD ripping	0.1			0.2					
	2003			2003			2003		
0	1.4	1.8	1.7	0.3	0.3	0.3	0.4	0.5	0.4
2.5	1.4	1.7	1.7	0.3	0.3	0.3	0.5	0.2	0.4
5.0	1.5	1.6	1.9	0.3	0.2	0.3	0.4	0.2	0.4
LSD gypsum	NS			NS			NS		
LSD ripping	0.1			NS			NS		

Interpretation

Over three seasons, albeit three dry seasons, there were no beneficial effects on crop yield resulting from gypsum applications (2.5 and 5.0t/ha). The affects of deep ripping were negative – in the first year (2001) the ripping to 70cm depth resulted in 0.7t/ha loss in wheat yield and 0.3t/ha reduced canola yield. In 2001 this was attributed to the ripping, carried out the previous spring, resulting in a loss of soil moisture.

In 2002 all of the crops failed due to the severe drought.

In 2003, the results were similar to 2001 with no affect of gypsum on yield and a decrease in yield resulting from the ripping carried out three years previously (wheat yield decreased by 0.3t/ha), there was no affect on canola or lentil yield resulting from the ripping.

The trial has been conducted during two very dry years and one drought and it is not known at this stage what would have happened if the seasons had been wetter. Although it could be assumed that three years after ripping, if there was going to be a benefit of increased rooting depth, than in 2003 the benefits of ripping should have shown up.

In a long-term trial conducted by the BCG in collaboration with the CRC for Soil and Land Management, from 1994 to 1996, on the property of Keith Barber (site with high sub-soil sodicity) the effects of tillage practices (direct drilling, minimum tillage, conventional tillage and agro-ploughing) in

combination with gypsum applications (0, 2, 4 and 8t/ha) resulted in no significant benefits of gypsum or tillage practice (note: there was no deep ripping on this trial only shallow agro-ploughing). It should be noted that the seasons in 1995 and 1996 were wet years and that yields in this trial were in excess of 4.0t/ha (see BCG-WFS manuals from 1996 and 1997).

The true value or otherwise of deep ripping needs to be evaluated in a wet season – the trial work will continue until there is a wet year!

Commercial Practice

It is known that sub-soil limitations (physical and/or chemical) reduce the ability of crop roots to penetrate the soil deep down the profile, resulting in reduced water and nutrient uptake. The current suggestions that deep ripping in combination with gypsum may ameliorate sub-soil limitations need to be questioned. There is no evidence in the BCG trials carried out over a number of years that ripping or gypsum will have a positive affect on ameliorating sub-soils. It is known that gypsum will have a beneficial affect on sodic topsoils in reducing dispersion and crusting, but there is no evidence that it will affect sodic sub-soils.

Both the practices of deep ripping and high application rates of gypsum are expensive and farmers should trial these practices on small areas before committing a significant cost on a practice which may not have the desired result.

It appears that managing sub-soil limitations is more related to knowing the extent of the problem on your farm and not sowing crops which are sensitive to sub-soil limitations on paddocks which are known to have a problem. Encouraging the development of a breeding program targeted at developing crops and varieties with tolerance to sub-soil limitations should also be considered.