Deep ripper tine spacing for increased profitability

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Key messages

- Irrespective of tine spacing, topsoil slotting plates provided additional yield response over ‘unplated’ tines when deep ripping a sodic clay loam.
- Yield response from 100cm tine spacing must be at least 60% of the yield response from 50cm tine spacing to provide economic return in year one (see assumptions in economic analysis) on a yellow sand.

Aims

To evaluate the feasibility of increasing tine spacing, and using topsoil slotting plates and winged points, when deep ripping to depths below 400mm in sand and clay loam soils.

Method

A 3.5m deep ripper, developed by DAFWA for experimental purposes, was used to investigate ripping to depths greater than 400mm, a depth where compaction is now an issue. The deep ripper has shallow leading parabolic tines, as used on a Grizzly Deep Digger®, and deeper following tines with the ability to rip to 600mm. This configuration allows greater penetration depth with less draft and reduced soil cloddiness. Topsoil inclusion plates were attached to the rear, deeper tines for incorporation of topsoil to depth behind the tine.

Table 1. Summary of site and treatments applied at Binnu and Dalwallinu

Site information	Dalwallinu	Binnu
GPS	-30.204642, 116.672766	-27.990334, 114.842002
Tine spacing	50, 100	50, 100
Topsoil slotting plates	plus, minus	plus
Tine point width (mm)	90	90, 180
Depth of ripping (mm)	500, Nil	450, Nil
Soil type	clay loam, gravel	yellow sandplain high, medium, low productivity within trial area
Plot size	3.5m x 500m	12m x 500m, within these 12x50m plots were selected from respective production zones
Crop, rainfall	Mace, approx. 235mm (Dalwallinu weather station)	Mace, approx. 295mm (Binnu weather station)

Results

Dalwallinu

Table 2. Soil analysis to depth from clay loam soil

Depth cm	Conductivity dS/m	Exc. Sodium Meq/100g	Exc. Sodium (%)	pH Level (CaCl2)	Organic Carbon (%)
0-10	0.040	0.17	2.05	6.1	0.62
10-20	0.051	0.32	3.24	6.0	0.79
20-30	0.064	2.36	10.9	7.4	0.23
30-40	0.068	2.89	13.21	7.4	0.22
40-50	0.055	2.81	16.13	7.5	0.20

50-60	0.081	2.87	18.43	7.4	0.29
60-70	0.106	2.73	20.52	7.5	0.18

The site area was large and varied in soil type across the trial, however there was sufficient replication to allow interpretation of the treatments. The eastern end of the trial has a gradient of brown loamy sand through to clay loam, while the western end has distinct boundaries between shallow gravel and clay loam. There was a measurably lower biomass in the crop at the western end where the soil was more gravelly compared to the clay loam soil at the eastern end. Due to this, the western and eastern ends of the trial were analysed separately. No soil analysis was completed for the gravel soil.

Table 3: Grain yield (t/ha) at Dalwallinu

Clay loam		**Yield (t/ha)**			
Tine spacing (cm)	Topsoil slotting plates	Depth (mm)			
		300	500	nil	
-	Nil			1.98[a]	***LSD: 059 (90%)***
50	Minus	2.35[ab]	2.64[b]		***P value: 088***
	Plus		3.2[c]		***%CV: 6.4***
100	Minus		2.3[b]		
	Plus		2.8[bc]		
Gravel					
-	Nil			1.36	***LSD: NS***
50	Minus	1.11	1.4		***P value: -***
	Plus		1.13		***%CV: 32***
100	Minus		0.61		
	Plus		0.78		

Deep ripping the clay loam increased yield by 0.37 – 0.66 t/ha although there was no significant difference between row spacing or ripping depth (Table 3). Deep ripping to 500mm with topsoil slotting plates further increased yield from unripped by 1.2t/ha in 50cm and 0.8t/ha in 100cm row spacing, but the difference between row spacing was not significantly different.

There was no yield benefit evident to ripping the gravel soil, but this was likely due to the large variation in the data (CV: 32%). It is also likely that low plant establishment in the 100cm, with plates, reduced yield potential of this ripping treatment. Further, the gravel soil has a number of constraints that may be limiting yield more than compaction and therefore are a higher priority for amelioration.

The clay loam soil is sodic at depth and exchangeable sodium increases rapidly from 2% at the surface to 10% at 20-30cm, and 20% at 60-70cm. Therefore, deep ripping can create more hostile soil conditions for plant growth and may not improve yield potential. However, the addition of topsoil slotting plates may incorporate sufficient organic matter to improve sodicity and yield reponse. Similar results to ripping with topsoil slotting plates were observed at Beacon in 2015 in a Morrel soil (Blackwell et al 2016). Further soil testing is required to confirm the effect of topsoil slotting plates on exchangeable sodium.

Binnu

Irrespective of tine spacing and soil type, yield was increased by deep ripping with topsoil inclusion plates below 400mm. The yield response of ripping at 50cm is greater than that at 100cm with standard 90mm points in all three soil types (Figure 1). When comparing within 100cm spacing, winged points appears to increase yield when ripping at 100cm, though the response was not statistically significant. Yield response in the high yielding soil type ripping at 100cm, with winged points, does not significantly differ from 50cm. Other trials are needed to check this increased spacing benefit of deep ripping with plates and wings.

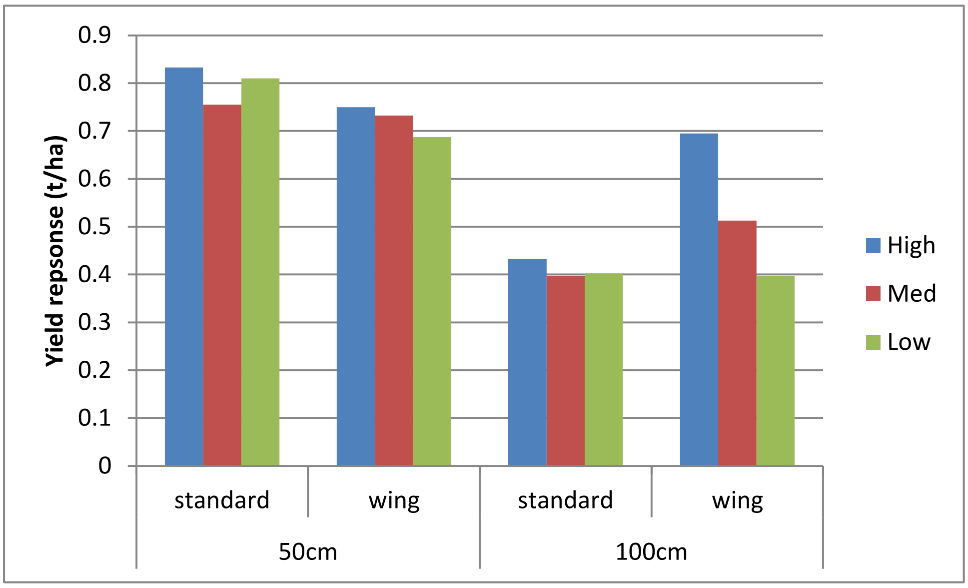

Figure 1. Yield response, (t/ha), from high, medium and low, production areas within the trial with respective ripping treatments: deep ripped to 450mm with topsoil slotting plates with standard (90mm) or wing (180mm) points.

The addition of wings to points increases breakout width and reduces the volume of un-fractured soil between tines. Increasing the width of the point increases the volume of soil lifted and then dropped by the lengthening of fracturing through the soil. At 100cm, the winged point did improve yield response, when compared to 100cm standard point, in the high and medium performing soils. Winged points did not to improve yield over narrow points using 50cm tine although volume of fractured soil was greater.

Economic Analysis

A simple economic model was developed to determine the added value to a farm business from annually ripping a greater area with wider ripper tine spacing but lower yield response, compared to a smaller area with narrower ripper tine spacing and higher yield response. The assumptions of this model included:

- the yield responses are averaged from Binnu trial observations, in the 50cm spacing at 800kg/ha and 530kg/ha with tines at 100cm
- we are able to annually rip 480ha on 50cm and 840ha on 100cm using a ripper 12m wide
- yield response to ripping declines with time, but it is not accounted for in this model (It is assumed that ripping responses remain constant for ten years and is not re-compacted by cropping traffic or natural settlement)
- machinery depreciation and fuel cost were not included in this analysis and tines with plates and wings will require more draft than tines without (these differences were not measured at this site), and
- grain price is $250/t.

The hypothetical property has 5000ha to rip, which is achieved in the sixth year of ripping when tines are at 100cm and is achieved in year 10 for the 50cm spacing. In the first year of ripping there is an additional $15,300 income ripping on 100cm row spacing (Figure 2). It is not until the ninth season of ripping, three years after completion with 100cm, that 50cm begins to provide more income to the business than 100cm. This because the yield benefit from ripping on 50cm is higher and no further ripping has taken place on 100cm since year six.

However the ripping response does decline over time depending on soil type therefore it is likely after 6 years the ripping program at 100cm will begin again. The longevity of ripping with topsoil slotting plates is being measured at six sites in WA on different soil types see paper by Parker et al in this proceedings.

A basic sensitivity analysis was conducted to consider a variation of possible yield responses given season and soil variability. An 800kg/ha yield response from 50cm requires at least a 500kg/ha response from 100cm to provide increased income to the business for 6 years. At 300kg/ha response, 50cm, a 200kg/ha response is required of 100cm ripping. In this trial the poor performing soil type did not produce a large enough response at 100cm to improve business income. These numbers indicate that the response from ripping at 100cm should be at least 60% of the yield response of ripping at 50cm, keeping in mind that this is generated from one site in one season. Further data is required to validate and enhance our predictions.

A similar positive response is developed when using the yield response data from Dalwallinu when ripping at 100cm using slotting plates. If the magnitude of this response can be replicated then it would be advisable to rip clay loams at 100cm using topsoil slotting plates.

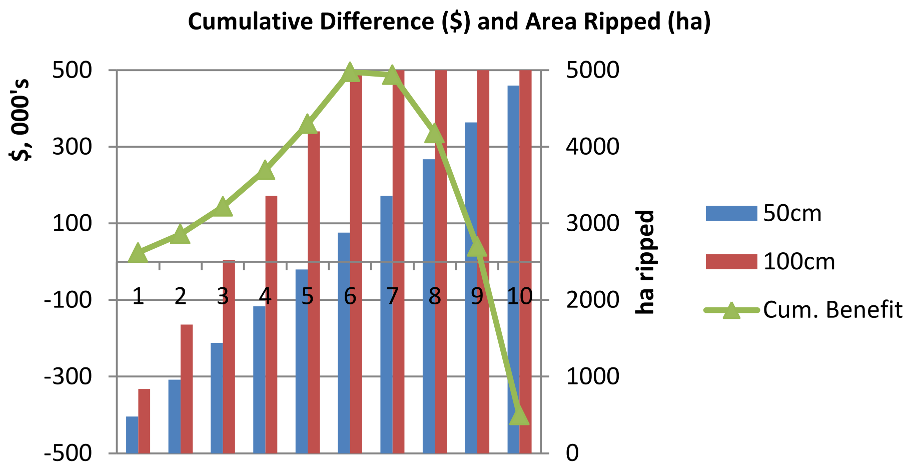

Figure 2. The cumulative benefit to the business of ripping on 100cm, 530kg/ha response, when compared to yield response on smaller area of ripping with 50cm spacing, 800kg/ha response

Table 4. Basic sensitivity analysis for annual return from ripping at 100cm, given 800, 500 or 300kg/ha response from ripping at 50cm.

	$/ha return		
50cm response	800kg	500kg	300kg
100cm response			
800	72,000		
700	51,000		
600	30,000		
500	9,000	45,000	
400	-12,000	24,000	
300	-33,000	3,000	27,000
200	-54,000	-18,000	6,000
100	-75,000	-39,000	-15,000
0	-96,000	-60,000	-36,000

Conclusion

Topsoil slotting plates continue to benefit deep ripping on sodic soils (Blackwell et al 2016). The mechanism that assists this is not fully understood, but possibly include:

1. Addition of organic matter provides a buffering capacity through adsorption of sodium ions by long chain humic acids.
2. Physical influence of the slot and furrow ridging to increase water volume in the soil directly surrounding the roots and dilute the concentration of sodium will assist plant growth (pers. comm. Mulvany 2016).

If such responses are consistent, using topsoil slotting plates will increase the return on investment in the lower rainfall, eastern wheatbelt where deep ripping does not provide a response each season.

Deep ripping at 100cm width is less effective than at 50cm spacing in clay loam and sandy soils in yield improvement. However, yield responses by deep ripping at 100 am width can be improved by topsoil slotting and use of winged points, which enable deeper ripping, efficient use of horsepower, increased hectares/hour, reduced fuel use when using the same ripping width.

Large yield responses are possible where the ripping penetrates the deeper hard pan. If this is not possible at the ripping spacing used, it is advisable to increase tine spacing or reduce the total ripping width to break below the hardpan. Growers with difficulty ripping below 400mm with 12m rippers lift tines and reduce ripping width or reduce ripping depth. It is likely that yield response will be greater where ripping gets beneath the hard pan irrespective of tine spacing (Blackwell et al 2016). Tine spacing of 100cm may assist in getting below the hard pan while still being able to pull 12m although the yield response will be lower.

Key words

Topsoil slotting, compaction, controlled traffic farming, deep ripping, clay loam, yellow sand,

References

Blackwell P, Isbister B, Riethmuller G, Barrett-Lennard E, Hall D, Lemon J, Hagan J, Ward P, (2016) Deeper ripping and topsoil slotting to overcome subsoil compaction and other constraints more economically: way to go!, Proceedings GRDC Grains Research Updates 2016, available at http://www.giwa.org.au/2016researchupdates

Acknowledgments

Thanks to growers James and Gary Butcher, Dalwallinu trial, and Piet Diepeveen and Nigel Moffat, Binnu trial, for their time and machinery used to implement and manage these trials. The efforts of the NAG and Liebe members who attended field walks and presentations was greatly appreciated and makes such trials worthwhile. Ripper points and hardfacing were provided by Mark Dawson Tuncoat The efforts of Jenni Clausen, then Liebe Group Research Officer, to record observations at appropriate times were invaluable..

Economic analysis and interpretation support by James Hagan, QAF, Toowoomba.
Detailed statistical analysis and support by Andrew Van Burgel, DAFWA Albany.

This is an activity of DAFWA's GRDC funded project DAW00243 Minimising the impact of soil compaction on crop yield.

GRDC Project Number: DAW000243

Paper reviewed by: Shahab Pathan