Yield response to ripping depth on a South Stirling sandplain. Kojaneerup, Western Australia.

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Key messages

1. Removing soil compaction increased barley yield by between 710kg/ha and 1,130kg/ha in 2016.
2. Very deep ripping (1200mm) gave the greatest yield increases at this site though there are factors that may inhibit the ability to rip this deep on a large scale.

Aims

To assess the yield response to deep ripping depth on a productive sand plain near Kojaneerup, WA.

Method

Trial Details

Deep ripping treatments were established at this site between 2014 and 2016. All treatments were aligned with existing 12 metre Controlled Traffic Farming (CTF) run lines (Figure 1).

Treatment summary:

2014: 16 ripping strips to a depth of 350mm were setup on alternative run lines using a Grizzly Deep Digger

2016: 4 strips originally ripped to 350mm in 2014 were ripped to a depth of 700mm using a Heliripper on 500mm tine spacing. An additional 4 strips originally ripped to 350mm in 2014 were ripped to a depth of 1200mm using a bulldozer on 1000mm rip spacing.

The paddock was sown to barley in 2016 and canola in 2017. Yield data was recorded in the harvester yield monitor, extracted using Ag Leader SMS and ANOVA analysis carried out using Genstat software.

Figure 1: The deep ripping trial design on Josh and Tony Goad's farm near Kojaneerup was finalised in 2016. The trial consisted of three ripping treatments at 350mm, 700mm and 1200mm in 12 metre wide plots. Undisturbed 'Nil' plots allowed yield comparisons to be made in barley and canola crops in 2016 and 2017.

Soil and plant measurements

A number of soil and plant measurements were collected during the 2017 season in addition to yield. Soil penetration resistance using a digital cone penetrometer was measured twice in each plot and used to assess differences in soil compaction. The rip line was located and five insertions were recorded at each site with the average of these insertions used to characterise the soil resistance at each location. Plant density (plants/m^2) and soil pH analysis (pH analysis in 10cm intervals to 50cm) was also carried out at each soil penetrometer recording site to establish subsurface acidity levels and assess crop establishment differences. 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.

Results and Discussion

Crop Yield

Yield differences due to deep ripping were observed in the 700mm and 1200mm rip treatments for barley in 2016 though only in the 1200mm ripping depth treatment for the 2017 canola (Figure 2).

2016 Barley Yield

The 700mm ripping treatment provided a significant average yield increase of 710kg/ha more grain than the control plots. The 1200mm rip treatment provided a significant average yield increase of 420kg/ha over the 700mm rip treatment and 1130 kg/ha over the control plots. The 350mm rip treatment provided a slight average yield increase over the control plots though this was not significant.

2017 Canola Yield

A marginal, though significant average yield increase of 70kg/ha was provided by the 1200mm ripping treatment in canola with all other treatments and the control showing no significant yield differences. The trial site experienced water logging and frost towards the end of the 2017 season which are thought to be contributors to this outcome.

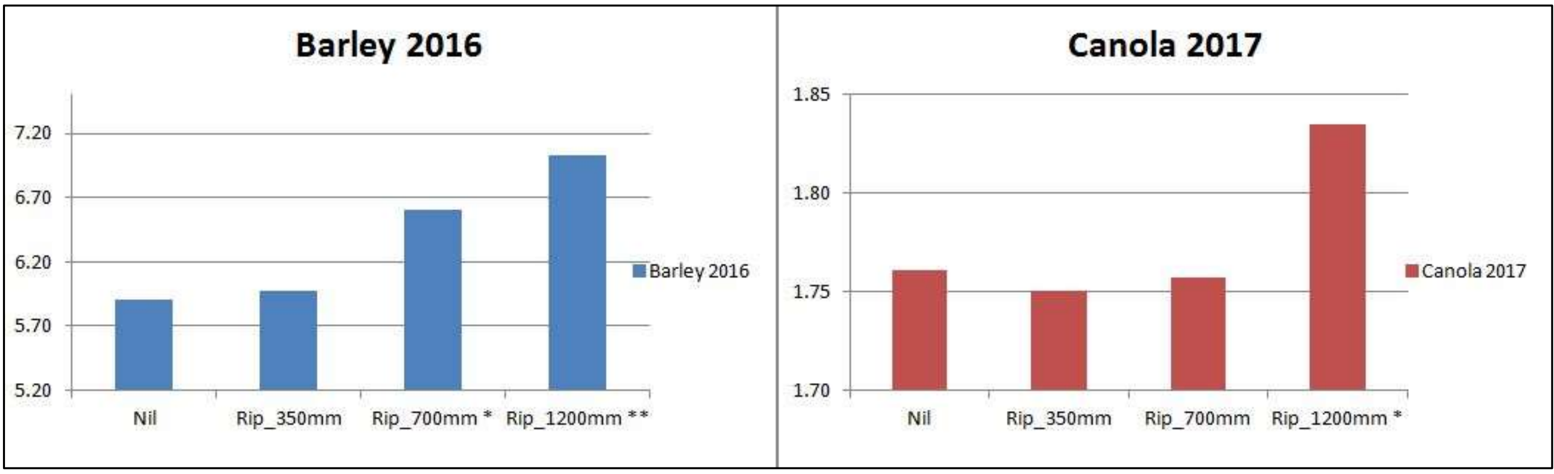

Figure 2: Average crop yield for the deep ripping and control plots showed that deep ripping provided significant yield benefits to 700mm and 1200mm ripping in barley (2016) though the only benefit came from 1200mm ripping in canola (2017). Significant differences are denoted by * and **

Soil and Plant Measurements

Soil coring across the trial found that pale sand over gravel and deep pale sand were the two soil types present at the site (Figure 3).

A Rimick CP300 Cone Penetrometer was used to measure soil compaction at 26 locations across the trial site and found there were differences in soil strength after deep ripping. Three soil penetrometer insertions in the pale sand over gravel soil type were discarded due to gravel interfering with the readings though all other insertions were kept.

Figure 3: Soil types found at the site were either pale sand over gravel (left) or deep pale sand (right).

Soil compaction in the undisturbed plots increased steadily from the surface to peak at around 3000kpa at approximately 250mm, with this value being maintained to at least 600mm. The 350mm rip treatment showed a reduction in soil compaction to approximately 300mm and then increased to peak and maintain 2600kpa to 600mm. Both the 700mm and 1200mm rip treatments were much less compact to 600mm with neither treatment having levels greater than 2000kpa in any insertion. Previous research has found 2500kpa to be the compaction level where plant root growth begins to be inhibited so it is expected that the Nil and 350mm treatments will experience compaction as a soil constraint at this site and may help explain yield differences observed.

Soil pH analysis found 0-10cm pH levels were below targets of pH 5.5 though the pH generally increased to be above pH 5.0 from 10 - 50cm (Figure 4b). There was a small amount of soil pH spatial variation across the site with four sites being below pH targets in the 0-30cm layers though this is not thought to pose a major factor in yield difference at this site.

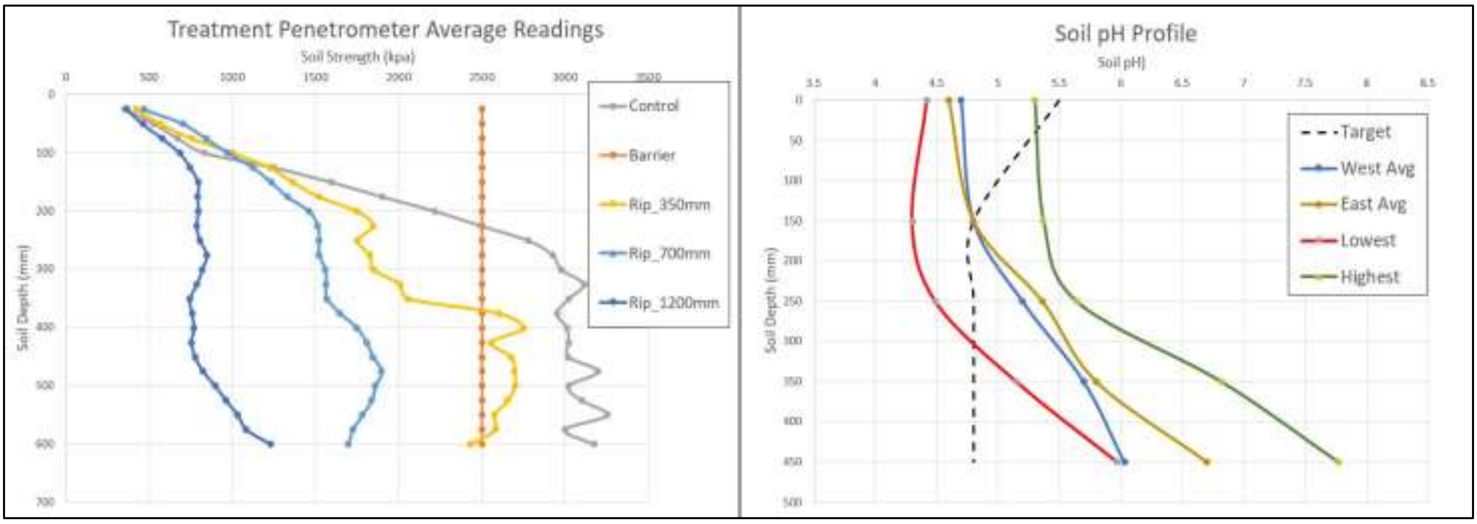

Figure 4a and 4b: Average soil resistance measurements from ripped and control plots as recorded by a cone penetrometer in august 2017 and soil pH values collected in February 2018.

Plant counts showed no overall difference between the treatments with a very small range and variance seen in the canola density recorded in plots of each treatment. The imagery captured by the UAV shows small variation in NDVI across the trial site (Figure 5) and is due to plant biomass rather than plants/m2. The imagery suggests that there may be higher biomass in the centre of each plot though as this occurs over all treatments and nil plots it is likely to be caused by the seeding bar rather than a treatment effect.

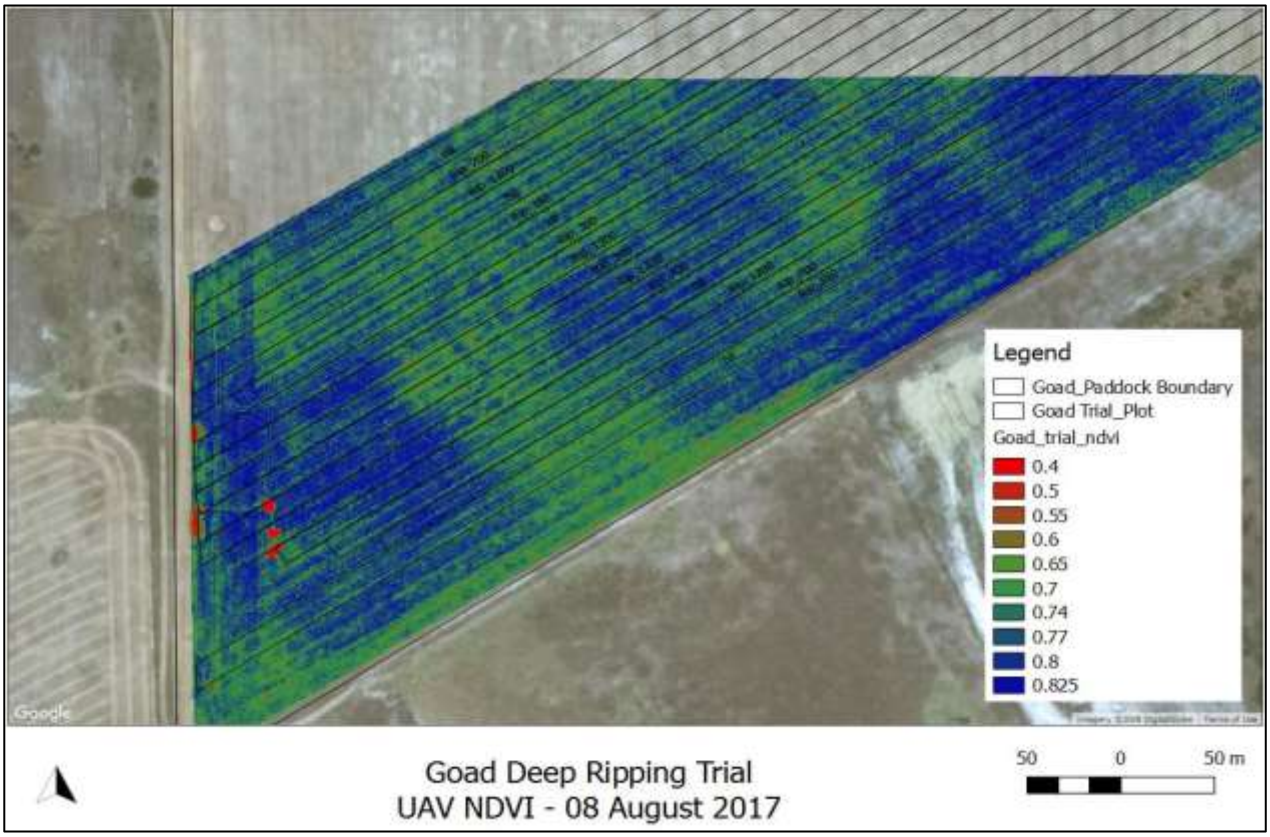

Figure 5: NDVI imagery shows biomass variation across the trial though no difference between treatments

Conclusion

There have been positive yield responses seen in each season since the deep ripping treatments were established in 2015. The cumulative yield increase 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.

A detailed economic analysis of the advantage of deep ripping has not yet been carried out. The 1200mm ripping treatment has provided the greatest yield advantage at this site though as it was carried out using a bulldozer it is not thought to be cost effective, or practical to implement on a larger scale. It does encourage further work to see how ripping deeper than 700mm can be achieved in a cost effective manner. Taking the frost and water logging issues encountered in the 2017 into account, 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 yield results from the 2018 season will be important to quantify how long the ripping effect seen here will last.

Acknowledgments

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