4.1 Ameliorating problem subsoils for improved cereal crop production

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Locations: Balliang and Mt Pollock.

Rainfall for growing season (April-Nov 2006):
Balliang: 189mm
Mt Pollock: 188mm

Summary of Findings
Under the low rainfall conditions experienced in the 2006 wheat-growing season (particularly during grain fill) at Balliang and Mt Pollock, increases in yield could not be expected using the treatments in this experiment. The lower harvest indices (HI) observed at Balliang for the two treatments receiving manure at 30cm depth would suggest that the plants were able to access extra nitrogen released from the manure during late vegetative growth but were unable to convert that biomass growth to grain due to sub-optimal soil water during grain-filling. If the plant roots were able to access these nutrients at 30cm depth then they were penetrating deeper into the soil than they would have without the deep ripping. Such deep root penetration indicates the presence of a pathway for greater water penetration and storage at depth in a season of normal rainfall and could lead to more plant available water during grain fill.

Background:
Many agricultural soils in Victoria's high rainfall southwest region have shallow topsoil and subsoils with high clay and exchangeable sodium contents. These subsoil properties lead to clay particle dispersion so that useful root growth at depth is limited by poor soil structure and porosity. In years of typical rainfall, topsoil waterlogging is caused by poor drainage into the subsoil. Waterlogging has been reduced in the region by the use of raised beds and controlled traffic. These practices have increased the potential for root growth (SFS, 2005) at greater depth and this has led, in many cases, to greater total plant biomass. This increased growth has not been converted into increased grain yield, hence the low harvest indices. For grain yields to increase as a proportion of total biomass, more water needs to be available during grain fill than current systems can provide.

Objective of Study:
Ripping can create a path for water to penetrate the problem subsoils. If a means for maintaining this improved porosity in and adjacent to the rip lines can be devised, water may be stored at depth for plant use during the critical grain fill period of cereal crop growth.

Two experiments were conducted as a follow-up to previous SFS trials, to test whether deep ripping with various organic amendments could lead to water storage deep in the soil profile and therefore extra water provision during grain fill.

Method:
Two replicated experiments were set up to compare the various treatments, at Balliang and at Mt Pollock.

Balliang site Details:
The 100mm deep topsoil is a mildly acidic, sodic brown clay. The entire site was treated with 1 t/ha lime. The soil increases in alkalinity with depth as clay content and sodicity increase.

Treatments:
Six treatments were laid out in a 6 by 6 Latin square design:
The six treatments were:

1. Ripping + 2t/ha gypsum: (R + G)
2. Ripping + 2t/ha gypsum + sand (10m3/ha): (R + G + S)
3. Ripping + gypsum + chicken manure (10m3/ha): (R + G + M)
4. Ripping + gypsum + peat (10m3/ha): (R + G + P^+)
5. Ripping + gypsum + peat (2.5m3/ha): (R + G + P)
6. Ripping + gypsum + chicken manure (7.5m3/ha) + peat (2.5m3/ha): (R + G + M + P)
7. Control. An area to which no treatment was applied was marked out as the control; this could not be included in the Latin square design because of the difficulty of adjusting the ripper precisely over short distances.

Each treatment was replicated six times with each replicate covering $20m^2$. The amendments were slotted at a depth of approximately 30cm.

Mt Pollock Details:
The soil is a heavy, black shrink/swell clay and treatments were applied on raised beds, including the control that had no other treatment.

Treatments:
Mt Pollock had the same treatments 1 to 5 as Balliang but treatment 6 was excluded. There was also an untreated control. This experiment was laid out in a 5 by 5 Latin square. The control was marked out adjacent to the Latin square for the same practical reasons as at Balliang. The control was replicated 5 times, as were the five treatments.

Application Rates:
Treatment applications were measured in the customary commercial units, i.e. peat, manure and sand by volume, gypsum by weight. $10m^3$ of the chicken manure used yielded approximately 3.4 tonnes of dry matter and $10m^3$ of the peat used yielded approximately 2.6 tonnes of dry matter. These application rates were selected for their affordability to farmers and to allow for meaningful comparisons between treatments.

Results:

Balliang Site:

Initial plant counts:
No significant differences in seedling emergence were detected. However, the initial plant count was included in the data analysis as a covariate to account for any effect the emergence number may have had on final yields and harvest indices.

Soil moisture:
No significant differences were detected at the Balliang site.

Grain Yield and Harvest Index:

Treatment	Yield (t/ha)	Harvest Index %
1. (R+G)	2.4	32
2. (R+G+S)	2.3	31
3. (R+G+M)	2.2	28
4. (R+G+P^+)	2.5	32
5. (R+G+P)	2.3	30
6. (R+G+M+P)	2.1	27
7. Control	2.2	31
SED	0.2	1.2

These results indicate that any differences in yield could not be attributed to anything other than chance. The analysis indicated that treatments 3 and 6 (those with chicken manure) resulted in significantly lower HI than the other five treatments.

Mt Pollock Site:
Initial Plant Counts:
No difference was detected between initial plant counts but again these results were used as a covariate in the analysis of grain yield and harvest index to remove any variation that may have occurred as a result of variable seedling emergence.

Soil moisture:
Soil moisture was measured at 0-20cm, 20-40cm and 40-60cm with no significant difference detected between treatments.

Grain Yield and Harvest Index:

Treatment	Yield (t/ha)	Harvest Index %
1. (R+G)	3.1	34
2. (R+G+S)	2.6	29
3. (R+G+M)	3.1	35
4. (R+G+P^+)	3.0	34
5. (R+G+P)	3.3	37
7. Control	2.4	30
SED	0.5	1.8

Again, the differences in yield measured between treatments could not be attributed to anything other than chance but the Control and treatment 2 did have significantly lower harvest indices than the other treatments. These differences in harvest indices were not consistent with the differences detected at Balliang where the two treatments containing manure resulted in reduced harvest indices.

Discussion

The observation of a lower HI in treatments where poultry manure was applied is an interesting one. During the current season a similar observation has also been made in a trial conducted at Yallock estate in Ballan (Singh-Gill. Pers. Comm.), where the result is attributed to enhanced biomass production during the late vegetative phase and the subsequent inability of that biomass to be translocated to grain as a result of the sub-optimal soil water status during grain-filling. If adequate water was available, there may have been a different result similar to that reported from Ballan during the 2005/06 season (Singh-Gill *et.al*., 2006). It is proposed that the broad acre applicability and practicalities of these treatments are further tested under average rainfall conditions to determine the most feasible and beneficial amelioration options.

References:

Jaikirat Singh-Gill, Peter Sale and Caixian Tang 2006. Deep incorporation of organic matter improves wheat growth on a Sodosol with dense subsoil. Proceedings of the 13th Australian Agronomy Conference, Perth, 2006. Australian Society of Agronomy. http://www.regional.org.au/au/asa/2006/poster/environment/4539_tangc.htm

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