Yield response in barley, canola and lupins to deep ripping over three seasons near Broomehill, Western Australia.

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Key messages

1. Subsurface soil compaction has been shown to be a major constraint to crop production and the removal of this compaction via deep ripping can lead to large yield increases.

Aims

To assess the yield response in barley, canola and lupins to deep ripping over a three year period (2015 – 2017) near Broomehill, WA.

Method

Three deep ripping demonstration plots were put down by Scott Thompson in late February 2015. Undisturbed 'Control' plots were left either side of the treatment strips creating a replicated trail design (Figure 1). Four passes of a 3m wide Grizzly Deep Digger with 500mm tine spacing's was used at a working depth of 450mm to create 12 metre wide plots. These plots were aligned to fit with the existing 12m Controlled Traffic Farming (CTF) system.

The demonstration plots were sown using a 12m John Deere Air Drill as part of normal seeding operations in 2015, 2016 and 2017 to Barley, Canola and Lupins respectively. The trial area was given the same nutrition, herbicide and fungicide package as the surrounding paddock.

Yield data from the 2014 - 2017 seasons was collected using the yield monitor in a Class 750 Harvester. Yield data for the 2014 season was examined to determine the yield variation at the trial site prior to deep ripping. Post ripping yield for each plot was extracted and analysed using GIS software (QGIS 3.0).

A number of soil and plant measurements were collected during the 2017 season in addition to yield. Soil penetration resistance using a digital cone recording penetrometer was measured randomly across plots and used to assess differences in soil compaction. Plant density (plants/m^2) was collected at each soil penetrometer recording site. Normalised Difference Vegetation Index (NDVI) was collected using an Un-manned Aerial Vehicle (UAV) to assess differences in above ground plant biomass and plant greenness between plots.

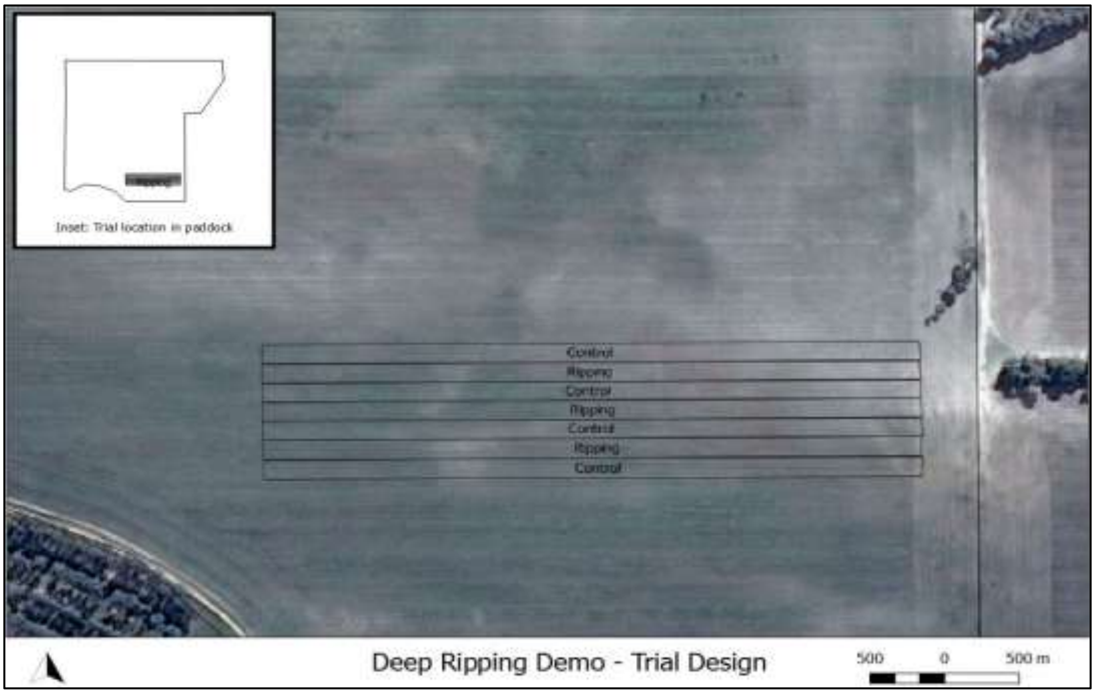

Figure 1: A deep ripping trial at Nardlah Grazing Co, Broomehill was established in 2015. The trial consisted of three, 12 metre wide ripping plots that were ripped to a depth of 450mm. Undisturbed 'Control' plots between each ripping plot allowed yield comparisons to be made in Barley, Canola and Lupin crops in 2015, 2016 and 2017.

Results and Discussion

Crop Yield

ANOVA analysis of crop yields for the trial showed a significant increase in yield between the ripped and control plots in each subsequent crop after deep ripping and that no significant difference existed in the season immediately prior to ripping treatments being established (Figure 2). The largest yield increase was seen in the 2016 Canola crop where an average 310 kg/ha yield increase was recorded in the ripped plots over the control. Lower yield increases were seen in the 2015 Barley and the 2017 Lupin crops where 157 kg/ha and 90kg/ha yield increases respectively were recorded in ripped plots over the control plots.

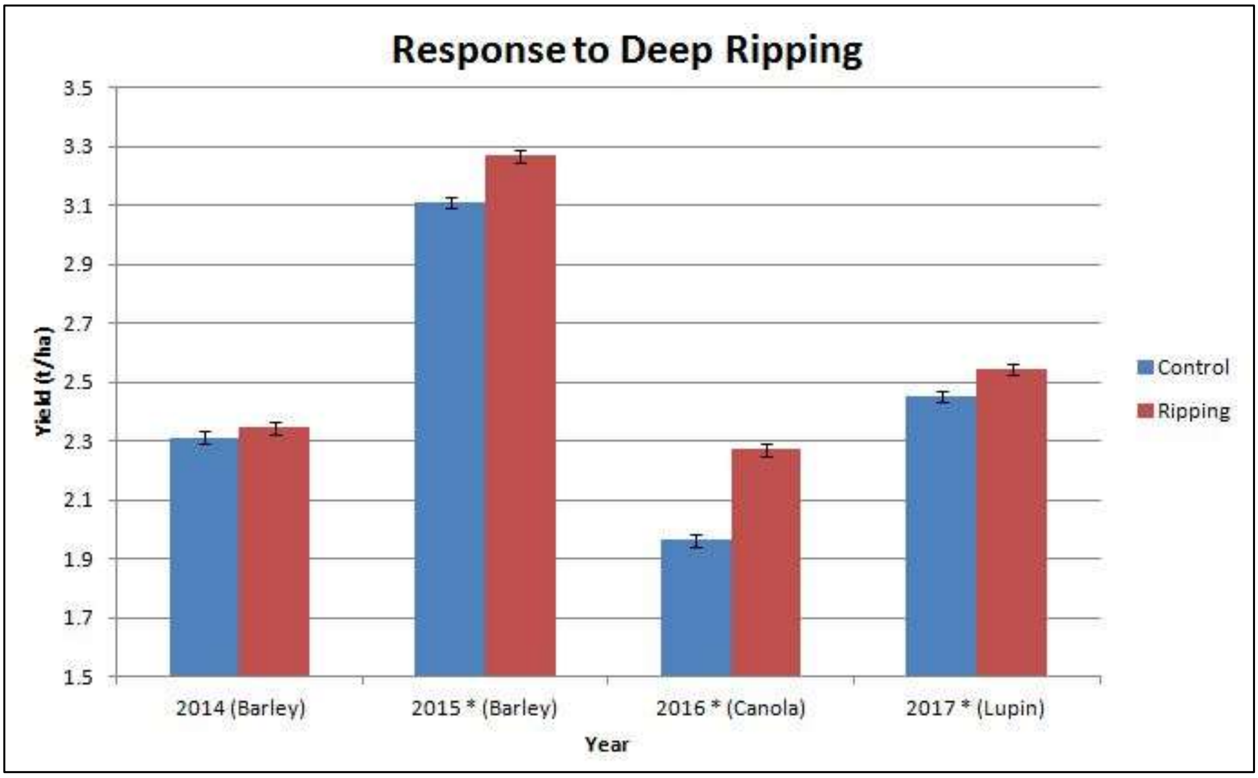

Figure 2: Average crop yield for the ripping and control plots showed there was no significant difference observed pre-treatment (2014) though significant differences (denoted by *) were present in each season and crop type after ripping (2015 - 2017).

Soil and Plant Measurements

A Rimick CP300 Cone Penetrometer was initially used to measure soil compaction at 27 locations across the trial site (Figure 3). Five insertions were recorded at each site and the average of these used to characterise the soil resistance at each location.

Gravel in the soil interferes with the ability to obtain an accurate measurement and limited the number of recordings that could be used to 5 from ripped plots and 5 from the control plots. These sites were all within a sand over clay duplex soil type rather than the sandy gravel soil type which dominated the trial area.

For this reason it was suggested that the data presented be viewed as only a guide to soil compaction at the site.

In the soil type where soil penetrometer recordings could be made it was found that there was a reduction in soil resistance within the ripped plots when

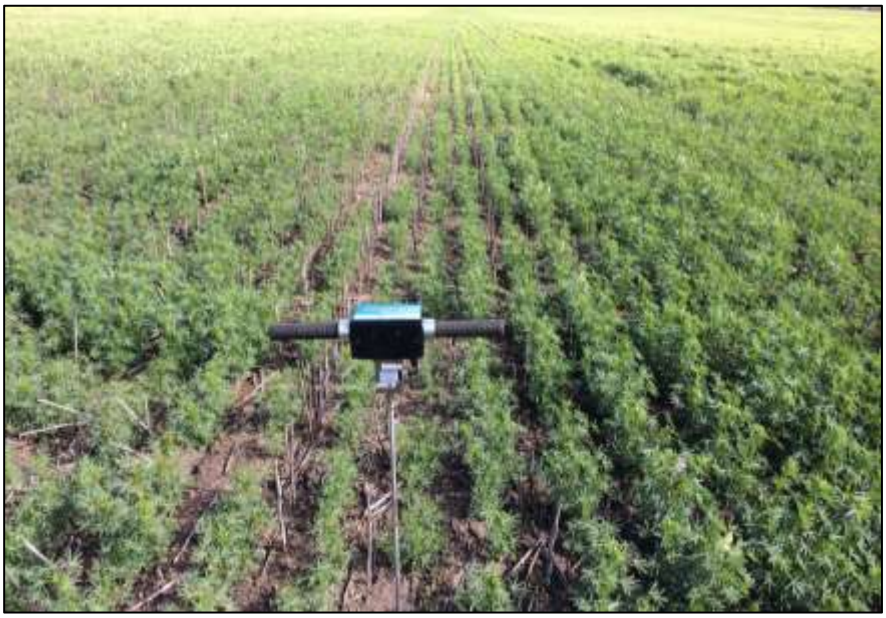

Figure 3: Rimick CP300 Cone Penetrometer used to record soil resistance across the trial site.

compared to the control plots, particularly in the soil layers between 100 – 300mm (Figure 4). It was also found that the reduction in soil resistance in the ripped plots gave an overall average reading that was less than 2500 kpa which previous research has found to be the value where plant root growth begins to be inhibited. In comparison, the average measurements in the control plots peaked at above 3000 kpa which indicate that there may be a soil constraint at this site caused by compaction. The severity of the constraint may not be all that large as the soil strength drops below 2500 kpa after 250mm soil depth.

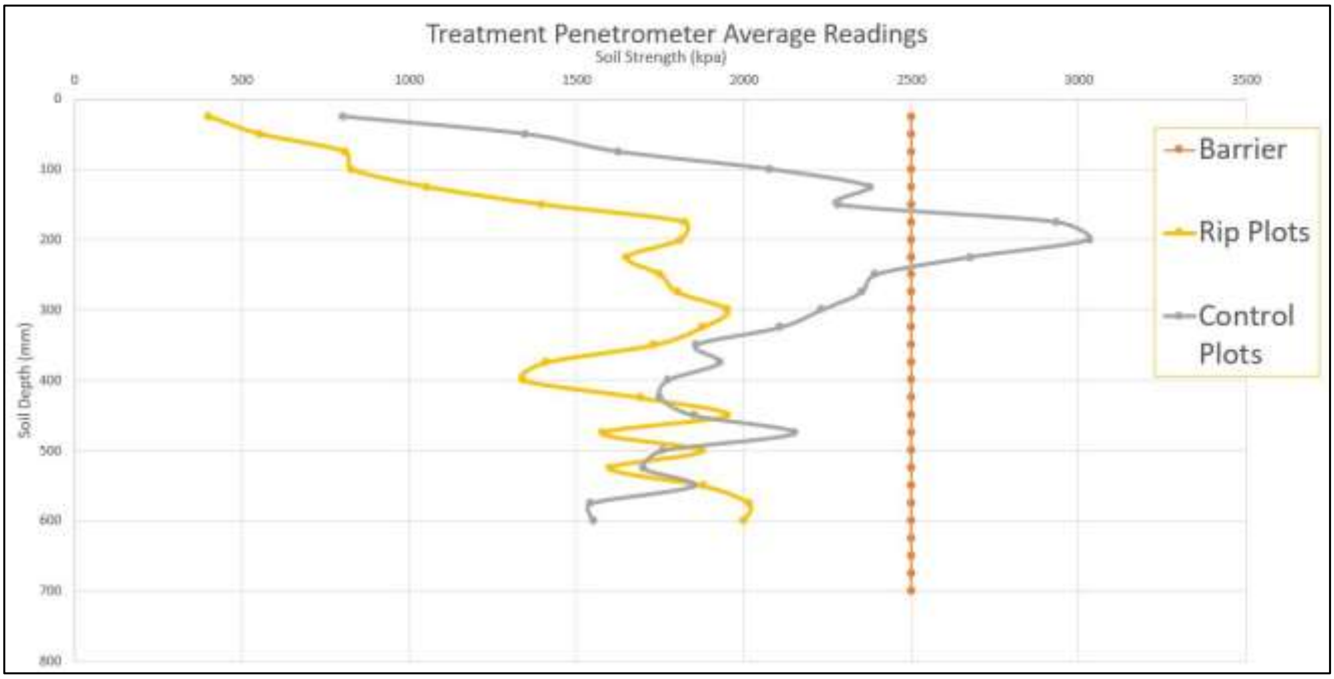

Figure 4: Average soil resistance measurements from ripped and control plots as recorded by a cone penetrometer.

Plant counts showed no overall difference between the treatments with a large range and variance seen in the plots of each treatment. This is best shown in the imagery captured by the UAV which shows large variation in NDVI across the trial site (Figure 5). The imagery suggests that there may be a reduction in areas of low NDVI in the ripped plots though this is not supported in the ANOVA analysis between ripped and control plots.

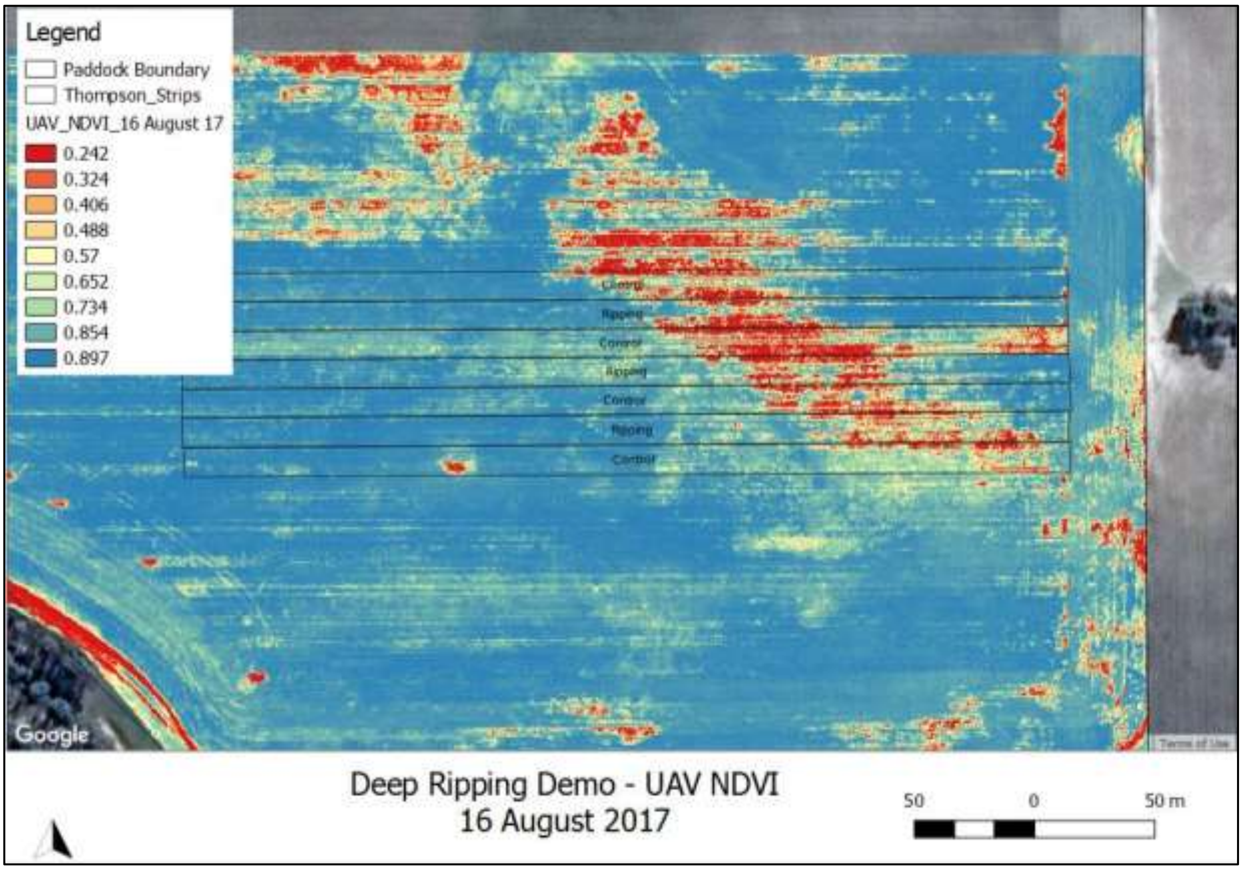

Figure 5: NDVI imagery shows biomass variation across the trial though no difference between treatments

Returns of Deep Ripping

A detailed economic analysis of the advantage of deep ripping has not yet been carried out. It is thought that the positive yield increases seen in the trial would have provided a positive return on investment though actual costs of the treatment and prices of crops in each season have not yet been examined.

The yield responses to deep ripping will continue to be monitored over the 2018 season to see if the treatment effects continue. The longevity of the treatment effect will determine how cost effective deep ripping is in this environment and on these soil types.

The 2017 season saw the smallest yield difference between treatment and control plots which may be due to a lupin crop being less responsive to deep ripping than barley or canola or may be a result of the deep ripping effect being reduced with time. The yield results from the 2018 season will be important to quantify how long the ripping effect seen here will last.

Testing for the presence of other soil constraints such as soil water repellence and subsurface acidity is planned for the 2018 season. This will indicate if there are other factors that are contributing to the yield differences seen at this site and if greater returns can be achieved if they are removed.

Conclusion

There have been positive yield responses seen in each season since the deep ripping treatments were established in 2015. The cumulative yield increase of 560 kg/ha of grain across the 2015, 2016 and 2017 season is likely to have provided a positive return on investment to the farm business. The yield response from the upcoming 2018 season will give an indication as to the longevity of the deep ripping effect and therefore how likely it is an ongoing economic advantage will be realized from the practice.

Acknowledgments

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