Improving soil structure on hardsetting soils of Eastern Eyre Peninsula

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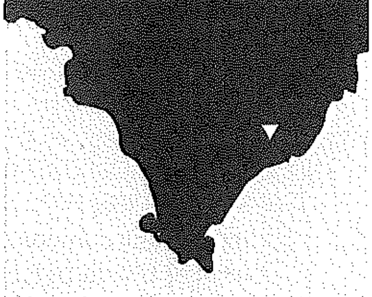
RESEARCH

Searching for answers



Location:
Mangalo
Joel and Blake Nield, Grant Hannemann, Isaac Gill, Michael Petersen, John Turnbull
Crossville Ag Bureau
Rainfall
Av. Annual: 450 mm
Av. GSR: 375 mm
2014 Total: 400 mm
2014 GSR: 260 mm
Soil Type
Hard sandy clay loam on dispersive red clay and Sandy loam on coarsely structured red clay.
Plot Size
Large plot demonstrations
5 m x 35 m x 2 reps
Yield Limiting Factors
Limited rainfall from the end of July to harvest.

Key messages

- **Deep ripping soils with poorly structured clay subsoils can improve crop performance. However, on soils with sodic subsoil layers better results are achieved through the addition of gypsum.**
- **Knowledge of the characteristics of the soil profile at depth is vital for determining an appropriate and effective management strategy.**
- **High rates of surface applied gypsum can impact negatively on crop growth in at least the season of application.**
- **The development of appropriate and affordable machinery to effectively deliver soil ameliorants into constrained soil layers on a broadacre scale is required.**

Why do the trial?

Poorly structured, hardsetting and sodic soils which can reduce plant emergence, restrict plant root growth and soil biological activity resulting in low water use efficiency are common in the Cleve Hills and district. Understanding of the most effective, practical and affordable means of addressing these constraints is limited. Trials have shown that the use of deep ripping and gypsum applications on soils with sodic subsoil layers can improve production but results have been inconsistent (refer EPFS Summaries 1999, p 72, 2000 p 105, 2005 p 129, 2010 p 154, 2011 p 166).

Constraints result from a number of different factors and appropriate treatments need to be developed.

How was it done?

This project demonstrated the use of disc and deep tillage technologies with and without the addition of soil conditioners such as organic matter and gypsum to effect improvements to soil structure and productivity.

The target soils were loam to clay loam surface soils with highly sodic clay subsoils with increasing carbonate at depth typical of soils of the Cleve Hills. Seven demonstration sites were established in August and September 2013 (Table 1). Tillage treatments included:

- deep ripping to 40 cm using an Ausplow DBS Easy-Till deep ripping plough (2.6 m wide demonstration model on 45 cm row spacings)
- discing (5 m wide offset with ribbed cutting coulters).

Soil ameliorant treatments consisted of organic matter and gypsum treatments as appropriate for the site. At Nield's sites and Hannemann 2 the discs treatments also incorporated crop i.e. green manure. At Petersen 1 and Hannemann 1sites oaten hay (10 t/ha) was applied to the surface prior to discing. Gypsum treatments were applied in spring at these sites and prior to seeding in 2014 at the other sites (Table 1).

Sites were sown by the farmer and treated the same as the rest of the paddock during the season.

What happened?

Heavy rainfall and cold temperatures in early winter slowed growth at all sites and resulted in some waterlogging at Nield and Hannemann sites. Emergence counts were taken on all sites in mid June 2014 (Figure 1). Discing alone did not result in increased crop establishment. On Nield 1 and Hannemann 2 emergence was greater where discs were used to incorporate gypsum and organic matter. The response to the other treatments at crop establishment was variable across the sites. There appeared to be crop establishment benefits from ripping with and without 5 t/ha of surface applied gypsum at Hannemann and Petersen sites. Surface applications of 10 t/ha gypsum prior to soil modification treatments had lower crop establishment figures than at the 5 t/ha rate. This is perhaps due to temporary salinisation around the seed from such a high rate and is not expected to cause an impact beyond the year of application.

Soils and Tillage

Table 1 Summary of demonstration sites established in 2013

Site ID/Location	Crop	Soil Type	Treatments	Measurements
Nield 1, Yabmana	Wheat	Calcareous loam on dispersive red clay (Shallow Cleve soil).	Untreated, Disc (green manure), Surface applied gypsum (5 and 10 t/ha), Disc + gypsum (5 and 10 t/ha)	Complete soil analysis, baseline soil carbon and bulk density, crop establishment, spring dry matter, grain yield
Nield 2, Yabmana	Canola	Hard sandy clay loam on dispersive red clay	Untreated, Disc + organic matter (OM) (vetch green manure - low and high), Rip + OM (low and high) Disc + OM + gypsum (10 t/ha), Rip + OM + gypsum (10 t/ha)	Complete soil analysis, baseline soil carbon and bulk density, crop establishment
Hannemann 1, Mt Desperate	Wheat	Hard sandy clay loam on dispersive red clay	Untreated, Disc, Rip, Surface OM (10 t/ha oaten hay) Disc + OM, Rip + OM, surface gypsum (5 t/ha spring and autumn applied), Disc + gypsum, Rip + gypsum	Complete soil analysis, baseline soil carbon and bulk density, crop establishment, spring dry matter, grain yield
Hannemann 2, Mt Desperate	Wheat	Hard sandy clay loam on dispersive red clay	Untreated, Disc (green manure lupin crop), Rip, Disc+ Rip, Surface gypsum (5 t/ha and 10 t/ha), Disc + gypsum, Rip +gypsum, Disc + Rip + gypsum	Complete soil analysis, baseline soil carbon and bulk density, crop establishment, spring dry matter, grain yield
Petersen 1, Mangalo	Wheat	Sandy loam on coarsely structured red clay.	Untreated, Disc, Rip, Surface OM (10 t/ha oaten hay), Disc+ OM, Rip + OM, Surface gypsum (5 t/ha spring), Disc + gypsum, Rip + gypsum	Complete soil analysis, baseline soil carbon and bulk density, crop establishment
Petersen 2, Mangalo	Canola	Sandy loam on coarsely structured red clay.	Untreated, Disc, Rip, Surface gypsum (5 t/ha and 10 t/ha) Disc + gypsum, Rip + gypsum	Complete soil analysis, baseline soil carbon and bulk density, crop establishment
Turnbull, Mt Millar	Canola	Sandy loam on coarsely structured red clay.	Untreated, Rip, Surface applied gypsum (5 and 10 t/ha), Rip + gypsum	Complete soil analysis, baseline soil carbon and bulk density, crop establishment

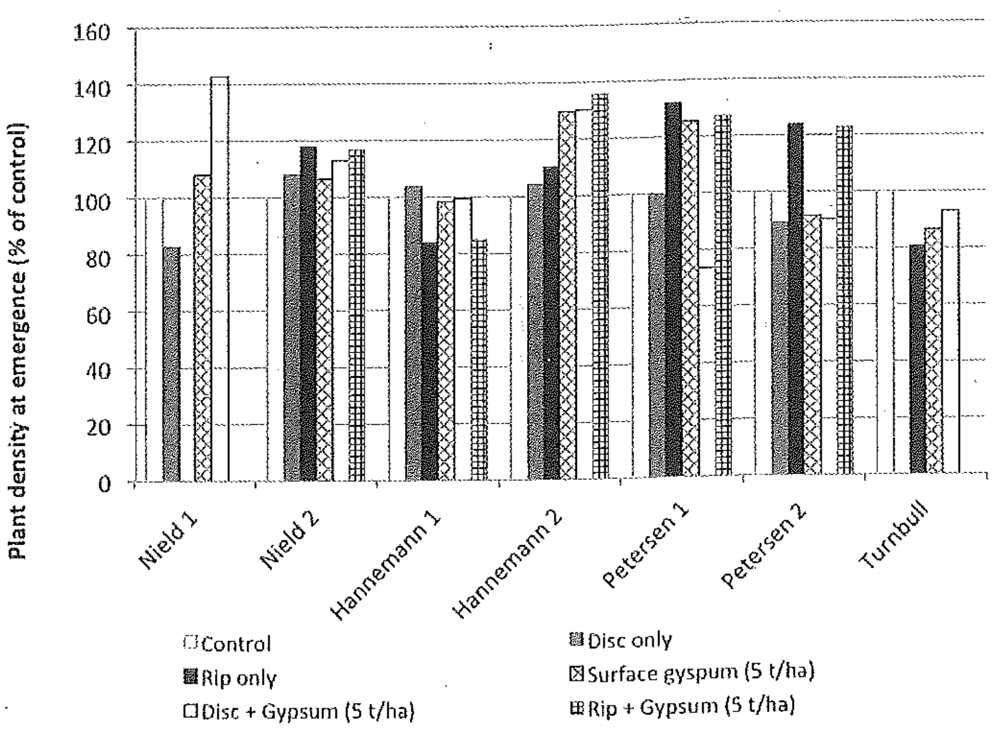


Figure 1 Plant density at crop establishment (% of control treatment), June 2014

Table 2 Dry matter cuts at Nield site 1, August 2014

Nield 1	Dry matter (t/ha)	% of control
Control	**7.3**	**100**
Disc only	7.1	97
Surface gypsum (5 t/ha)	8.2	112
Disc + gypsum (5 t/ha)	9.5	130
Surface gypsum (10 t/ha)	8.5	116
Disc + gypsum (10 t/ha)	9.0	123

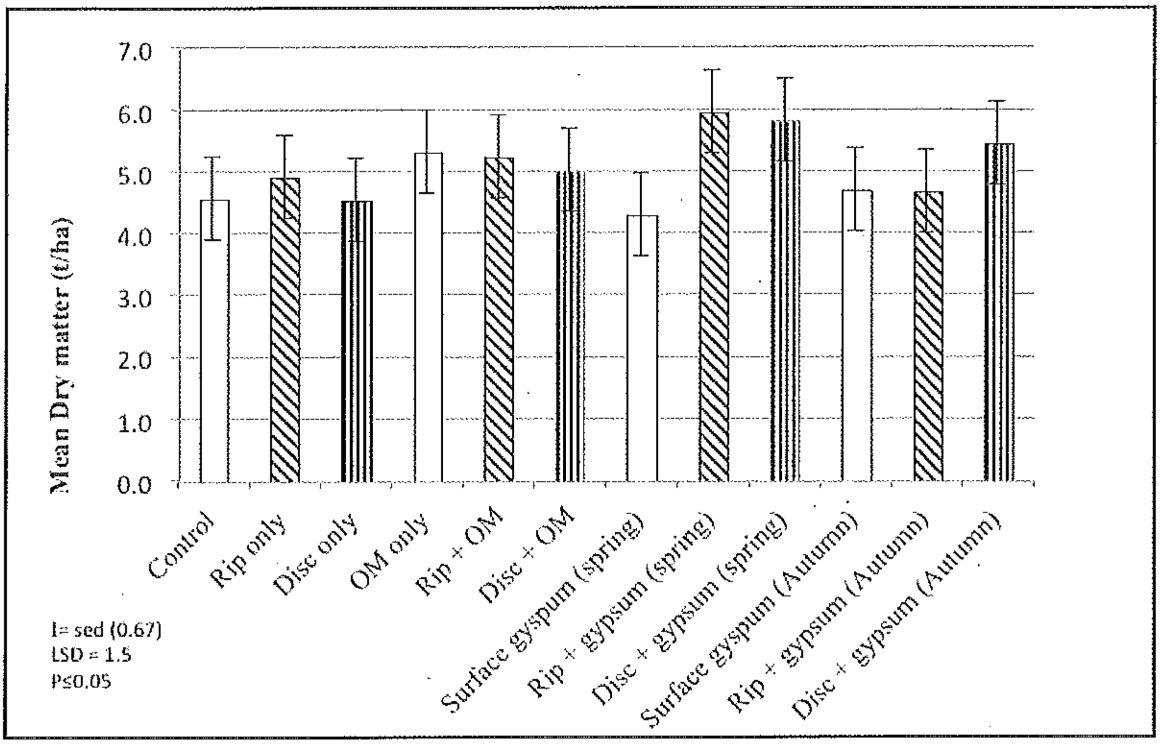


Figure 2 Hannemann 1 dry matter, August 2014

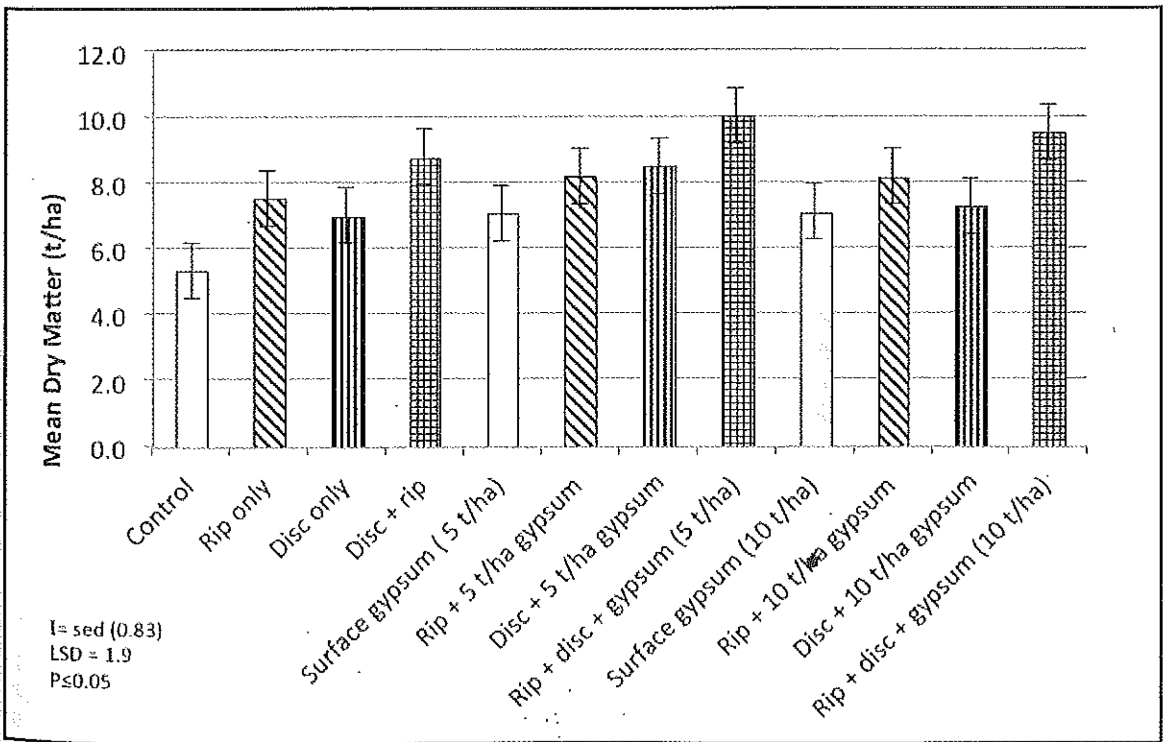


Figure 3 Hannemann 2 dry matter, August 2014

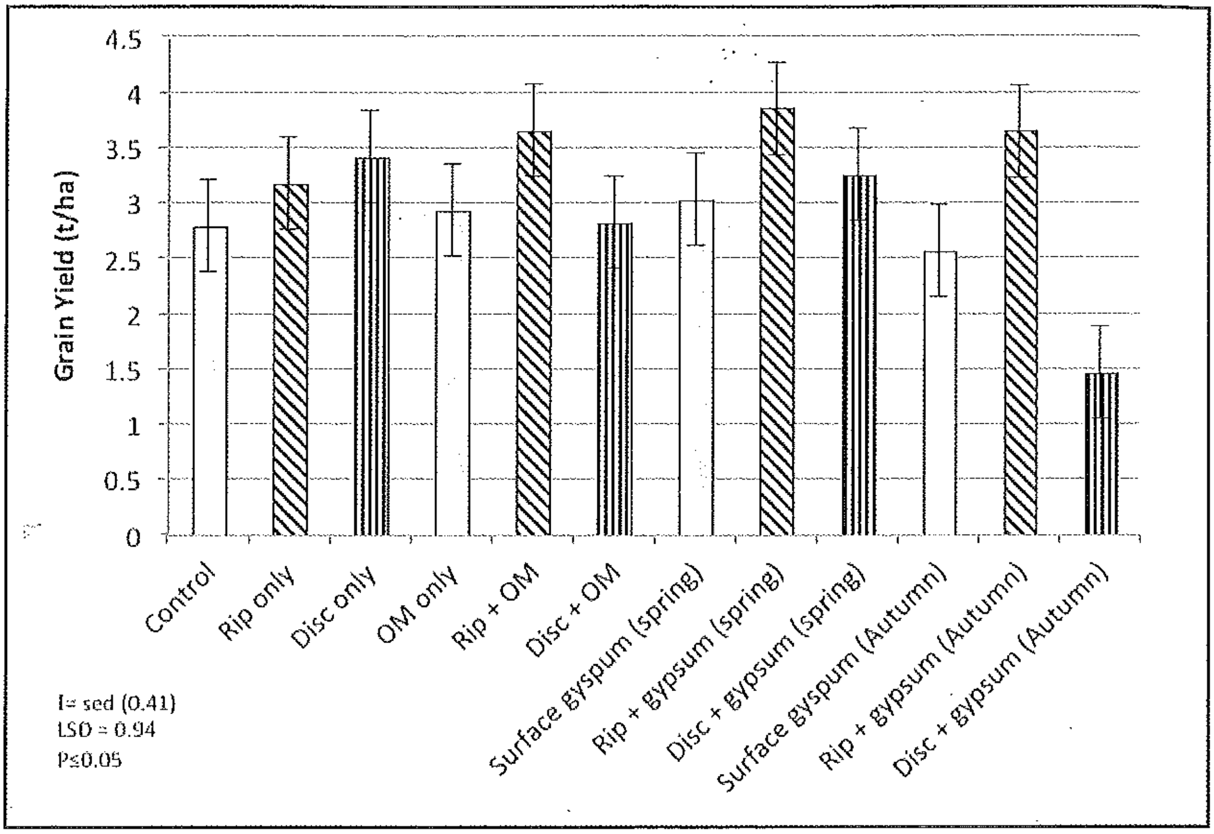


Figure 4 Hannemann site 1 grain yield data, November 2014

Dry conditions from the end of July to harvest caused canola crops (Nield 2, Petersen 2 and Turnbull) to bolt rapidly from rosette stage to flower with little vegetative growth during this period so dry matter was not collected at these sites. Dry matter cuts were taken in the last week of August on the sites sown to cereals. Petersen's wheat site at Mangalo was severely frosted throughout July and early August and dry matter cuts were taken from this site but it was difficult to separate the treatment response from the frost impact.

Dry matter data from Nield 1 indicated some response from the application of gypsum with an increased response when incorporated with discs (Table 2). There was no additional response by increasing the rate of gypsum.

There were no dry matter responses to surface application of gypsum at Hannemann's sites however there was a response where gypsum was incorporated (Figure 2 and 3). Dry matter data and visual observations at the sites indicated slight responses to ripping.

Grain yield data from Hannemann's wheat trial sites was obtained from 3 x 1 metre row cuts and threshing out the grain. Grain weights were extrapolated to give a plot yield in t/ha. Grain yield data reflected the dry matter trends (Figures 4 and 5).

The yield responses from tillage treatments alone were not statistically significant at Hannemann 1. However, ripping with addition of soil ameliorants did deliver significant yield increases (Figure 4).

At Hannemann's second site grain yields from tillage treatments alone were also not significant except on the disc + rip treatments. The addition of gypsum did not generate a higher yield response than the combined ripping and discing (Figure 5).

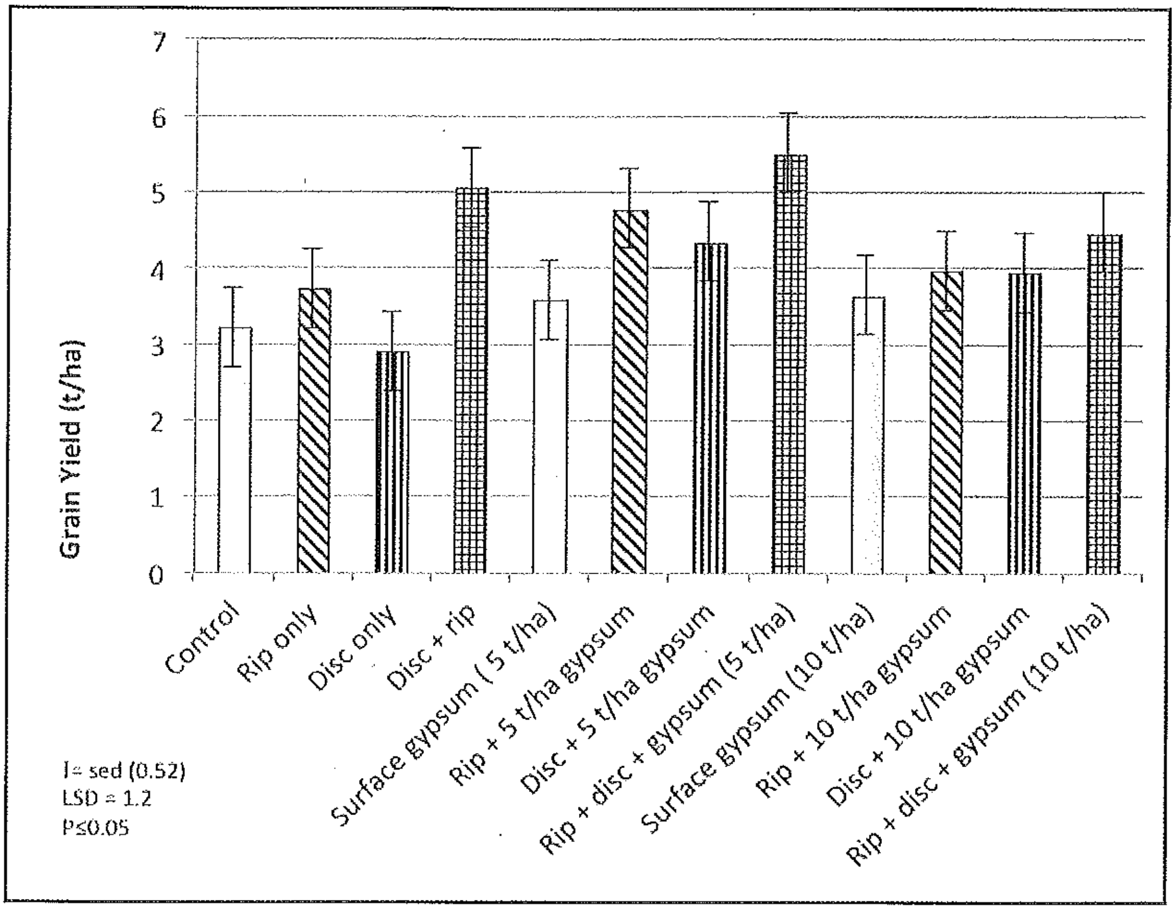


Figure 5 Hannemann site 2 grain yield data, November 2014

What does this mean?

These demonstrations have shown that while production can be increased by a combination of appropriate soil modification practices and the results with the use of soil ameliorants vary between sites and with seasonal conditions. This is consistent with the results of earlier trials.

Gypsum can provide benefit on sites which have sodic layers, however treatment is most effective if gypsum is applied directly into the sodic layers. High rates of gypsum applied at the surface prior to sowing reduced crop establishment. This may be due to localised salinization around the seed at germination and should only be of short duration. The high rate may improve production on responsive soils in future years as soil structure improves.

Ripped treatments evidenced slightly better growth than unripped and disc only treatments. However, dry matter and grain yield increases were greater where the ripping treatment was accompanied with the addition of organic matter or 5 t/ha of gypsum.

These trials have further highlighted results from earlier work that although ripping can be used to break through a compacted layer; where a sodic layer is present it will not provide a long term benefit without the application of an appropriate soil ameliorant.

Further questions arising from these demonstrations are:

- What is the role of deep incorporated organic matter in improving soil structure on hardsetting soils and those with sodic layers?
- How long before responses from applied soil ameliorants can be expected?
- How long are the potential gains are going to last?
- What are the implications for soil carbon levels?
- What are the costs/benefits of these treatments options?

Acknowledgements

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Australian Government

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