7.9 AMELIORATION OF HOSTILE SUBSOIL IN HIGH RAINFALL SOUTH-WEST VICTORIA (INVERLEIGH, MT POLLOCK VIC)

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Location: SFS Inverleigh Research site and Mt Pollock, Victoria

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GSR: (Apr – Nov) 350.3 mm
Rainfall distribution for Inverleigh site is provided in the Appendices.

Summary:
A range of subsoil problems impact on successful cropping in the high rainfall, long, cool season cropping zone of South-west Victoria. Despite the alleviation of waterlogging through raised beds, these subsoil hostilities still prevent the realisation of potential yields from crops grown in the region.

Experiments were conducted on two different soil types to test if (a) amelioration of these subsoils with a mix of gypsum and organic peat would increase the ability of the soil to hold more 'plant available' water and (b) if this extra water availability, would assist crops to achieve a better yield.

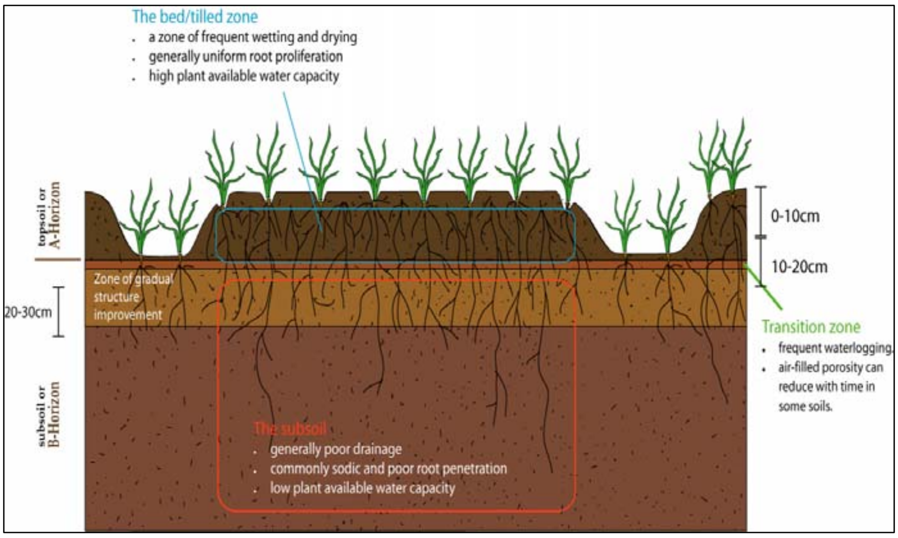
Two rates of ameliorants were applied. Data collected in early Spring showed that both treatments led to increased soil water at varying depth in soil compared to the control. Different soils responded differently.

In heavier soil, root penetration appeared to be limited by the lack of water due to sub-optimal seasonal conditions and its history of management. Due to sub-optimal rainfall conditions experienced, there were no significant yield responses to the treatments at harvest.

Background:
Waterlogging occurs as a result of heavy clay subsoils reducing movement of water through the soil profile following heavy rains. Raised beds and controlled traffic (CT) help alleviate waterlogging in broad acre cropping systems. However, the full potential of the raised beds is still hampered by a number of recurring problems.

The soils of the volcanic plains generally have dense, rocky and large structural units at depth, that are difficult for crop roots to penetrate. In such cases roots usually follow naturally occurring cracks in the soil but the full exploitation of the profile for water could still be hindered. The efficient use of soil water at depth can also be affected by the chemical nature of the subsoil. Most of the cropping soils are sodic (high in exchangeable sodium) at depth. This sodicity causes dispersion of soil particles, which lead to the collapse of soil structure and loss of pore spaces, affecting the growth and efficient function of plant roots.

Previous work by SFS has shown, that following the installation of raised beds the porosity of the soil can improve even below the depth of the initial tillage. There appears to be a consequent improvement in hydraulic conductivity (the rate at which water moves through the profile) of the soil at depth that could contribute to storage of higher plant available water (PAW). However, we are yet to successfully address the issue of low harvest index (the proportion of total dry matter partitioned to grain) in cereal and oil crops, which is most likely a result of the PAW during grain fill being inadequate to meet the higher demand of the bigger crop canopies produced on raised beds.



It has also been observed that although the soil structure at depth under beds is improving, there can often be a problem zone under the bed at the same depth as the furrows. Initially, following the tillage undertaken when the beds are formed, aeration and conductivity increased at this depth. However, if water is allowed to sit in the furrows for extended periods, some of those initial benefits to the soil in the beds appear to reverse. The saturation of this band of soil can lead to lack of oxygen, which slows biological activity. The problem is further exacerbated in dispersive soils leading to a decline in macro-porosity, which means there are less large pores to move water rapidly and provide oxygen for root respiration.

This work has led us to the identification two major problem zones under raised beds:

- the dense and large structural units of soil at depth which generally provide little access to water and nutrients for crops growing on beds
- a shallower zone, occurring around furrow depth, which interferes with the connectivity between the topsoil on beds and the subsoil

Objectives of study:
The lack of connectivity at (b) appears essentially to be a result of a loss of air-filled porosity (large pores) in the subsoil in the transition zone (see picture in 'Background'). The problem is addressed through a field experiment replicated on two different soil types. Two different ameliorants are used at different rates with the expectation that these additives in the subsoil will:

- improve the porosity of soil through the addition of organic matter
- enhance the rate of movement of water through soil (improved connectivity)
- enhance the capacity of soil to provide greater storage of water and
- crops will use this water more efficiently to produce higher grain yields

Methodology:
Field trials were established at two sites, one at Inverleigh and the other at Mt. Pollock South-west of Geelong in the 500+mm rainfall zone in Southern Victoria.

Site details-Mt Pollock:
The soil at Mt. Pollock was a heavy black cracking clay. In 2005, the site was coming out of a 4-year lucerne pasture. This self-mulching cracking clay soil (also known as a Vertosol in the Australian soil classification) is known to behave in typical fashion as described in 'Background'. The surface soils are high in clay (40-50%) and the subsoil is increasingly sodic at depth.

***Site details-Inverleigh*:**
The soil at Inverleigh is derived out of coastal plains sedimentary deposits and is less clayey in nature. The surface is a loam but clay content increases at depth below 40cm. Sodicity is not an issue at depth.

Experimental design:
The experimental design was similar at both sites. Each treatment plot consisted of 3 raised beds of 2m width and 20m length. Each treatment was replicated three times at random. The treatments were,

a) Control
b) Deep ripping + Gypsum + Peat pellets (10 ton/ha) [S+G+P1] – **T1**
c) Deep ripping + Gypsum + Peat pellets (15 ton/ha) [S+G+P2] – **T2**

A modified deep ripper with a hopper mechanism was used to slot the subsoil with the peat pellets. The ripper created two rip lines, 50cm apart on a 2m wide raised bed. The experiment at Mt Pollock was laid down on 18 May and the one at Inverleigh on 9 June. Both sites were sown to a crop of Canola.

Results, Observations and Discussions

Figure 7-8: Soil Water Inverleigh 9/9/05

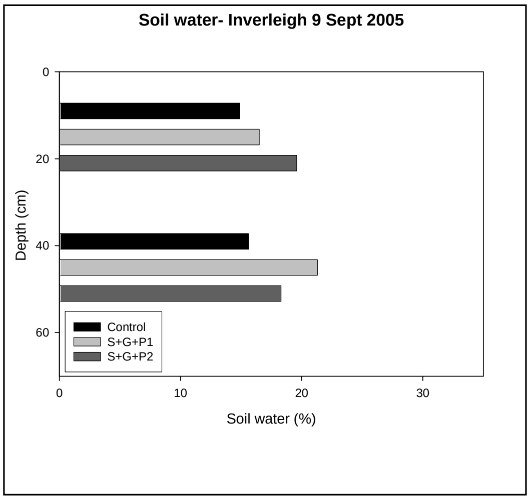


Figure 7-9: Effect Of Treatment On Depth Of Rooting (Inverleigh)

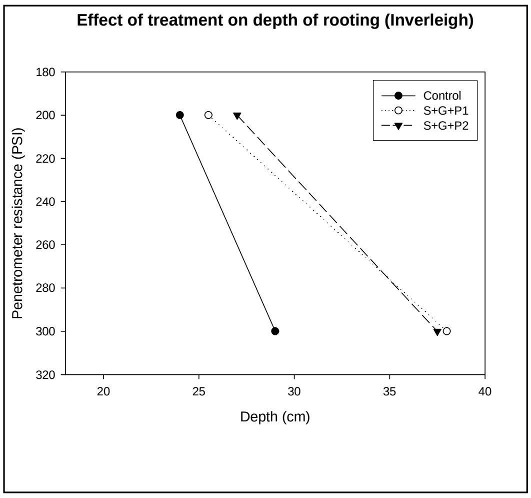


Figure 7-10: Soil Water Mt Pollock 2005

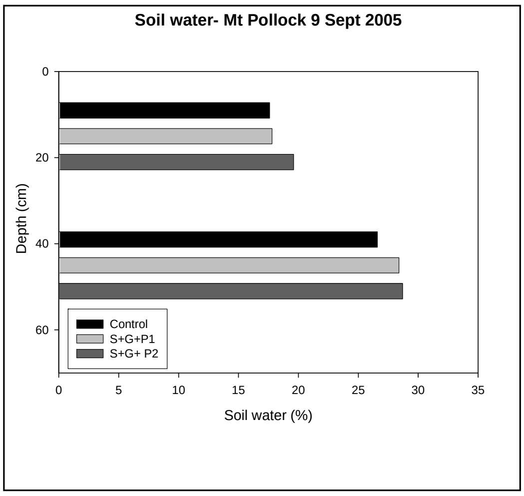
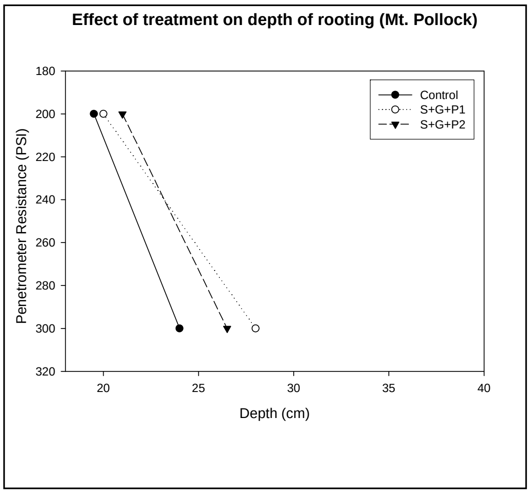


Figure 7-11: Effect of Treatment On Depth Of Rooting (Mt Pollock)



The amelioration treatments to the soil at both sites were expected to increase the capacity of the soil to hold water, improve root proliferation to extract that water during periods of critical growth and result in better (improved) yield of the crop.

The trial experienced sub-optimal autumn and winter rainfall making it difficult to make any quantitative measurements on soil water earlier in the season. The data sets on soil water discussed here were taken on 9 September 2005, five days after the first spring rainfall event of 38mm occurred. Soils were sampled in each plot to a depth of 60cm. Samples were taken at centre of beds between the two rip lines that were used to shatter the soil and insert the ameliorants.

Samples from similar treatments were bulked according to their depth interval to assess the gravimetric soil water content (water content by weight) at depths of 0-30cm and 30-60cm. At the same time a penetrometer was used in each treatment to assess soil strength to understand the ease with which roots would access soil water. As a general rule, root growth will not be adversely affected (physically) below a soil strength of 200 PSI (pounds per square inch). Root growth would be marginal between 200-300 PSI and there would be little growth at values higher than 300 PSI. There is a genetic variation within and between crop species in resistance to rooting.

Data on soil water and penetrometer resistance for Inverleigh are shown in Figure 7-8 and Figure 7-9 respectively. At depths of 0-30 and 30-60cm both amelioration treatments showed increased soil water compared to the control, suggesting that the treatments were effective in increasing the soil water content in the subsoil.

The response was similar at Mt. Pollock but the magnitude of the difference was smaller compared to lighter soils at Inverleigh. Penetrometer data suggests that at Inverleigh the amelioration treatments had created an additional 8cm of rooting depth compared to the control. However, at Mt. Pollock the soil strength below 30cm was still too high for any effective root proliferation at time of measurement. This response is partly related to the fact that this paddock was in lucerne in the past four years and has gone through a period of extreme drying as a result of the deep roots of lucerne.

From the available data it may be inferred that the amelioration treatments are capable of modifying the subsoil to enhance its capacity to store water. This enhancement apparently comes as a result of increased connectivity between topsoil and subsoil through the incorporation of organic matter (Peat) in the amelioration process. However, because of the sub-optimal weather conditions that continued to maturity of the crop, no yield differences were observed at either site (Table 7-17).

Table 7-17: Harvested Grain Yield From Slotting Trials At Inverleigh and Mt. Pollock

Site	Trt	Yield (t/ha)	Std. Dev.	SE
Inverleigh	Control	1.5	0.53	0.30
	T1	1.9	0.59	0.34
	T2	1.4	0.36	0.21
Mt. Pollock	Control	1.1	0.07	0.04
	T1	1.3	0.10	0.06
	T2	1.2	0.12	0.07