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Annual Results Report Template

2019
Annual Results Report
Ripper Gauge

Project code:	9176166
Prepared by:	Aidan Sinnott and Michelle Handley (Researchers) aidan@sepwa.org.au michelle@sepwa.org.au SEPWA Michelle Handley (Administrator) michelle@sepwa.org.au
Date submitted to GRDC:	[30th May 2019]

REPORT SENSITIVITY

Does the report have any of the following sensitivities?

Intended for journal publication	NO	
Results are incomplete	Yes (this report covers year 1 of a 3 year project)	
Commercial/IP concerns	NO	
Embargo date	NO	If Yes, Date: DD/MM/YYYY

KEY MESSAGES

- Deep ripping to alleviate compaction and allow better water absorption has improved crop yields at 4 of the 5 EPZ Ripper Gauge demonstration sites in 2018.
- Not all ripping responsive soils required ripping to the same depth.
- While early season dry conditions were challenging and total growing season rainfall was low at the Dunn Rock demonstration site, the deep tillage treatments applied to the site's sandy gravel over clay soil were a profitable means of increasing barley yield.
- Early season conditions were dry at the Cascade demonstration site. The results collected suggest deep tillage to 300mm or 600mm in the heavy sodic soils present at this site did not improve wheat yield. The rip to 600mm strip achieved an operating gross margin of less than half of both the control strips and the rip to 300mm treatment.
- While the mixing effect of the TopDown achieved a gain of 0.28t/ha when compared to the control, gains in yield were not as large as the effects of deep ripping, spading or a combination on the gravelly sand over clay soil type present at the Coomalbidgup site. The latter tillage treatments improved wheat crop yield by 0.51t/ha to 0.78t/ha when compared to the control strip average of 3.75t/ha, equating to a gross margin increase of between $54/ha and $174/ha.
- The loamy clay to circle valley sand over clay soils present at the Salmon Gums site showed an increase in crop yield of almost 0.91t/ha from ripping to 450-540mm depth. While both the control and shallow deep ripping (ie to 300mm depth) treatments yielded 2.5t/ha of wheat, the deepest tillage treatment yielded approximately 3.4t, equating to a gross margin increase of $316/ha.
- Tillage of the Neridup site's sandy gravel over clay soils to 300mm increased canola yield compared to the control by 0.41t/ha which equated to a gross margin increase of $179/ha. Tillage to 600mm reduced canola crop yield by 0.35t/ha when just ripped and by 0.9t/ha when exposed to ripping to 600mm combined with a Topdown.

SUMMARY

The practices of soil amelioration (deep ripping) and controlled traffic farming can be confusing for some growers due to soil variability and varying options for treatment. There is indecision as to what treatments suit what soil types, and what their economic benefits are (if any) in the short, medium and long term. Also, combined approaches to ameliorate more than one constraint can be worthwhile, but there are still some soil types that growers are nervous about touching due to associated risks (such as bringing hostile subsoils to the surface and erosion concerns).

In addition, strategic tillage practices have been found to compact again over time following amelioration, often to greater levels that prior to treatment. Currently, the solution is to repeat the deep ripping process every few years, with the period in between deep ripping dependent on the soil type and amount of wheeled traffic on the paddock. This is a costly, repetitive process that may become unsustainable in the long term as soils become compacted to greater depths with successive tillage treatments and larger/heavier machinery.

This project aims to demonstrate and evaluate the benefit, or not, of soil amelioration across a range of soil types in the Esperance Port Zone. Four demonstration sites will be established in locations, and on soil types, that help fill gaps in knowledge regarding the economic return from soil amelioration techniques over time. A variety of treatments at each trial location will be implemented, based on the availability of machinery, geographical location and soil type.

This project links with other grower groups in Western Australia working on the same topic and will continue for the 2019 and 2020 seasons to follow the impact of each amelioration treatment over time.

As a result of this project, growers will have an increased awareness of the benefits of amelioration and the benefits of controlled traffic practices to give the greatest benefit and longevity on a range of soil types in both the Esperance region and more widely in Western Australia.

1.0 BACKGROUND

The presence of soil constraints including compaction, water repellence, top soil acidity and subsurface acidity across the agricultural region of WA limits the opportunities for grain growers to increase crop production.

These soil constraints can be effectively dealt with through the numerous strategic soil amelioration practices that have been developed as part of previous and current projects (DAW00242, CSA00033, DAW00236). A number of strategic tillage practices have been adopted by many growers to ameliorate soils, with mouldboard ploughing and spading being used to bury the non-wetting surface layer, or thoroughly dilute the water repellent soil into the soil profile. Deep ripping can also be used to break up sub-soil compaction that is formed through tillage and from trafficking the paddock with heavy agricultural equipment.

While deep ripping has been shown to improve crop yields and decrease soil strength, the lifespan of soil amelioration practices is often determined by the time it takes to recompact the soil in the years following amelioration. Coarse sandy soils, which are common in WA, naturally compact over time but the most severe soil compaction comes from random wheel traffic from paddock operations. This can compact the soil to greater levels than previously recorded before amelioration.

The adoption of controlled traffic practices by growers is one solution to extend the benefits of soil amelioration over a greater length of time. Controlled traffic practices mean the establishment of permanent wheel tracks across the paddock to carry all the heavy wheel traffic during paddock operations, so that the total amount of wheeled area in the paddock is less than 20%. This is considerably less than a random wheeled system, where at least 35-70% of the paddock can be wheeled in any given season.

The benefit of combining deep ripping and controlled traffic practices has been extrapolated by Wayne Parker as part of DAW00242 project. It is considered that the benefit of deep ripping to ameliorate soil compaction may last for only 3 years under random wheel traffic, but these benefits may last at least 5 years under controlled traffic practices. However, the potential for controlled traffic practices to increase the longevity of amelioration treatments has only been evaluated on a narrow range of soil types.

2.0 OBJECTIVES

This project aims to establish 4 demonstration sites in the Esperance Port Zone that are used by growers to increase their knowledge and adoption of deep ripping and controlled traffic farming to alleviate non-wetting soils, compaction and waterlogging on different soil types in the port zone to improve crop production.

To do so the project will measure the grain yield and gross margin outcome of each soil ameliorant treatment at each site.

3.0 METHODS

In 2018 demonstration sites were established in each of the following five locations:

- Dunn Rock (Ravensthorpe)
- Cascade

- Coomalbidgup
- Salmon Gums
- Neridup

A side by side demonstration strip design was used at each of the 5 sites to compare 2 ripping depth treatments to an untreated control. The ripping depth treatments were tillage to 30cm and tillage to as close to 60cm as possible. A "local solution/combination of method" treatment was applied at 3 the Dunn Rock, Coomalbidgup and Neridup locations where equipment was available and the soil type lent itself to another amelioration technique question, beyond depth to rip to. Additional soil amelioration treatments were not applied at the Salmon Gums and Cascade sites for two reasons. Firstly, access to additional soil amelioration equipment was limited in these locations. Secondly, the primary question that needed to be addressed at these locations was whether ripping would bring hostile subsoils to the surface that impeded crop performance or not.

Each site was established in February-March 2018 with the treatments implemented by the trial site host growers. During the winter cropping season the sites were sown, sprayed, fertilised and harvested under the management of host growers with the soil amelioration treatment being the only difference between plots. A Controlled Traffic Farming system was in place at each of the 5 locations.

Following application of ameliorant treatment, the amount of soil disturbance was measured by placing a 50cm straight ruler across the rip line so that the rip line corresponded with the 25cm mark on the ruler. A push rod was then used to make insertions at 12.5cm increments to measure the amount of loose soil between and within the rip- line.

Prior to seeding a bulked soil sample for the following depth increments 0-10cm, 10-20cm, 20-30cm, 30-40cm and 40-50cm was submitted for comprehensive analysis by CSBP. Plant establishment counts were taken either 4 weeks after seeding or close to, depending on when emergence occurred as the season's dry start delayed germination. During the season plant growth was measured using a Trimble® Greenseeker®.

Soil strength was measured using a data-logging penetrometer in winter 2018 when the soil should have been at field capacity. Five insertions were made in each quadrat in a similar manner to the measurement of soil disturbance. However, because winter rainfall was low at each of these locations, field capacity was not reached at any of the five sites hence soil strength could not be measured effectively. The data collected has not been included in the body of this report but can be found in Appendix 2.

Grain yield was measured at the Dunn Rock, Cascade, Salmon Gums and Neridup sites using yield monitor data from the host grower's header and by weigh trailer at the Coomalbidgup site.

Gross Margin was calculated for each treatment per demonstration site based on grower data for inputs and costs for the season.

The communication and extension activities undertaken to support this project during 2018 are listed in Appendix 1.

4.0 LOCATION

	Latitude (decimal degrees)	Longitude (decimal degrees)
Trial Site #1 - Dunn Rock	-33.465942	119.735612
Nearest Town	Ravensthorpe	
Trial Site #2 - Cascade	-33.382425	120.943011
Nearest Town	Cascade	
Trial Site #3 - Coomalbidgup	-33.570733	121.421373
Nearest Town	Coomalbidgup	
Trial Site #4 – Salmon Gums	-33.039886	121.736452
Nearest Town	Salmon Gums	
Trial Site #5 - Neridup	-33.634446	122.053783
Nearest Town	Neridup	

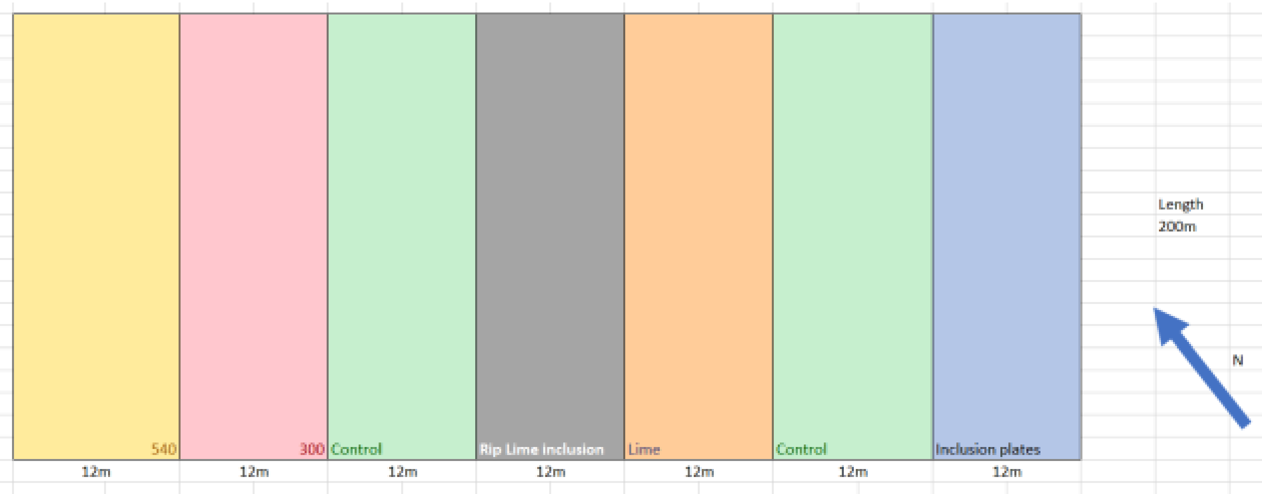
If the research results are applicable to a specific GRDC region/s (e.g. North/South/West) or GRDC Agro-Ecological Zone/s please indicate which in the table below:

Research	Benefiting GRDC Region (can select up to three regions)	Benefiting GRDC Agro-Ecological Zone (see link: http://www.grdc.com.au/About-Us/GRDC-Agroecological-Zones) for guidance about AE-Zone locations	
Experiment Title	Western Region Western Region Western Region	☐ Qld Central ☐ NSW NE/Qld SE ☐ NSW Vic Slopes ☐ Tas Grain ☐ SA Midnorth-Lower Yorke Eyre ☐ WA Northern ☐ WA Eastern ☒ WA Mallee	☐ NSW Central ☐ NSW NW/Qld SW ☐ Vic High Rainfall ☐ SA Vic Mallee ☐ SA Vic Bordertown-Wimmera ☐ WA Central ☒ WA Sandplain

5.0 RESULTS

5.1 Dunn Rock (Ravensthorpe) Demonstration Site

5.1.1 Soil Amelioration Treatment Regime



The Dunn Rock site had the following treatments applied using a Nufab ripper in the order illustrated above and was sown to barley:

- Ripped to 540mm depth, spacing 300mm
- Ripped to 300mm depth, spacing 300mm
- Untreated control
- Lime 2t/ha and inclusion plates, spacing 600mm, rip depth 300mm
- Lime 2t/ha
- Control
- Inclusion plates, spacing 600mm, rip depth 300mm

Rainfall was very low in 2018 and 3 separate severe wind events occurred. Fortunately, the host grower's use of CTF and no-till seeding meant that there was minimal soil erosion due to the presence of retained stubble.

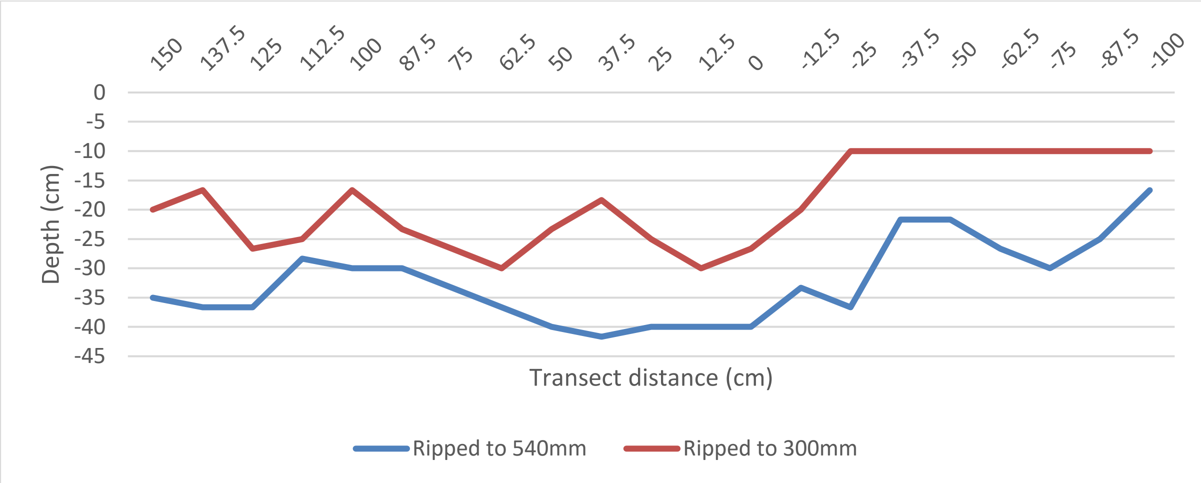
5.1.2 Soil Type

Soil at the Dunn Rock site was a sandy gravel over yellow/orange clay (see photo above). pH ($CaCl_2$) was acidic at the surface, approaching neutral from 10-30cm depth and alkaline beyond 30cm depth (see table below). Potassium levels were marginal between 0cm and 30cm depth and Sulphur levels were low between 10cm and 30cm.

Name	Depth	Colour	Gravel	Texture	NH4-N	NO3-N	Col P	Col K	S	OrgC	Cond	pH CaCl2	Boron
Burrell	0-10	BRGR	5	1	2	17	24	50	6.9	1.33	0.051	4.9	0.35
Burrell	10-20	BRGR	5	1	1	4	10	45	1.6	0.44	0.027	6.1	0.25
Burrell	20-30	BRGR	5	1	< 1	3	9	44	1.5	0.3	0.027	6.2	0.28
Burrell	30-40	GRYW	0	3	1	1	< 2	407	7.3	0.13	0.22	8.3	6.11
Burrell	40-50	GRYW	0	3	< 1	1	< 2	444	6.5	0.1	0.176	8.2	5.28

5.1.3 Soil Disturbance Post Treatment

The figure below indicates that the target depth was most likely achieved for the 300mm ripping depth treatment but that the 540mm ripping treatment achieved a depth of 410mm. The data does not, however, clearly illustrate where the rip line is in the transect and its highly likely that the presence of gravel in the soil affected the results collected.



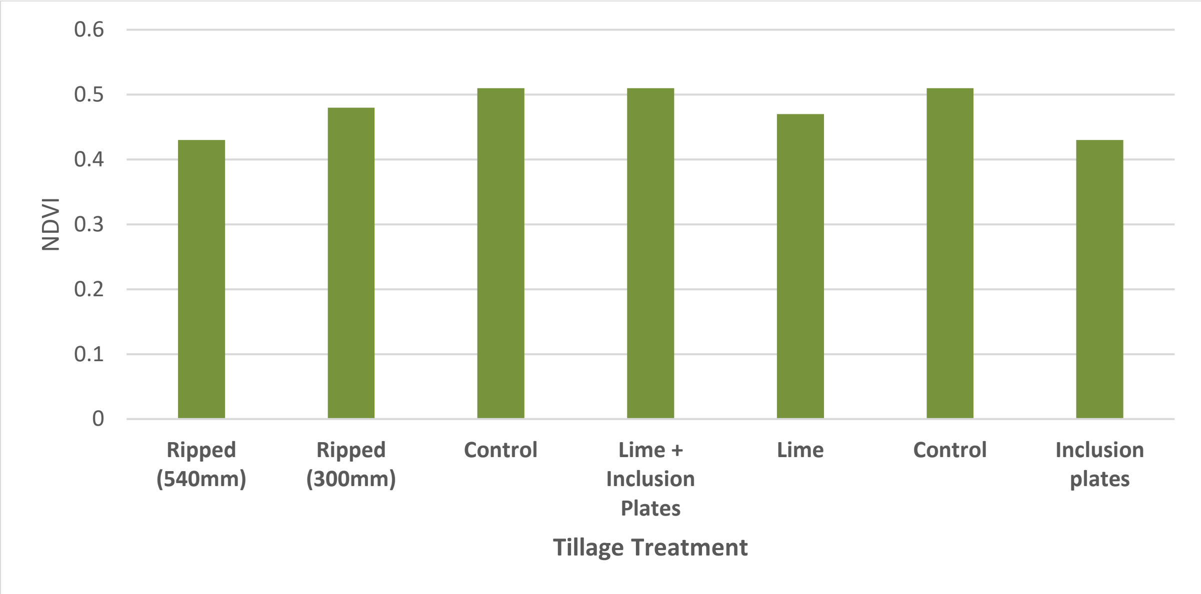
Soil disturbance following ripping to 300mm and 540mm depth at Dunn Rock, 2018

5.1.4 Plant Establishment

Plant establishment numbers were not collected from this site. Due to the low rainfall received germination was staggered and very patchy which made the random selection of meter stick measuring sites unsuitable. There were areas throughout the treatments with no plants at all (see photo below).

Crop Establishment, Dunn Rock Ripper Gauge SIte, 30th May 2018

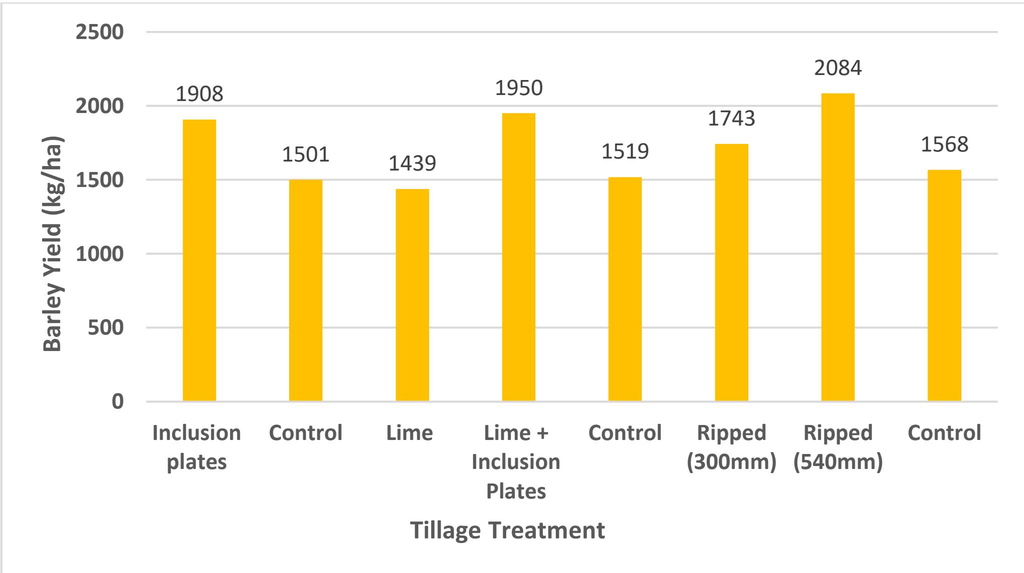
5.1.5 In-season Crop Biomass



Dunn Rock Tillage Treatment Barley Plots Biomass, July 2018

Early (July) barley crop biomass data is presented above. There was minimal difference (less than 0.1) in NDVI levels recorded between each of the soil amelioration treatments applied.

5.1.6 Harvest Yield



Dunn Rock Tillage Treatment Plots Barley Harvest Yield, 2018

Barley crop harvest yield data is presented above. The ripping treatments (ie inclusion plates (300mm depth), rip to 300mm and rip to 540mm) resulted in higher yields than the un-ripped control strips and the un-ripped lime treatment strip on Dunn Rock's sandy gravel over clay soil type. The addition of lime to address surface acidity without the addition of a ripping treatment did not increase yield when compared to the control strips.

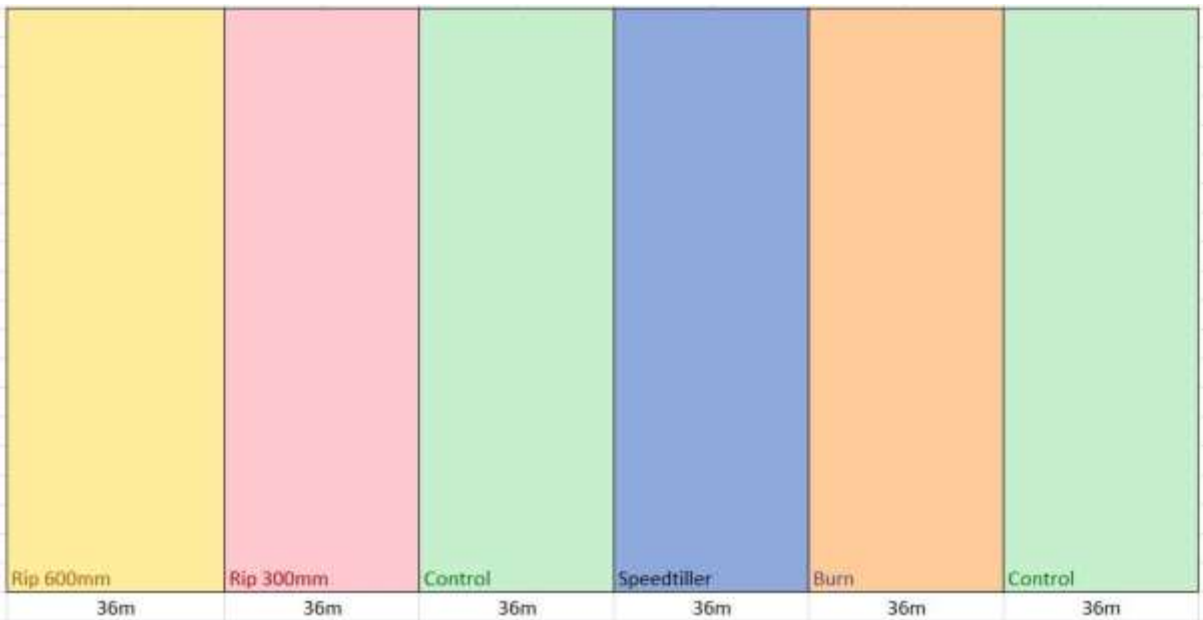
5.1.7 Gross Margin Analysis

Barley		Control	Rip 540mm depth	Rip 300mm depth	Lime & Inclusion Plates	Lime @ 2t/ha	Inclusion Plates
Yield	t/ha	1.53t/ha	2.08t/ha	1.74t/ha	1.95t/ha	1.43t/ha	1.91t/ha
Average Grain Price (FIS)	$/t	$280	$280	$280	$280	$280	$280
Income	**$/ha**	**$428**	**$582**	**$487**	**$546**	**$400**	**$535**
Variable Operating Costs	**$/ha**						
Seed & Treatments		$22	$22	$22	$22	$22	$22
Wages Gross			$12	$12	$12	$12	$12
R&M Mach./Plant/Vehicle			(hire)	(hire)	(hire)	(hire)	(hire)
Fuel			$24	$24	$24	$24	$24
Fertiliser		$95	$95	$95	$95	$95	$95
Lime & Gypsum							
Herbicides, Pesticides, Fungicides		$95	$95	$95	$95	$95	$95
Variable Operating Costs	$	$212	$248	$248	$248	$248	$248
Operating Gross Margin	**$/ha**	**$216**	**$334**	**$239**	**$298**	**$152**	**$287**

Gross margin data is presented in the table above for each of the soil amelioration treatments applied to the Dunn Rock demonstration site. Once input costs were factored in the most profitable of the treatments applied to the sandy gravel over clay soil at this site was the ‘rip to 540mm’ treatment (remembering push rod testing suggests the depth achieved was more likely 410mm), then the ‘lime, rip to 300mm and inclusion plates’ treatment, closely followed by the ‘rip to 300mm and inclusion plate treatment’, then the ‘rip to 300mm depth’, then the control strips and lastly the ‘lime’ treatment.

5.2 Cascade Demonstration Site

5.2.1 Soil Amelioration Treatment Regime



The Cascade site had three tillage treatments applied and a burn treatment to see if stubble management appeared to be more important than soil amelioration (see above). The 2 ripping depth treatments (300 mm and 600mm) were undertaken using a straight shank NuFab ripper with a crumble roller. The Speedtiller treatment cultivated to a depth of 100mm. The site was later sown to wheat.

5.2.2 Soil Type

Heavy sodic clay soils were prevalent at the Cascade demonstration site (see photo & table below). pH was alkaline throughout the depth profile with the levels seen at 30cm and below getting in to the range that may affect nutrient availability. Conductivity levels recorded at 40-50cm were in the semi saline category and boron from 30cm was high. The high levels of sulphur recorded in the 0-10cm layer was high, reflecting the gypsum application history of the paddock (2t/ha spread 3 years ago).

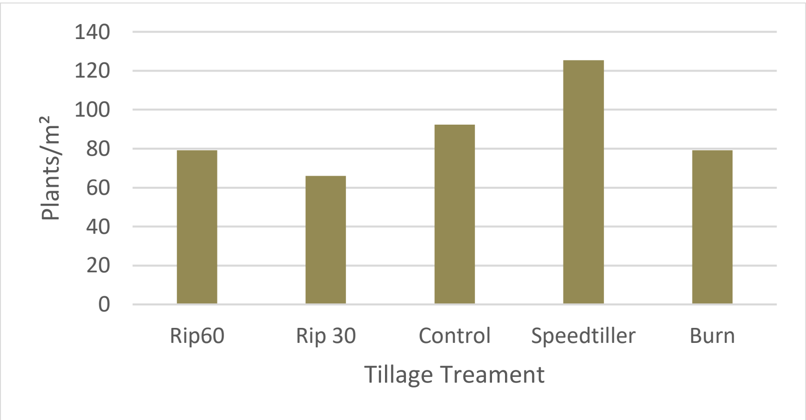
There has been little deep ripping trial work conducted on heavy soils of this type in the EPZ due mainly to concerns about bringing toxic subsoils to the surface and creating problematic sodicity issues at the surface.

Name	Depth	Colour	Gravel	Texture	NH4-N	NO3-N	Col P	Col K	S	OrgC	Cond	pH CaCl2	Boron
Carmody	0-10	GR	5	3.5	< 1	15	17	321	50.6	1.34	0.16	7.7	1.3
Carmody	10-20	GR	0	3	2	5	3	447	4.5	0.63	0.115	8	3.11
Carmody	20-30	GRWH	0	3	1	5	4	435	7.4	0.51	0.19	8.2	4.1
Carmody	30-40	GRWH	0	3	1	4	4	436	14.1	0.56	0.281	8.5	6.41
Carmody	40-50	GRWH	0	3	< 1	2	3	463	30.1	0.33	0.458	8.8	10.62

5.2.3 Soil Disturbance Post Treatment

Push rod data was not collected from this demonstration site as the ground was too dry and hard for meaningful data to be collected post ripping. Clay lumps/clods were brought to the surface during the ripping process.

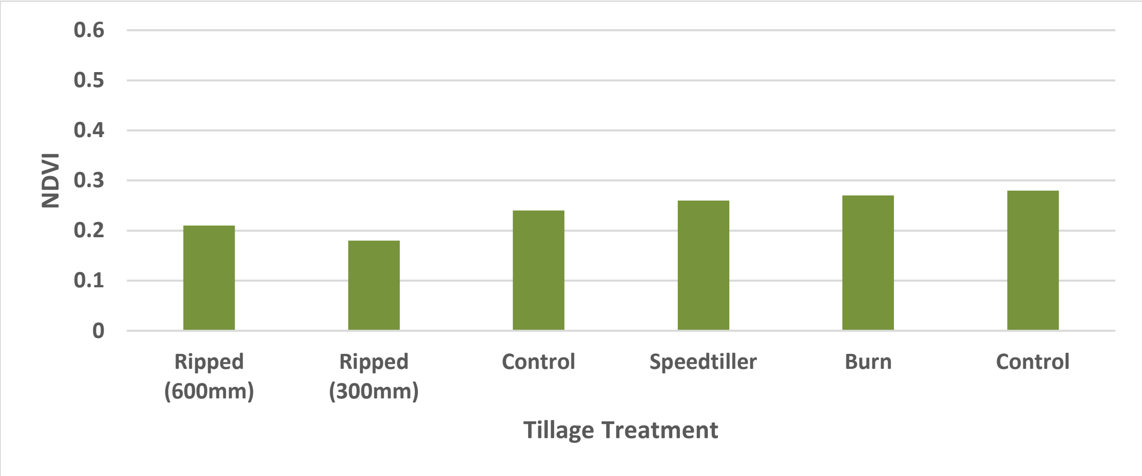
5.2.4 Plant Establishment



Cascade Tillage Treatment Plots Wheat Plant Counts, 18th July 2018

Following a dry start, plant numbers were lower and less even in the deep tilled plots when data was collected on 18th July, most likely due to the clumpy nature of the ripped clays affecting seed/soil/moisture contact. The ripping treatment did appear to dry out surface soil. Given the dry start to the season at this site, soil moisture levels were of paramount importance.

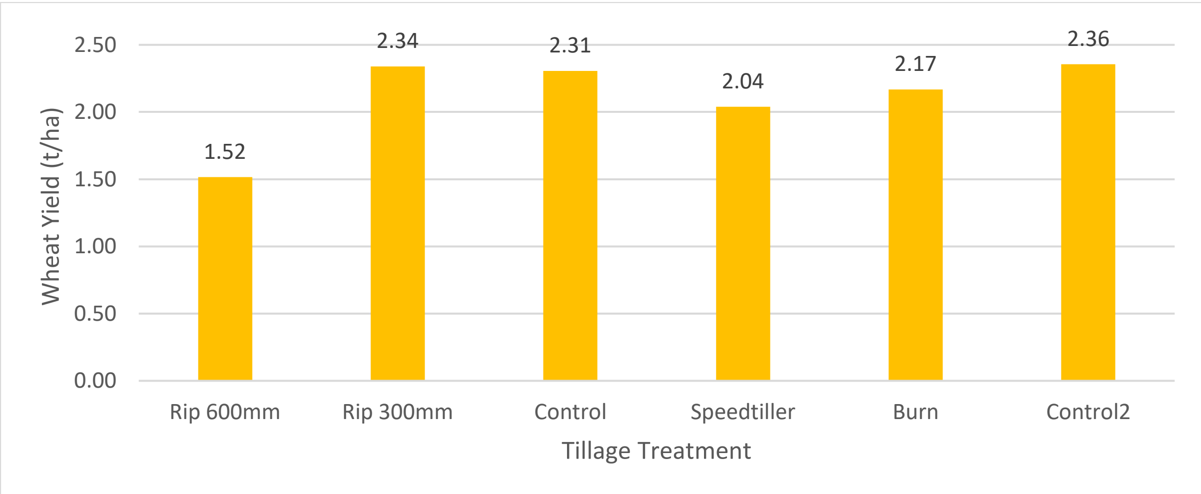
5.2.5 In-season Crop Biomass



Cascade Tillage Treatment Plots Wheat Biomass, July 2018

Early (July) wheat crop biomass data is presented above. There was minimal difference (less than 0.1) in NDVI levels recorded between each of the treatments applied.

5.2.6 Harvest Yield



Cascade Tillage Treatment Plots Wheat Harvest Yield, 2018

Wheat crop harvest yield data is presented above. The deep tillage treatment (ie rip to 600mm) resulted in the lowest yield while there was little difference between the control strips and the 300mm rip treatment. The Speedtiller (tillage to 100mm) and burn treatments resulted in yields lower than the controls suggesting stubble load management was not a significant management issue to address in 2018.

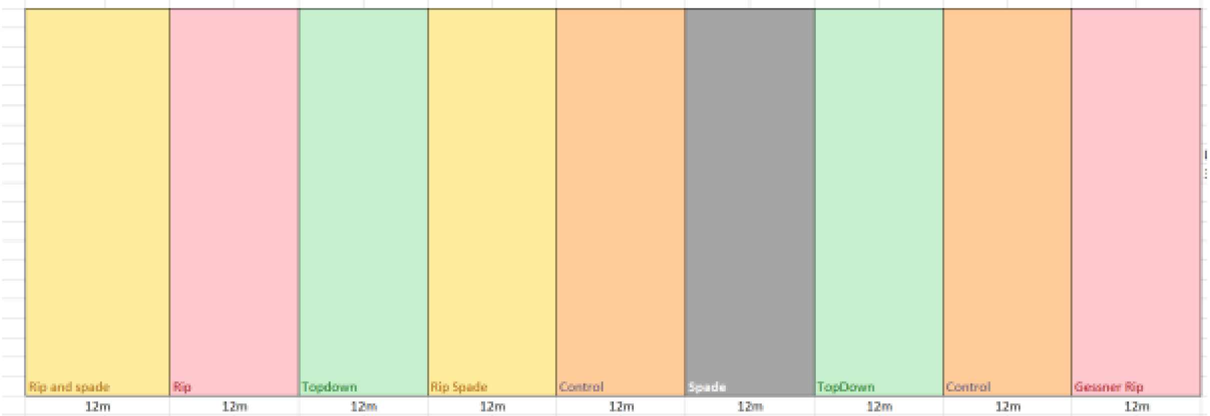
5.2.7 Gross Margin

Wheat		Control	Rip 600mm depth	Rip 300mm depth
Yield	t/ha	2.33t/ha	1.52t/ha	2.34t/ha
Average Grain Price (FIS)	$/t	$320	$320	$320
Gross Income	**$/ha**	**$746**	**$486**	**$749**
Variable Operating Costs	**$/ha**			
Seed & Treatments		$30	$30	$30
Wages Gross			$7	$7
R&M Mach./Plant/Vehicle			$17	$17
Fuel			$16	$13
Fertiliser		$100	$100	$100
Lime & Gypsum				
Herbicides, Pesticides, Fungicides		$85	$85	$85
Variable Operating Costs	**$/ha**	**$215**	**$255**	**$252**
Operating Gross Margin	**$/ha**	**$531**	**$231**	**$497**

Given the deep tillage treatments had the largest effect on yield, gross margins for these 2 treatments and the controls were calculated. The most profitable of the soil amelioration treatment strips applied to the heavy sodic clay soils present at the Cascade site was the controls to which nothing was applied, closely followed by the 'rip to 300mm' treatment. The rip to 600mm strip achieved an operating gross margin of less than half of both the control strips and the rip to 300mm treatment.

5.3 Coomalbidgup Demonstration Site

5.3.1 Soil Amelioration Treatment Regime



The Coolmalbidgup site had the following treatments applied using a 4.5m Gessner 'C' shank ripper with a crumble roller and a Vaderstad Topdown and was later sown to wheat.

- Ripped to 600mm depth & Spade
- Ripped to 600mm depth
- Vaderstad Topdown – tillage to 300mm
- Untreated control
- Spade – tillage to 300mm

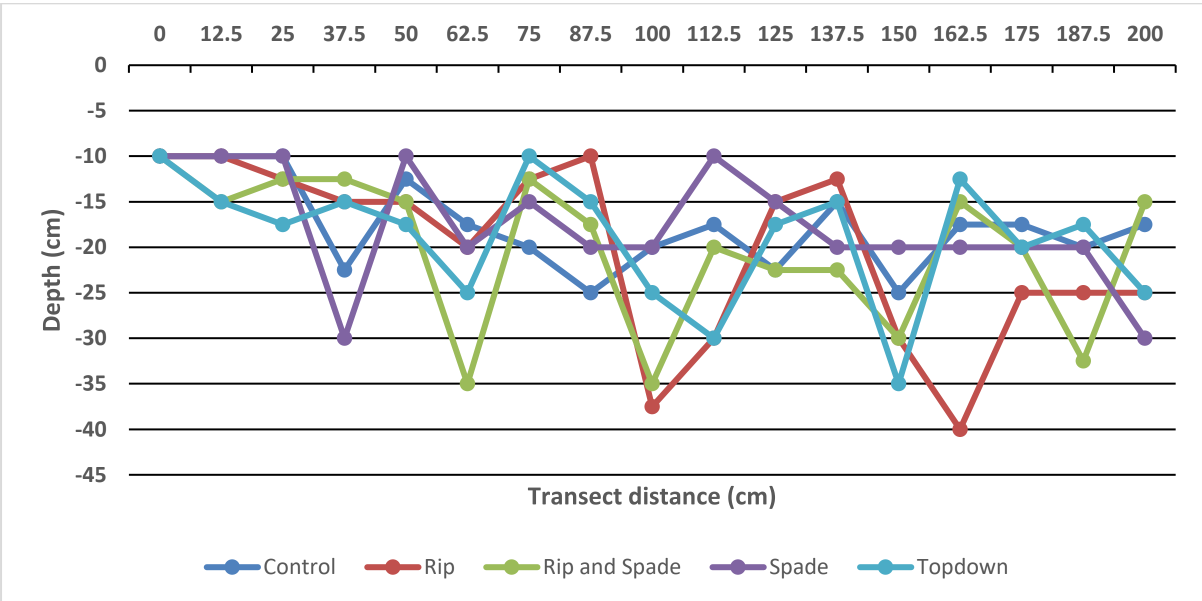
5.3.2 Soil Type

Soil at this location was a gravelly sand over an orange clay (see below), which was prone to waterlogging due to perching of water on top of a compaction layer at the top of the duplex. The gravel levels recorded from 20cm depth suggest soil at this location has quite low water and nutrient holding capacity.

Name	Depth	Colour	Gravel	Texture	NH4-N	NO3-N	Col P	Col K	S	OrgC	Cond	pH CaCl2	Boron
Curnow	0-10	GR	5	1.5	1	30	59	102	19.2	1.63	0.228	6.2	0.61
Curnow	10-20	BRGR	5	1.5	1	3	34	189	13	0.43	0.118	6.3	0.42
Curnow	20-30	GRBR	55-60	1.5	< 1	1	3	119	10.1	0.16	0.071	6.4	0.33
Curnow	30-40	GRBR	75-80	1.5	< 1	< 1	< 2	96	9.5	0.18	0.065	6.5	0.37
Curnow	40-50	GRBR	75-80	2	< 1	< 1	< 2	96	12.2	0.23	0.105	6.5	0.62

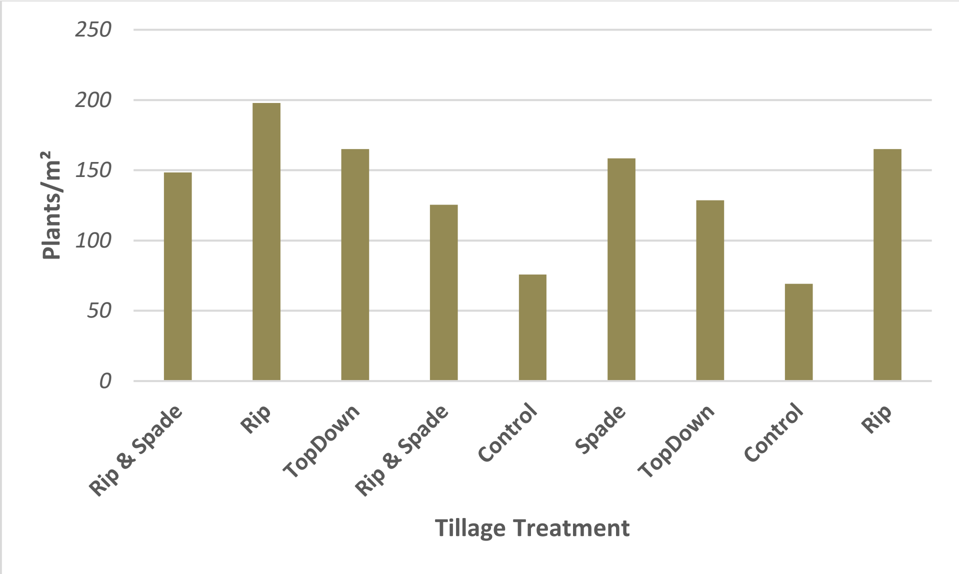
5.3.3 Soil Disturbance Post Treatment

The figure below indicates that the target depth was most likely achieved for the 300mm tillage depth treatments (ie Spader and Topdown) but that the 600mm ripping treatments achieved a depth closer to 400mm. The data does not, however, clearly illustrate where the rip line is in the transect and its highly likely that the presence of gravel in the soil affected the results collected.



Soil disturbance following application of different soil amelioration treatments at Coomalbidgup, 2018

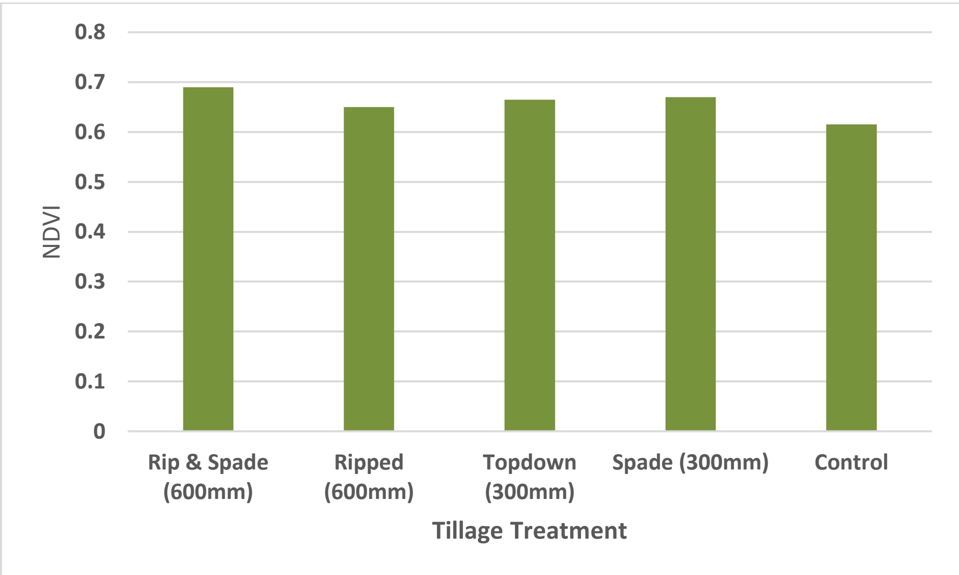
5.3.4 Plant Establishment



Coomalbidgup Tillage Treatment Plots Wheat Plant Counts, 1st June 2018

Plant establishment data collected from this site suggest that tillage to 300-400mm depth improved germination of the wheat crop (see figure above) when compared to the control strips.

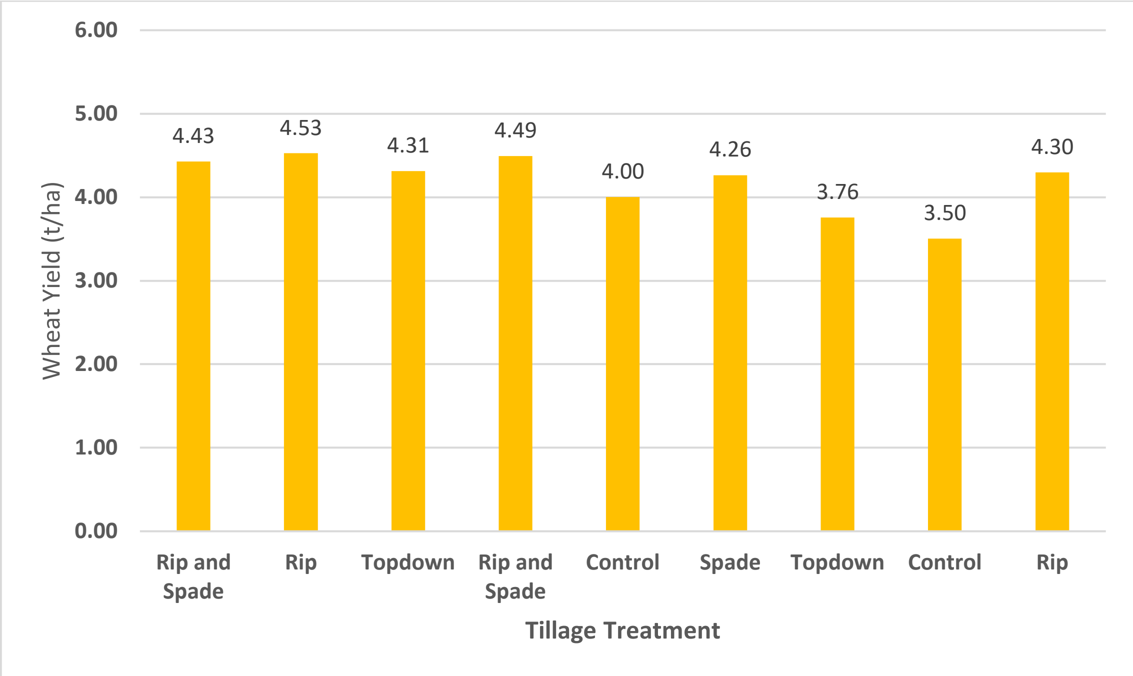
5.3.5 In-season Crop Biomass



Coomalbidgup Tillage Treatment Plots Average Wheat Biomass, July 2018

Early (July) wheat crop biomass data is presented above. There was minimal difference (less than 0.1) in NDVI levels recorded between each of the treatments applied.

5.3.6 Harvest Yield



Coolmalbidgup Tillage Treatment Plots Wheat Yields, 2018

Wheat crop harvest yield data is presented above. In 2018 tillage treatments (ie to 300-400mm depth) applied to the gravelly sand over clay soil type present at this demonstration site improved wheat crop yield by 0.28t/ha to 0.78t/ha (see figure above) when compared to the control strip average of 3.75t/ha.

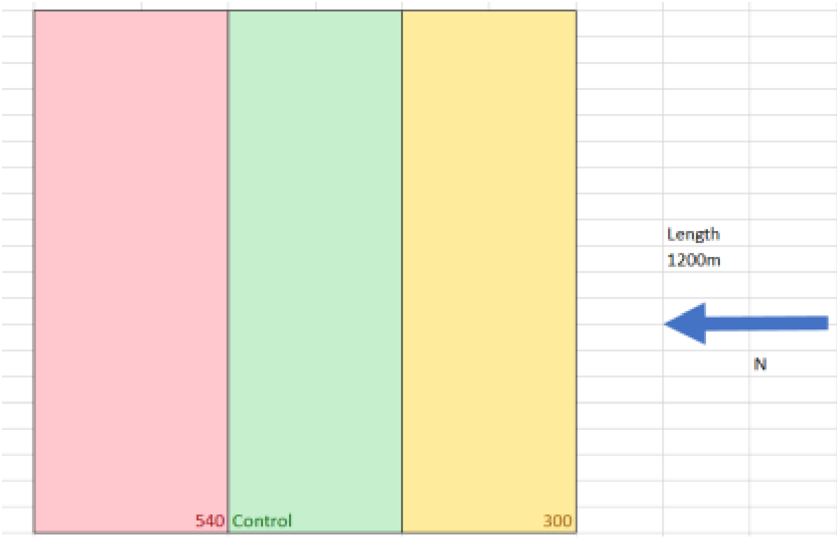
5.3.7 Gross Margin

Wheat		Control	Rip (600mm)	TopDown (300mm)	Rip & Spade (600mm)	Spade (300mm)
Yield	t/ha	3.75t/ha	4.41t/ha	4.03t/ha	4.46t/ha	4.26t/ha
Average Grain Price (FIS)	$/t	$330	$330	$330	$330	$330
Income	**$/ha**	**$1,238**	**$1,455**	**$1,330**	**$1,472**	**$1,406**
Variable Operating Costs	**$/ha**					
Seed & Treatments		$20	$20	$20	$20	$20
Wages Gross			$4	$4	$8	$4
R&M Mach./Plant/Vehicle			$15	$10	$25	$15
Fuel			$24	$24	$48	$24
Fertiliser		$120	$120	$120	$120	$120
Lime & Gypsum						
Herbicides, Pesticides, Fungicides		$120	$120	$120	$120	$120
Variable Operating Costs	**$/ha**	**$260**	**$303**	**$298**	**$341**	**$303**
Operating Gross Margin	**$/ha**	**$978**	**$1,152**	**$1,032**	**$1,131**	**$1,103**

Gross margin data (see table above) indicated that, in 2018, tillage treatments (ie to 300-400mm depth) improved wheat crop performance by between $54/ha and $174/ha.

5.4 Salmon Gums Demonstration Site

5.4.1 Soil Amelioration Treatment Regime



The Salmon Gums site had the above treatments applied with DPIRD's trial shallow leading ripper with a crumble roller and was later sown to wheat. The trial ran the length of the paddock so treatment strips were over 1km in length and 12m wide. The paddock landscape was undulating.

5.4.2 Soil Type

Soil at the site was loamy clay in the hollows and circle valley sand over clay on the rises (see photos below).

Site 1 – in a hollow

Site 2 – on a rise

Soil collected from a low-lying area at the site was mildly acidic at the surface and alkaline below 10cm depth. The pH's close to 9 recorded from this area from 30cm depth may be problematic for crop growth (see Table below).

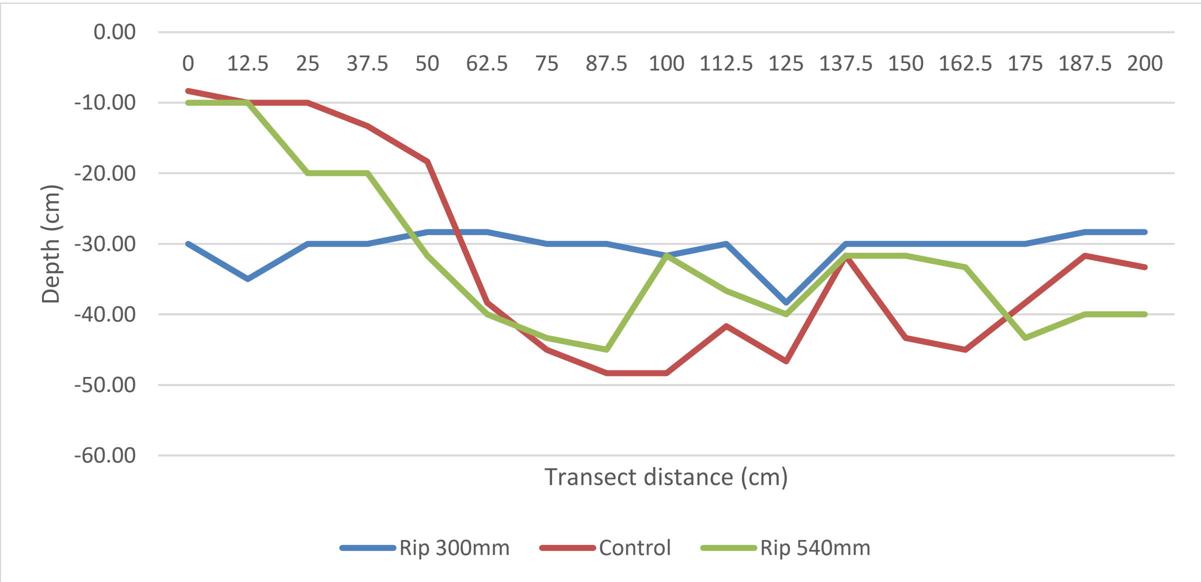
Soil from an area on a rise was mildly acidic from the surface to 30cm depth, close neutral from 30-40cm depth and then alkaline below 40cm. Soil from this area was also mildly saline at 30-40cm with salinity increasing at 40-50cm depth. Further, Potassium levels were low to marginal from the surface to 30cm depth in this sample.

Name	Depth	Colour	Gravel	Texture	NH4-N	NO3-N	Col P	Col K	S	OrgC	Cond	pH CaCl2	Boron
Starcevic 1	0-10	GRWH	0	1	< 1	22	27	112	3.6	0.48	0.09	6.1	0.64
Starcevic 1	10-20	GRYW	0	3	< 1	9	21	455	6.5	0.19	0.398	8.5	9.46
Starcevic 1	20-30	GRYW	0	2.5	< 1	12	5	614	21.4	0.18	0.55	8.8	22.28
Starcevic 1	30-40	GRYW	0	3	< 1	9	< 2	586	43.6	0.32	0.66	8.9	21.09
Starcevic 1	40-50	GRYW	5	3	< 1	7	< 2	617	70.1	0.19	0.848	8.9	20.51
Starcevic 2	0-10	GRBR	5	1.5	1	20	19	55	2.9	0.47	0.06	5	0.42
Starcevic 2	10-20	GRBR	5	1.5	< 1	17	11	40	2.2	0.3	0.06	5.8	0.3
Starcevic 2	20-30	GRYW	0	1	< 1	10	5	38	1.7	0.16	0.042	6.5	0.29
Starcevic 2	30-40	GRYW	0	3	< 1	3	< 2	226	3.4	0.15	0.101	7.6	2.78
Starcevic 2	40-50	YWGR	0	3	< 1	4	2	302	6.5	0.14	0.298	8.6	4.94

5.4.3 Soil Disturbance Post Treatment

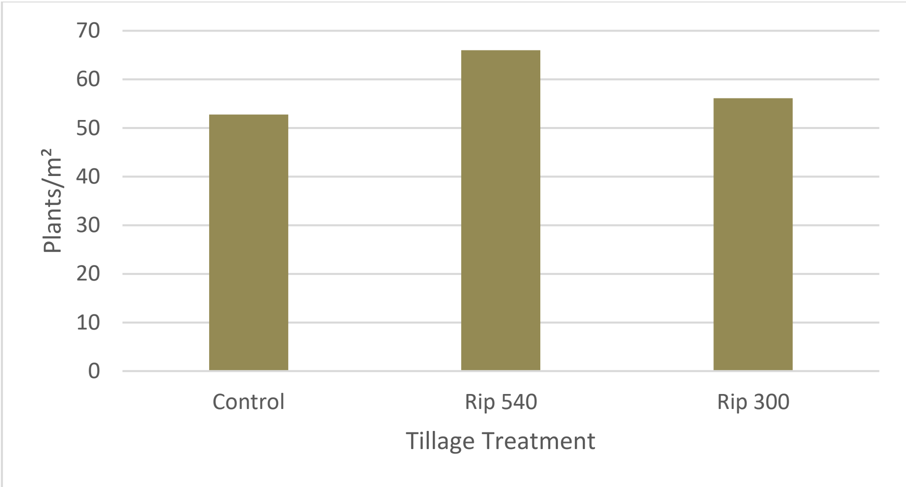
The figure below is difficult to interpret given the data collected from the control treatment strip suggests that the push rod penetrated the soil to a greater depth than from the 300mm and 540mm ripping depth treatments.

The data does suggest that the 300mm ripping depth treatment did achieve this target depth and that the 540mm ripping depth treatment achieved close to 450mm depth.



Soil disturbance following ripping to 300mm and 600mm depth at Salmon Gums, 2018

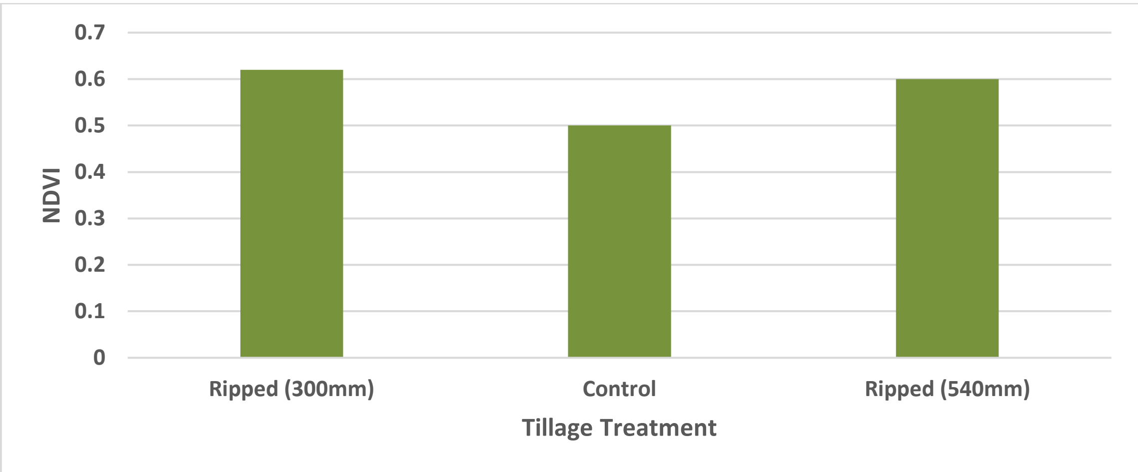
5.4.4 Plant Establishment



Salmon Gums Tillage Treatment Plots Wheat Plant Counts, 31st May 2018

Plant establishment data collected from this site suggest that tillage to 450-540mm depth improved germination of the wheat crop the most, followed by tillage to 300mm when compared to the control strip (see figure above).

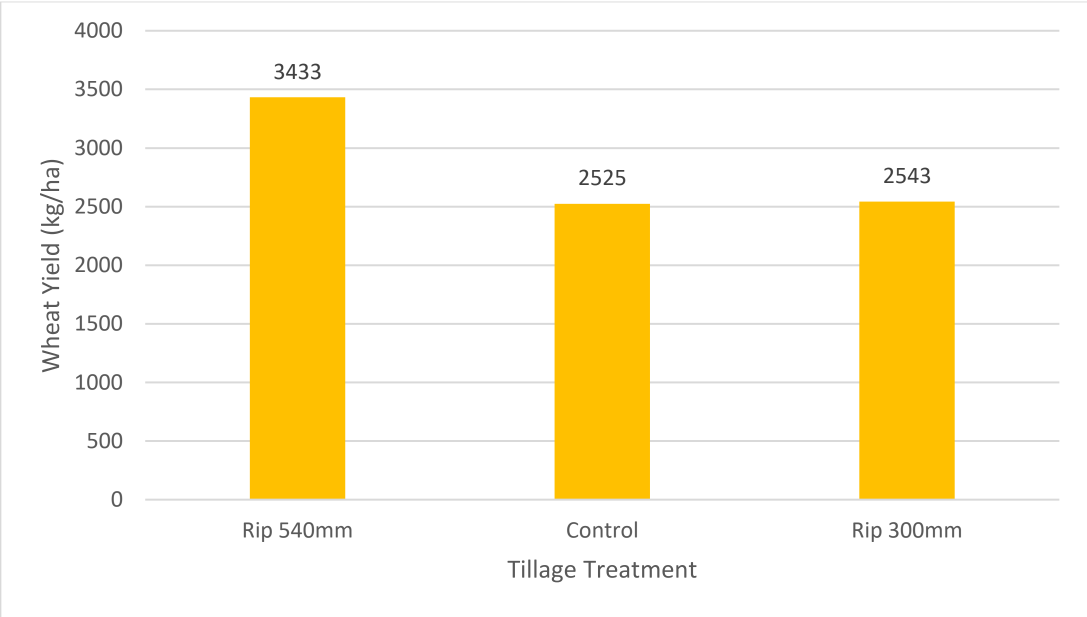
5.4.5 In-season Crop Biomass



Salmon Gums Tillage Treatment Plots Wheat Biomass, July 2018

Early (July) wheat crop biomass data is presented above. NDVI levels recorded were higher (and almost the same) in each of the 2 tillage treatments compared to the control strip (see figure above).

5.4.6 Harvest Yield



Salmon Gums Tillage Treatment Plots Wheat Yields, 2018

Wheat crop harvest yield data is presented above. In 2018 while tillage to 300mm of the loamy clay to circle valley sand over clay soils present at the Salmon Gums site did not increase yield much when compared to the control, tillage to 450-540mm improved wheat crop yield by 0.91t/ha (see figure above).

5.4.7 Gross Margin

Wheat		Control	Rip540mm depth	Rip 300mm depth
Yield	t/ha	2.52t/ha	3.43t/ha	2.54t/ha
Average Grain Price (FIS)	$/t	$380	$380	$380
Income	**$/ha**	**$958**	**$1,303**	**$965**
Variable Operating Costs	**$/ha**			
Seed & Treatments		$22	$22	$22
Wages Gross			$5	$5
R&M Mach./Plant/Vehicle			(hire)	(hire)
Fuel			$24	$24
Fertiliser		$80	$80	$80
Lime & Gypsum				
Herbicides, Pesticides, Fungicides		$56	$56	$56
Variable Operating Costs	**$/ha**	**$158**	**$187**	**$187**
Operating Gross Margin	**$/ha**	**$800**	**$1,116**	**$778**

Gross margin analysis of the Salmon Gums demonstration site (see table above) indicated that, in 2018 the deep tillage treatment (ie 450-540mm depth) improved wheat crop performance by $316/ha. Tillage to 300mm depth reduced wheat crop performance by $22/ha.

5.5 Neridup Demonstration Site

5.5.1 Soil Amelioration Treatment Regime

The purpose of this trial was to determine the effects of deep tillage in a high rainfall environment on a soil type susceptible to waterlogging. The site is generally leaching in the top 30cm and may or may not suffer from compaction from previous owners running stock quite intensively. Alleviation of waterlogging and soil compaction were the main goals on this soil type and potentially lifting topsoil pH through incorporation and mixing of deeper soils with higher pH levels.

The following treatments were applied using a Nufab ripper and/or a Vaderstad Topdown to the Neridup demonstration site and later the site was sown to Canola:

- ripped to 600mm
- ripped to 600mm and Vaderstad Topdown
- Control
- Vaderstad Topdown – tillage to 300mm

5.5.2 Soil Type

The trial site was located in an area prone to waterlogging and the soil type consisted of a sandy gravel over clay. pH was acidic from the surface to 20cm depth and then close to neutral from 20-50cm depth (see table below).

Name	Depth	Colour	Gravel	Texture	NH4-N	NO3-N	Col P	Col K	S	OrgC	Cond	pH CaCl2	Boron
Reichstein	0-10	GR	5	1	< 1	23	33	59	7.3	1.02	0.098	5.9	0.51
Reichstein	10-20	LTGR	5	1	< 1	4	27	44	6.8	0.28	0.048	6.6	0.25
Reichstein	20-30	LTGR	75-80	1	< 1	1	13	87	21.9	0.17	0.064	7.3	0.34
Reichstein	30-40	BRGR	75-80	1	< 1	2	3	134	32.9	0.14	0.082	7.4	0.41
Reichstein	40-50	BRGR	75-80	1	1	2	2	159	23.2	0.18	0.106	7.5	0.65

5.5.3 Soil Disturbance Post Treatment

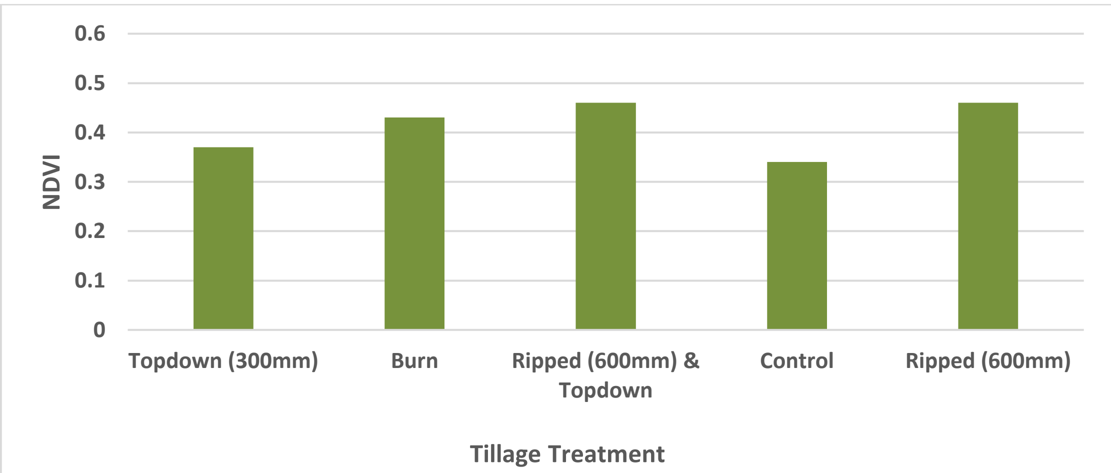
Push rod data was not collected at this site to measure the extent of subsurface soil disturbance following ripping treatments due to the gravelly sand soil type present at the site. The presence of randomly positioned, prevalent large pieces of gravel made the use of the pushrod along a transect in each treatment inaccurate.

5.5.4 Plant Establishment

Plant establishment numbers were not collected at the Neridup site. Due to the dry start, germination was staggered and patchy which made the random selection of meter stick measuring sites inaccurate (see photo below).

Crop Establishment, Neridup Ripper Gauge SIte, 21st May 2018

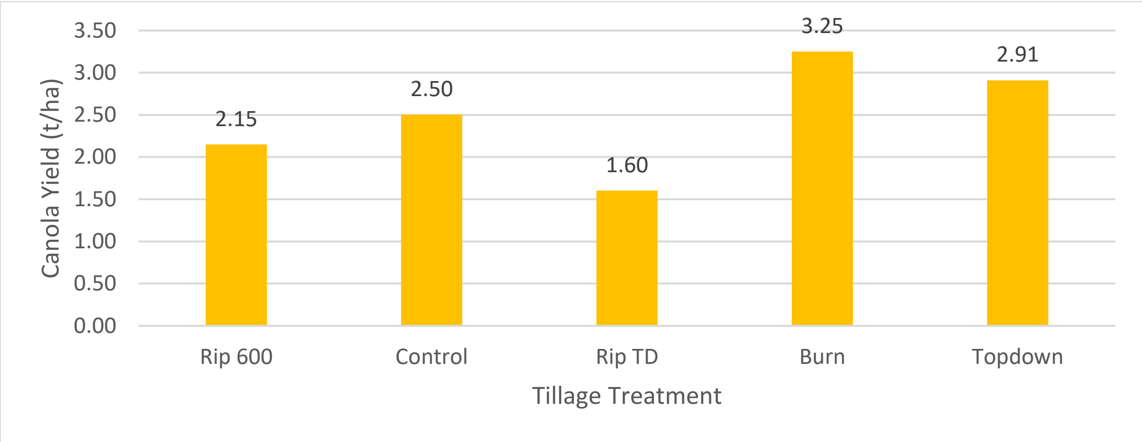
5.5.5 In-season Crop Biomass



Neridup Tillage Treatment Plots Canola Biomass, August 2018

August canola crop biomass data is presented above. NDVI levels recorded were higher (and almost the same) in each of the tillage treatments and the burn treatment when compared to the control strip (see figure above).

5.5.6 Harvest Yield



Neridup Tillage Treatment Plots Canola Yields, 2018

Canola crop harvest yield data is presented above. In 2018, tillage of the sandy gravel over clay soils present at the Neridup site to 300mm increased yield compared to the control by 0.41t/ha. Tillage to 600mm reduced canola crop yield by 0.35t/ha when just ripped and by 0.9t/ha when exposed to ripping to 600mm combined with a Topdown (see figure above).

The burn strip, which had no tillage applied but was burnt to reduce stubble load had the highest yield recorded suggesting that stubble load reduction was more of a priority management factor is the conditions presented at this site in 2018 than tillage. Rainfall was not high in 2018 and waterlogging was not extensive, the results may have been different if it was a year in which waterlogging was more prevalent.

5.5.7 Gross Margin

Canola		Control	Rip 600mm depth	Rip & TopDown	TopDown
Yield	t/ha	2.5t/ha	2.15t/ha	1.6t/ha	2.91t/ha
Average Grain Price (FIS)	$/t	$550	$550	$550	$550
Gross Income	**$/ha**	**$1,375**	**$1,183**	**$880**	**$1,601**
Variable Operating Costs	**$/ha**				
Seed & Treatments		$22	$22	$22	$22
Wages Gross			$5	$10	$5
R&M Mach./Plant/Vehicle			$20	$40	$20
Fuel			$22	$37	$22
Fertiliser		$98	$98	$98	$98
Lime & Gypsum					
Herbicides, Pesticides, Fungicides		$103	$103	$103	$103
Variable Operating Costs	**$/ha**	**$223**	**$270**	**$310**	**$270**
Operating Gross Margin	**$/ha**	**$1,152**	**$913**	**$570**	**$1,331**

Gross margin analysis of the Neridup demonstration site (see table above) indicated that in 2018 tillage treatment to 300mm depth improved canola crop performance by $179/ha. Tillage to 600mm depth reduced canola crop performance by $239/ha when only ripped and by $582/ha when ripping was combined with use of a Topdown.

CONCLUSIONS

While all sites will be monitored for the next two years as part of the GRDC Ripper Gauge project there are several points that can be drawn from each trial site from 2018, remembering that each trial location experienced varying rainfall conditions and had different soil types.

Site 1 – Dunn Rock: While early season dry conditions were challenging and total growing season rainfall was low the deep tillage treatments applied were an effective means of increasing yield in year one.

All of the ripping treatments applied to the sandy gravel over clay soil at this site (ie inclusion plates (300mm depth), rip to 300mm and rip to 540mm) resulted in higher yields than the un-ripped control strips and the un-ripped lime treatment strip. The addition of lime to address surface acidity without the addition of a ripping treatment did not increase yield when compared to the control strips.

Once input costs were factored in, the most profitable of the treatments applied was the 'rip to 540mm' treatment (remembering push rod testing suggests the depth achieved was more likely 410mm), then the 'lime, rip to 300mm and inclusion plates' treatment, closely followed by the 'rip to 300mm and inclusion plate treatment', then the 'rip to 300mm depth', then the control strips and lastly the 'lime (with no ripping)' treatment.

Site 2 - Cascade: The goal of this trial on the heavy sodic soils present at the Cascade site was to investigate the positive or negative effects of deep tillage in an area where not much ripping trial work has been previously conducted.

The results collected in 2018 suggest that while doing nothing resulted in the most profitable of the treatments applied, deep tillage to 300mm was the most beneficial of the tillage treatment applied in year one. It remains to be seen whether this treatment will prove to be beneficial when compared to the control strips in subsequent years and if the deepest tillage treatment (600mm) will prove to be beneficial also. The Speedtiller (tillage to 100mm) and burn treatments resulted in yields lower than the controls suggesting stubble load management was not a significant management issue to address in 2018.

In terms of gross margin the most profitable of the soil amelioration treatment strips applied was the controls to which nothing was applied, closely followed by the 'rip to 300mm' treatment. The rip to 600mm strip achieved an operating gross margin of less than half of both the control strips and the rip to 300mm treatment.

Site 3 - Coolmalbidgup: Germination at this site was probably the most even of all of the Esperance Port Zone Ripper Gauge sites in 2018, with each plot germinating relatively evenly. While the mixing effect of the TopDown achieved a gain of 0.28t/ha when compared to the control strips, gains in yield in these treatment strips were not as large as the effects of deep ripping, spading or a combination on the gravelly sand over clay soil type present at this demonstration site. The latter tillage treatments improved wheat crop yield by 0.51t/ha to 0.78t/ha when compared to the control strip average of 3.75t/ha.

Gross margin analysis indicated that, in 2018, the tillage treatments (ie to 300-400mm depth) applied to the Coomalbidgup demonstration site improved wheat crop performance by between $54/ha and $174/ha.

Site 4 – Salmon Gums: Deep ripping has had a limited uptake in the Salmon Gums area, which has largely to do with the seasonal risks of growing a winter crop. Increased investment in this area means that more is at risk each season, and there is a belief that deep ripping in this area can exacerbate subsoil constraints by mixing toxic subsoils through the soil profile.

Results collected in 2018 from the loamy clay to circle valley sand over clay soils of the trial site showed an increase in crop yield of almost 0.91t/ha from ripping to 450-540mm depth. While both the control and shallow deep ripping (ie to 300mm depth) treatments yielded 2.5t/ha of wheat, the deepest tillage treatment yielded approximately 3.4t.

Gross margin analysis of the Salmon Gums demonstration site indicated that the deepest tillage treatment (ie 450-540mm depth) improved wheat crop performance by $316/ha. Tillage to 300mm depth reduced wheat crop performance by $22/ha when compared to the control.

Site 5 - Neridup: The purpose of this trial was to determine the effects of deep tillage in a high rainfall environment on a soil type susceptible to waterlogging. The site is generally leaching in the top 30cm and may suffer from compaction from previous owners running stock. Alleviation of waterlogging and soil compaction were the main goals on this soil type and potentially lifting topsoil pH through incorporation and mixing of deeper soils with higher pH levels.

In 2018, tillage of the site's sandy gravel over clay soils to 300mm increased canola yield compared to the control by 0.41t/ha. Tillage to 600mm reduced canola crop yield by 0.35t/ha when just ripped and by 0.9t/ha when exposed to ripping to 600mm combined with a Topdown.

Gross margin analysis indicated that tillage treatment to 300mm depth improved canola crop performance by $179/ha while tillage to 600mm depth reduced canola crop performance by $239/ha when only ripped and by $582/ha when ripping was combined with use of a Topdown.

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Appendices

Appendix 1 – Communication Activities

1. Communication and Extension Plan – completed 30/5/18

2. SEPWA Newsletter Articles

a) April '18 Edition – "GRDC Projects on the Move"

b) August '18 Edition – "Ripping and Dry Conditions Impact Trial Site Germinations"

c) October '18 Edition – "Weighing up Deep Ripping Pros and Cons"

d) October '18 Edition – "Curnow's Delve in to Deep Ripping"

3. Demonstration Site Visits

a) 18/9/18 - RAIN Field Day (40 attendees)
The Ravensthorpe Ripper Gauge Site was visited during this field walk. Discussion at the site centred on the importance of trialling soil amelioration methods and fully understanding your soils before applying your preferred method to your farm on a larger scale

b) 19/9/18 - North Mallee Field Day (35 attendees)
The Salmon Gums Ripper Gauge Site was visited during this field walk. Discussion centred on ripper options for soil types prevalent in this part of the port zone, soil type responsiveness to ripping seen to date (based on previous DPIRD research and experience) and potential subsoil constraints that may be brought to the surface by ripping.

c) 20/9/18 - Cascade Field Day (45 attendees)
The Coolmalbidgup and Cascade Ripper Gauge Sites were visited during this field walk. Discussion centred on the ripping equipment used at each of the sites and the suitability of the prevalent soil types to ripping. A positive crop establishment response was evident at the Coolmalbidgup site but not the Cascade site.

4. Speaking Events

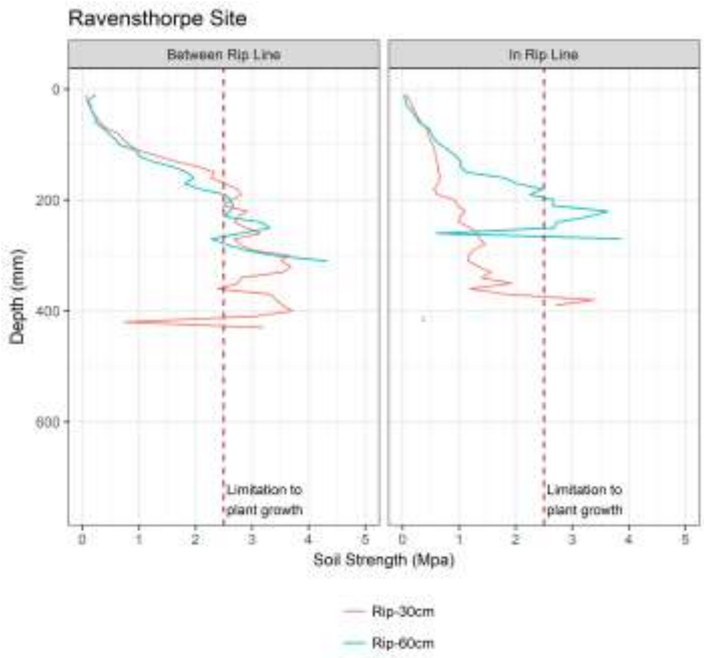
a) 23rd/24th July '18 – GRDC RCSN Open Forums; Dunn Rock, Munglinup and Condingup

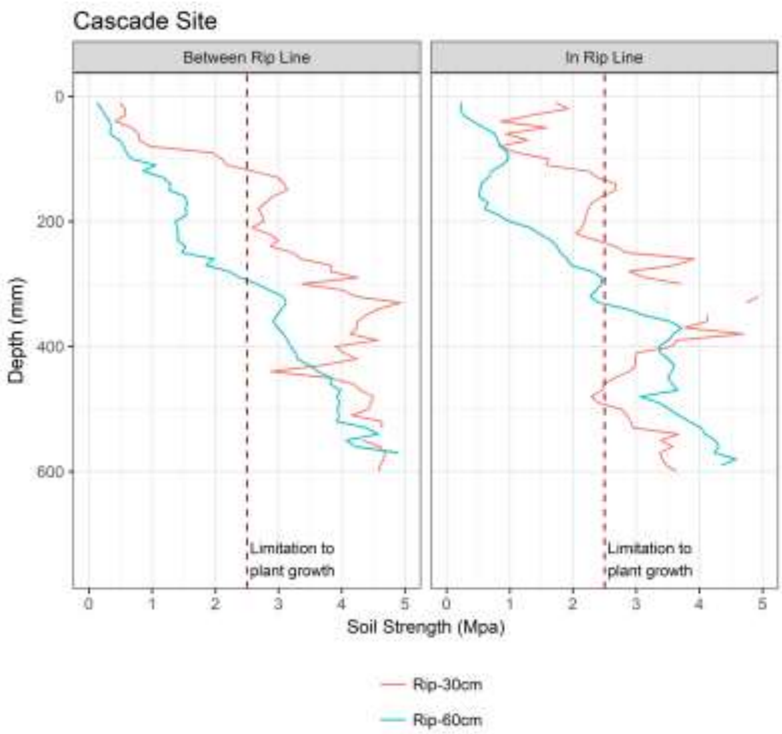
b) 15/2/19 - Harvest Review (110 attendees) – Ravensthorpe trial data was presented

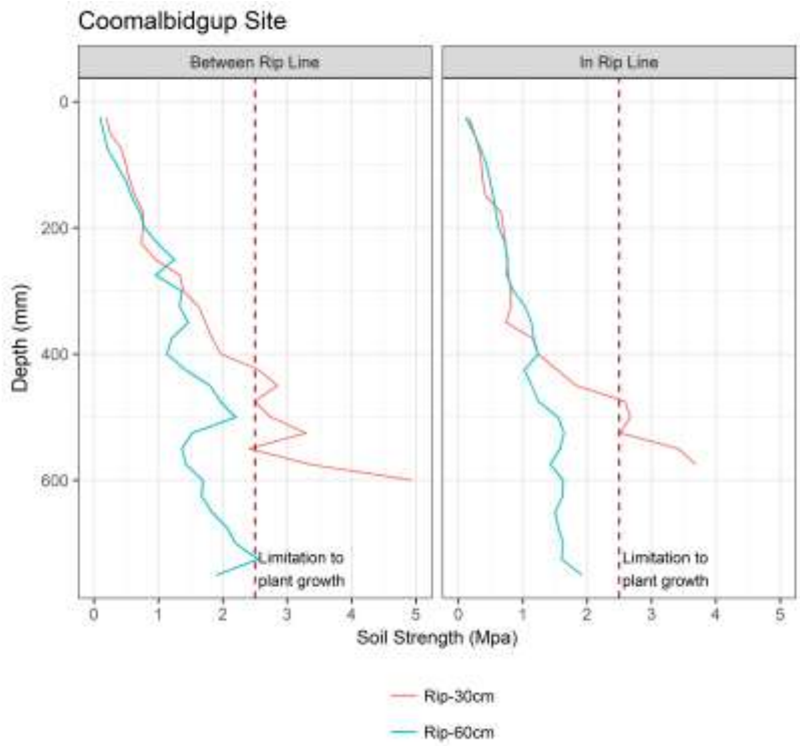
c) 20/3/19 – North Mallee Updates (35 attendees) – Salmon Gums trial data was presented

Appendix 2 - Soil Strength Data

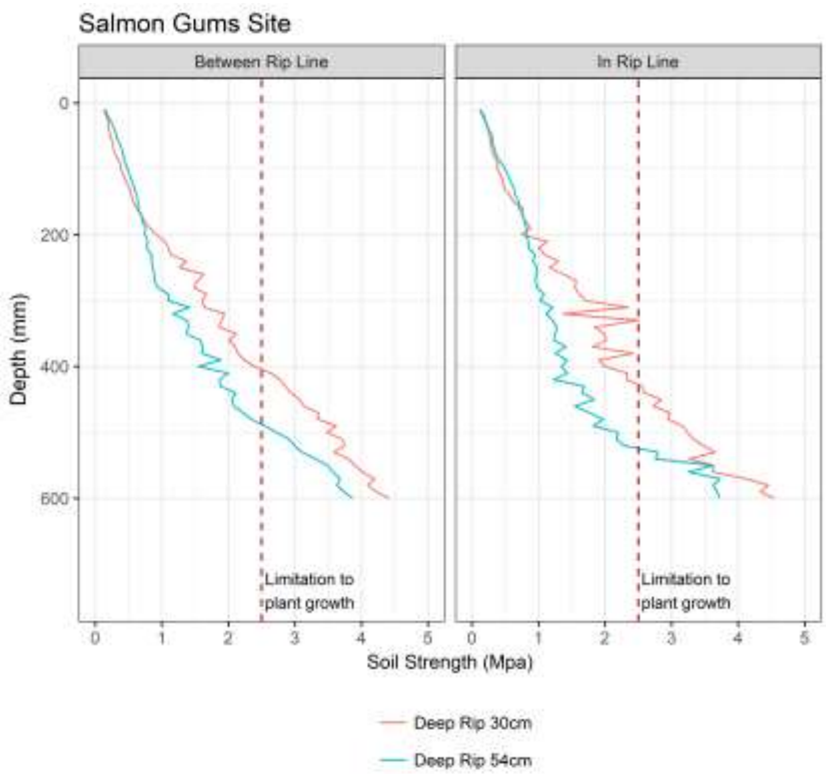
(not at field capacity as rainfall was too low in 2018 to reach field capacity)



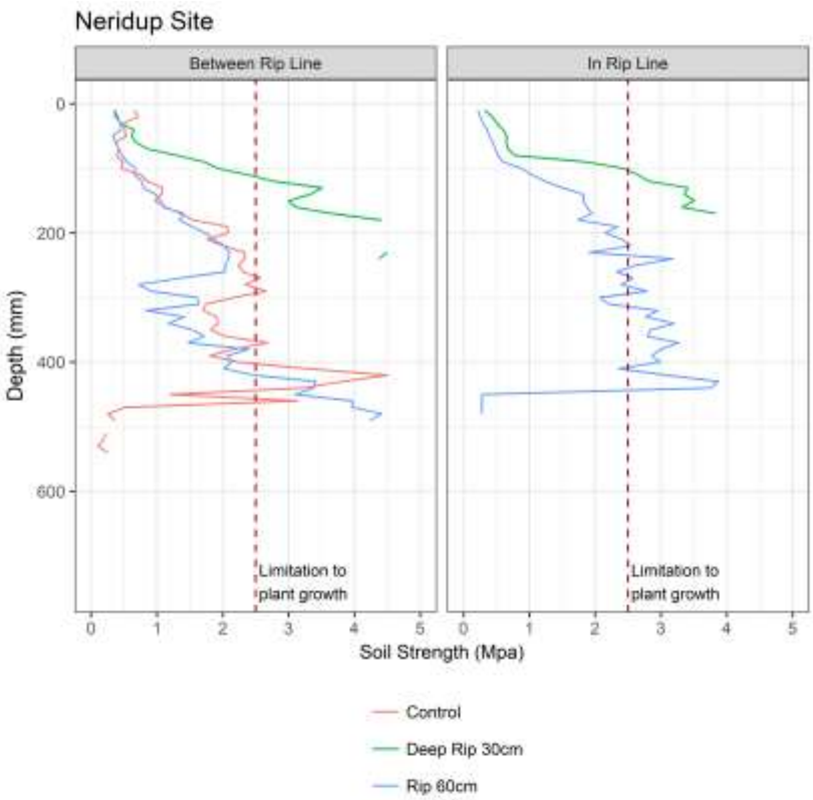




Coomalbidgup Site
Between Rip Line
In Rip Line
Depth (mm)
Limitation to plant growth
Soil Strength (Mpa)
Rip-30cm
Rip-60cm



Salmon Gums Site
Between Rip Line
In Rip Line
Depth (mm)
Limitation to plant growth
Soil Strength (Mpa)
Deep Rip 30cm
Deep Rip 54cm


Neridup Site
Between Rip Line
In Rip Line
Depth (mm)
0
200
400
600
Limitation to
plant growth
Limitation to
plant growth
0 1 2 3 4 5
0 1 2 3 4 5
Soil Strength (Mpa)
Control
Deep Rip 30cm
Rip 60cm