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Longevity of deep ripping and topsoil inclusion in soils under controlled traffic farming; evidence from the second season

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Purpose:	The primary aim of this trial is to test increasing the economic viability of deep ripping using controlled traffic and the addition of topsoil and ameliorants to the subsoil.		
Location:	Yanda, Rowes Road, Moora.		
Soil Type:	Deep loamy yellow sand		
Soil Test Results:	Depth (cm)	MED	$pH_{(CaCl)}$
	0-10	4.3	6.1
	10-20	0.3	4.4
	20-30	0.3	4.0
Rotation:	2014 Lupin, 2015 Canola, 2016 Barley		
Growing Season Rainfall (April- October 2015):	321mm		

BACKGROUND SUMMARY

Cultivation is the predominant management tool for subsoil compaction. This may be in the form of deep ripping, spading or ploughing – each with varying costs, benefits and disadvantages of the chosen application.

The majority of WMG growers are currently deep ripping their paddocks to a depth of up to 400mm to combat subsoil compaction. However larger, heavier machinery have pushed these hard pans to depths greater than 400mm. Deep ripping to depths >400mm is limited by machinery and soil type. To combat this issue, the Department of Agriculture and Food, Western Australia (DAFWA) designed a double-row ripper that has parabolic shallow leading tynes and deeper following tynes, allowing for a greater depth of penetration with less draft and reduced cloddiness when ripping in dry conditions. Deep ripping is the first step in removal of compaction and compliments Control Traffic Farming (CTF) to protect the soil resource from re-compaction. Ripping tines were spaced at 500mm.

In 2015 the DAFWA 3.5m trial ripper was used to investigate ripping to depths greater than 300mm to remove the deeper compaction (Blackwell et al, 2016). It had parabolic, shallow leading tines and deeper following tines, allowing for a greater depth of penetration with less draft and reduced cloddiness. Inclusion plates are a new component to the DAFWA deep

ripper designed to incorporate the topsoil and/or soil ameliorants to depth behind the tine. This innovation decreases the cost of incorporating soil amendments although ameliorating a smaller soil volume. The inclusion plates also aim to improve the longevity of ripping with the addition of soil organic matter down the ripping slot to improve soil structure stability. Inclusion plates had been attached to the rear, deeper tines for incorporation of topsoil to depth behind the tine. Topsoil inclusion plates had an inside separation measurement of about 130mm. This is the second year since the inclusion plates were developed and as such they require further trial work to improve their fit in the system. The addition of inclusion plates to the deep ripper gives growers the ability to remediate multiple constraints in one pass, giving great efficiencies and returns on investment.

Once ripping treatments were established the site has been sown, managed and harvested within the 12m controlled traffic system employed at Yanda. Individual ripping treatments have been applied on wings of the bar and between the tracks.

The intention of burying the topsoil is to incorporate organic matter and surface applied ameliorants to the depth of ripping to improve soil condition and help increase the longevity of ripping. Soil structure and structural stability is improved with increased organic matter (Moore 2004). Lime was also top-dressed over a section of trail to investigate how subsurface pH is constraining plant response to ripping.

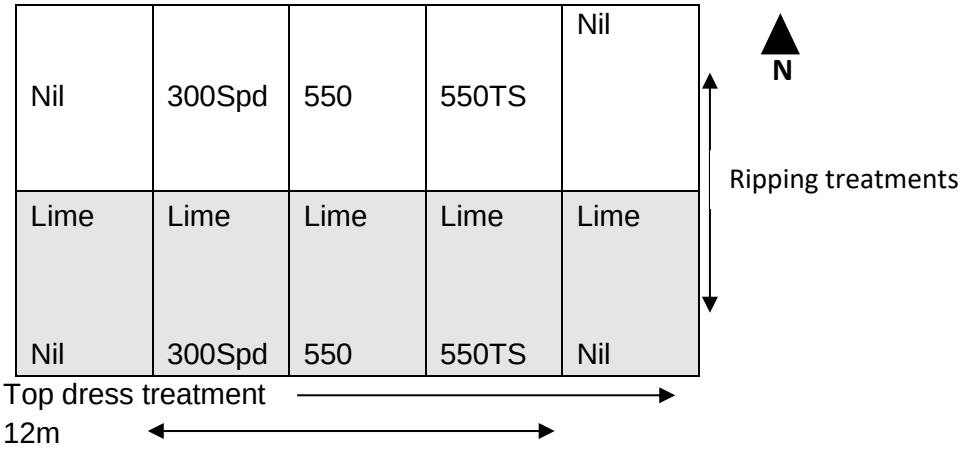
TRIAL DESIGN

Please insert methodology and any design details which could include:

Plot size: 3.5m x 20m
Repetitions: 4
Crop type and varieties used: Barley - Bass
Seeding date: 12 May
Ripping treatments (mm): Nil, 300, 300+Spading, 550, 550+topsoil slotting

TRIAL LAYOUT

Table 2 Showing one replicate of the four replicates at the Yanda site



RESULTS

Results presented here were analysed using a simple linear mixed model, REML, to compare incomplete factorial layouts of the treatments. Harvest windrow effects are present in treatments at Moora and have been analysed to account for this.

Table 3. Yield results, t/ha, from the Yanda trial with respective topdressing and ripping depth treatments. 10% LSD shown to account for complexity of trial interpretation, rip*tpdrs for comparison between ripping and topdress treatments, tpdrs for comparison of yield within a topdressing treatment

		Topdress		
	Ripping	Nil	Lime 5t/ha	**% LSD 10**
Moora	Nil	1.43	1.23	rip*tpdrs: 0.53
Barley	Nil + W	1.42	1.09	tpdrs: 0.39
	300	1.44	1.36	
	300 + Sp	1.90*	1.81*	
	550	1.90*	2.43*	
	550 + W	1.99*	1.92*	
	550 + TS	2.08*	1.51	
	550 + TS + W	2.19*	2.03*	

Note: TS topsoil slotting, Spd spading, W windrow, *90%prob of greater or less than unripped within topdressing

This trial has been analysed to account for windrow effects, because Nil and 550mm ripping treatments had lupin and canola harvest windrows within plots during 2014 and 2015. Ripping below 300m has shown a yield response in the second year after ripping. When ripping to 550mm topsoil, topsoil slotting provided an additional 0.9t/ha. There is some evidence of organic stabilisation of this higher clay content yellow sand, which is prone to self-settlement by wetting and drying after ripping, even without cropping traffic compaction.

The biomass and heads/m^2 measured at anthesis were lower across all treatments in the area topdressed with lime when compared to the Nil topdressing, potentially due to a nutrient constraint from increased surface pH. Some unreplicated preliminary canopy temperature measurements using infrared temperature loggers indicated large temperature differences between Nil ripping and deep ripped to 550mm with topsoil slotting treatments. The plants in the deep ripped soil were 0.59°C (se 0.36) cooler than those in the unripped soil. Such temperature differences indicate the plants in the deeper ripped soil had better access to soil moisture. Further investigation is required to understand this interaction. There were trends to greater biomass and head number in the 550mm topsoil slotting treatment but fewer grains per head when compared to the Nil treatment.

There are initial indications that the topsoil slotting plates are re-compacting soil between the rows during ripping (Fig 1). This needs further investigation. Where plates have been added, 550TS Between, the soil strength reaches 2000 kPa at approximately 200mm. Without plates, 550 Between, this strength isn't reached until below 400mm. In the rip line, 55TS Rip line, the soil is loose and low strength to 500mm.

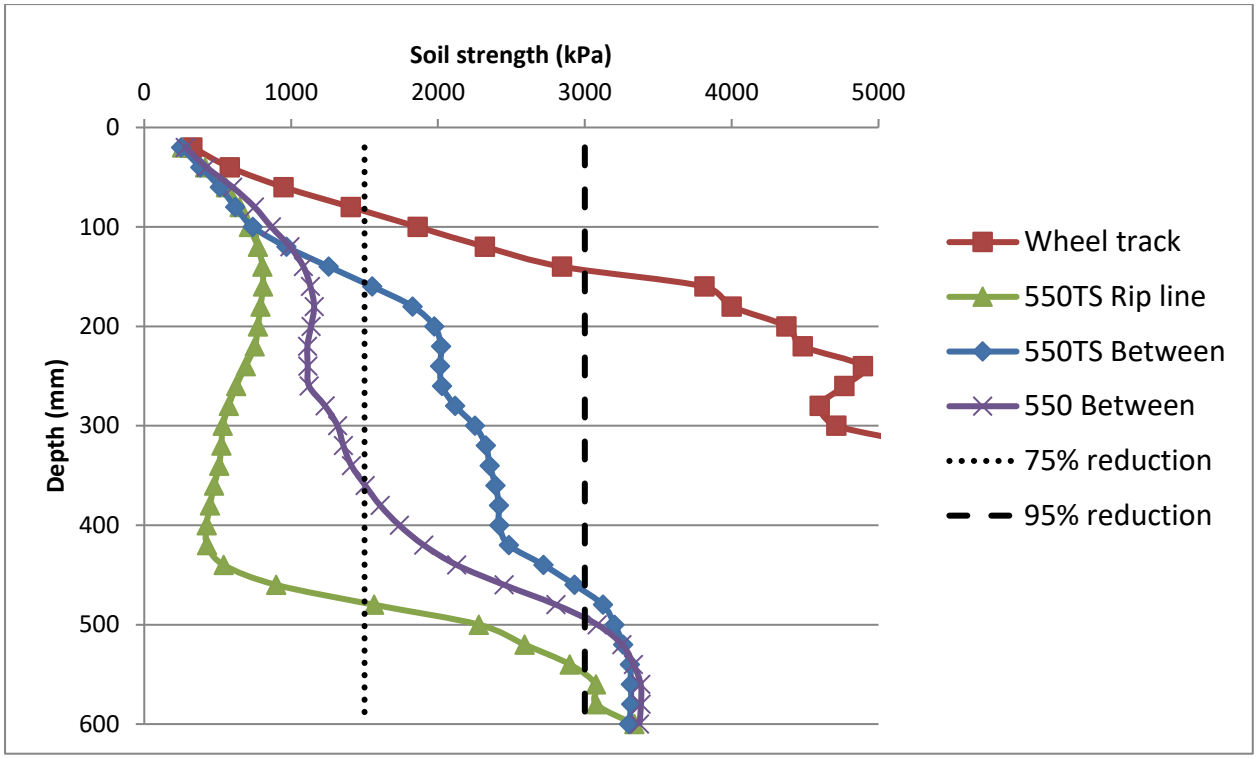


Figure 1. 2016 penetrometer data from the site, showing from the rip line and between the rip lines with and without topsoil slotting plates

FINANCIAL ANALYSIS OF RESULTS

Assumptions used for return on investment calculations;

- Price for canola year 1, $542/t. Price for barley year 2, $235/t
- Cost of lime $31/t, delivered and spread
- Total cost of ripping $28.71, $37.42 and $40.16 /ha for 300mm, 550mm and 550mmTS respectively. These costs are still to be reviewed with grower figures for deeper ripping, have been taken from the 3.5m trial ripper.

Ripping to 550mm with and without topsoil slotting plates, nil lime, has provided significantly more return on investment than any other treatment (Table 3). The large results due to the additional 1.2t/ha canola in the first year. The yield response from the lime top dress has not paid for the investment in the second year.

Table 3. Return on investment (ROI) over the first two seasons of deeper ripping, with topsoil slotting and top-dressed lime for Moora site. Table provides only a guide to possible return on investment using numbers generated from the trial and assumed costs and prices

Top Dress	Nil				Lime 5t/ha			
Ripping	300	300spd	550	550TS	300	300Spd	550	550TS
Yr 1	-1	2.5	16	14	1	2	3	2
Yr 2	-1	3.5	19	18	0.5	2.5	4	2.5

Lime continues to be a long term investment. The value of the lime in 2016 was greater than $100/ha in 550mm ripping. If this trend continues then lime will begin to provide larger return on investment as the un-limed site decreases in yield response over the remaining three years of the trial.

CONCLUSION

The results from this trial show the importance of ripping below the hard pan with deeper ripping. The hard pan at this site measured to a depth of 400mm prior to the ripping treatments going in. Ripping to 300mm, without spading, has not improved yield in either of the first two seasons as plant roots are slowed through the hard pan. For return on the dollars spent deep ripping it is important to understand where the hardpan is in your paddock before starting the program.

It is likely that the topsoil slotting plates are impacting the inter-row soil strength during the ripping process. Therefore, the design needs investigation. It may be that additional shatter is required through winged points allowing the plates to pass through with less impact. Monitoring of this trial continues during 2017 and 2018 seasons.

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